2004 IEEE Conference

on

Cybernetics and Intelligent Systems (CIS)
Robotics, Automation and Mechatronics (RAM)

December 1 to 3, 2004
Traders Hotel, Singapore

Final Program

Organized by

IEEE SMC Society Singapore Chapter
IEEE R&A Society Singapore Chapter

Supported by

Center for Intelligent Control, NUS
Center for Intelligent Machines, NTU
Mechatronics Group, SIMTech

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Foreword

On behalf of the Organizing Committee, it is our greatest pleasure to welcome you to *2004 IEEE Conference on Cybernetics and Intelligent Systems (CIS) and 2004 IEEE Conference on Robotics, Automation and Mechatronics (RAM)*, hosted at the Traders Hotel, Singapore, 1-3 December 2004.

The two conferences are jointly organized by IEEE R&A Society Singapore Chapter, IEEE SMC Society Singapore Chapter, and IEEE Singapore Section, and are supported by Center for Intelligent Machines of Nanyang Technological University; Center for Intelligent Control of The National University of Singapore; and Mechatronics Group of Singapore Institute of Manufacturing Technology. The joint conferences are to provide attendees to any of these conferences a consolidated proceedings volume, the opportunity to learn about new developments in closely related areas, and to bring together experts from different expertise areas and from different countries to discuss on the state-of-the-art and to present new research findings and perspectives of future developments with respect to the conference themes.

The International Program Committee has assembled a comprehensive technical program that covers a broad spectrum of topics in Automation, Cybernetics, Intelligent System, Mechatronic, and Robotics. For 2004 CIS, we received a total of 334 submissions (including invited and special sessions and contributed papers); and 251 papers have been selected for the conference proceedings, while for 2004 RAM, we received a total of 265 submissions (including invited and special sessions and contributed papers); and 210 papers have been selected for the conference proceedings. The 2004 CIS-RAM technical program begins on Wednesday (December 1), and comprises 63 sessions spanning a period of three days.

The highlights of the joint conferences include the plenary speeches given by distinguished individuals:
- Professor Tianyou Chai, China, Intelligent Decoupling Control System of Complex Industrial Process and Application,
- Professor Hidenori Kimura, Japan, Brain Motor Control and Robotics: A Control Theorist's Perspective, and
- Professor Kok-Meng Lee, USA, Machine Vision for Robotics, Automation and Mechatronics.

All participants are invited to attend the series of social functions that will be held in the lounge and function ballrooms of the hotel. The Welcome Reception will be held on Tuesday evening (November 30) at the Gallery Ballroom, Traders Hotel, and the Conference Banquet on Thursday evening (December 2) in Rasa Sentosa Resort.

Apart from attending the technical program, you are encouraged to experience the magic of the Garden City, Singapore. Located at one of the most important crossroads of the world, Singapore is truly a place where East and West come together. Singapore hosts to some of the most interesting attractions in Asia, ranging from the theme park island of Sentosa, to the wildlife preserves of the Jurong Birdpark, Singapore Zoological Gardens, the Night Safari and Wild Wetland. For a more

relaxed pace, dining and shopping adventures abound in this cosmopolitan and multicultural city-state where people of different races live in harmony happily. The well-connected mass transportation system makes getting around the island convenient and hassle-free. Singapore also serves as the jumping point to other exciting destinations in Asia.

Last, but definitely not least, we would like to express our sincere gratitude to everyone involved in making the conference a success. Many thanks go to advisory board members, the organizing committee, the plenary speakers, the special session organizers, the program committee and reviewers, the conference participants, and of course, to all the contributing authors who will be sharing the results of their research.

It is our great pleasure to have you with us at the conference, where we hope new ties are made and existing ones renewed and strengthened. With our best wishes for a wonderful and stimulating stay in Singapore,

Shuzhi Sam Ge, General Chair

Kay Chen Tan, Program Chair, CIS'2004

Danwei Wang, Program Chair, RAM'2004

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Kay Chen Tan National University of Singapore

RAM

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Advisory Committee

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International Program Committee

2004 IEEE CIS

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2004 IEEE RAM

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Pham Thouang Cat	Vietnam
Rajamani Doraiswami	Canada
Rafael Fierro	USA
Guido Herrman	UK
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Giuseppe Oriolo	Italy
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Jianbo Su	China
Fuchun Sun	China
Zengqi Sun	China
Min Tan	China
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Mohamed Zribi	Kuwait

Welcome to Singapore

Situated at one of the most important crossroads of the world, Singapore is truly a place where East and West come together. The Republic's geographical location (between latitudes 1°09'N & 1°29'N and longitudes 103°38'E & 104°05'E) has long been instrumental in Singapore's growth as an important centre in trade, tourism and communications.

CLIMATE

Singapore has a mild tropical climate throughout the year. Temperatures reach a maximum of 32-33°C during the day, falling to a pleasant 23-25°C during evening hours. Relative humidity often exceeds 90 percent at night and in early hours of the morning shortly before sunrise. On dry afternoons it is usually between 60 and 70 percent. Rainfall is most abundant during the Northeast Monsoon season from November to January. Much of the rain falls in sudden showers.

WHAT TO WEAR

The climate encourages informal dressing and few places require a jacket and tie for gentlemen. Visitors should bring the lightest of summer wear. For men, open-necked shirts and lightweight tropical slacks are ideal. For formal functions, lounge suites for gentlemen are also recommended.

Lightweight summer dresses, slacks and tops will be suitable for day wear for ladies. All hotels and shopping centres are air-conditioned, so a long sleeve shirt for men and a light wrap for ladies is advisable, especially in the evening.

POPULATION AND LANGUAGES

In Singapore, you will find Chinese, Indian, Malay and Eurasian Communities living harmoniously together, their long established cultures forming a unique backdrop to a clean and modern garden city.

There are four official languages: English, Malay, Mandarin and Tamil. English is spoken everywhere and it is the common business language of all.

TRANSPORTATION

Public transportation, including buses and the MRT (Mass Rapid Transit) system provides access for visitors to most areas of the island. You can buy a Transit-Link card, which can be used on the MRT and buses.

There are many taxis, which can be hired from the taxi stands, roadside or booking by telephone. A booking fee is usually charged when hired by telephone. There is also a surcharge for trips starting from the Changi Airport. You may wish to take the Airport Shuttle to almost all hotels within the city from Changi Airport. The operating hours and fares of the shuttle service can be obtained at the airport shuttle counters located

at the arrival hall of Changi Aiport Terminal 1 and 2. Payment is made to the driver who will accept cash, major credit cards and charge cards.

AIRPORT TAX

Tax is S$15. Coupons are available from the airport, travel agencies and some hotels.

CURRENCY

The unit of currency is the Singapore dollar. (US$1.00 = Approx. S$1.76)

CREDIT/CHARGE CARD

Credit cards are widely accepted in Singapore. Hotels, retailers, restaurants, travel agents and even some taxis readily accept international credit cards.

FOOD & SHOPPING

Singapore is the culinary capital of Southeast Asia, and eating out in Singapore is an experience few will forget. You can eat out at open-air food stalls or dine in the plushest of restaurants at world-class hotels. In terms of sheer variety, Singapore probably has no rival. Singapore's immigrant population and visitors from all over the world have brought a staggering array of cuisine and cooking skills as well as having created unique blends of their own.

Hawker centers and traditional coffee shop dishes rarely cost more than S$3 to S$4 each whereas dishes sold at food courts (air-conditioned and usually located at shopping centers are slightly more expensive). A meal and a soft drink in a fast food outlet cost S$4 to S$7, whereas restaurants can cost anything from S$10 to S$120 per person, depending upon where you dine and what you order. Tipping is not expected in any of Singapore's food or entertainment outlets. Most establishments will add to your bill a 10% service charge, a Good Services Tax (GST) of 3% and in most establishments, a 1% cess tax. Additional tipping is at your discretion.

Singapore was founded on the principle of free trade, and even today, most goods are sold duty-free. An endless range of goods from all over the world is available at prices that are often lower than those in the country of manufacture. Air-conditioned shopping complexes, department stores, emporiums and shopping arcades allow visitors to shop in comfort. Most of these places stay open till 9.30pm daily.

TRAVEL DOCUMENTS

Visitors must have passport valid for three months from the time of arrival. Visas are not required for a stay of up to 14 days for Commonwealth citizens, British passport holders and citizens of the Republic of Ireland. As regulations may change from time to time, visitors should check the latest visa requirements from the Singapore Overseas Mission in your country or may refer to the web page of Singapore Immigration at "**http://www.mha.gov.sg/sir/travel_tips/visareqs.html**".

ELECTRICITY

Singapore's voltage for electricity is 220 - 240 volts AC, 50 cycles per second.

TOURIST INFORMATION

For more information, please visit the Singapore On-Line Guide:
http://www.travel.com.sg/sog

USEFUL PHONE NUMBERS

Police	999 (no charge)
Ambulance / Fire Brigade – Emergency	995 (no charge)
Ambulance – Non-Emergency	1777
Taxi Service (24 hours)	6552-1111
	6481-1211
	6553-3880
Singapore Tourism Board (STB)	6736-6622
Website – http://www.stb.com.sg/	
Automobile Association of Singapore	6737-2444
AA Road Service (24 hours)	6748-9911
International Calls	104

Uniquely Singapore

Unique is the word that best captures **Singapore** - a dynamic, cosmopolitan city-state where different cultures, ethnic groups and religions blend harmoniously. A bridge between the East and the West for centuries, Singapore, located in the heart of fascinating Southeast Asia, continues to embrace tradition and modernity today. Brimming with unbridled energy and bursting with exciting events, the city-state offers countless unique memorable experiences waiting to be discovered. Only in Singapore can you…

- Feast around the clock and savour mouth-watering dishes not found anywhere else, with settings ranging from a cable car to a riverboat along the Singapore River….
- Get your hands on the latest buys from luxury labels or shop for basement bargains at 4am in the morning….
- Have breakfast with an orang utan, learn about the Chinese tea ceremony and watch a Broadway musical all in one day…
- Get catapulted 60 metres into the air on a reverse bungy ride or board an amphibious "duck" to explore the city…
- Dive with sharks, get up close and personal with cheetahs or enjoy a high-tea buffet 70 storeys in the air…
- Luxuriate in a garden spa a stone's throw from the best business facilities in the world…
- Take a step back in time and visit a Chinese temple, Muslim mosque, Hindu temple and Christian church all in one neighbourhood…
- Mingle with local youths along Orchard Road and pick up the latest fashion tips and amusing local catch phrases…

Singapore – truly a city like no other. With its friendly and welcoming people, state-of-the-art infrastructure and something new happening every day, Singapore is so easy to appreciate. Come and discover countless unique experiences, and take away memories that are uniquely Singapore.

General Information on Conference

Conference Venue:

Traders Hotel Singapore
1A Cuscaden Road,
Singapore 249716

Language

The conference and all its activities will be conducted in English.

Conference Secretariat

CIS-RAM 2004
c/o Integrated Meetings Specialist Pte Ltd
1122A Serangoon Road
Singapore 328206
Tel: (65) 6295 5790
Fax: (65) 6295 5792

Registration Fees

Advanced Registration (Before Sept 15, 2004)		On-Site Registration (After Sept 15, 2004)	
Category	SGD	Category	SGD
IEEE Member	630.00	IEEE Member	700.00
Non-Member	700.00	Non-Member	770.00
Reduced Rate	350.00	Reduced Rate	420.00

- Full conference registration fee includes the CD-ROM proceedings, coffee breaks, buffet lunches, and conference banquet.
- The reduced registration fee includes the CD-ROM proceedings and coffee breaks

Welcome Reception & Pre-conference registration:

Date: 30th November 2004
Time: 18:00 – 20:00hrs
Venue: Traders Hotel (The Gallery), Level 2
Registration: Traders Hotel (The Gallery), Level 2
* Cocktail Reception would be provided at the reception.

Conference Registration:

Date: 1st – 3rd December 2004
Time: 08:00 – 17:00hrs
Venue: Traders Hotel (Bencoolen Room – Conference Secretariat Room), Level 2

Conference Banquet (For delegates only):

Date: 2nd December 2004
Time: 1900 – 2300 hrs
Venue: Shangri-La's Rasa Sentosa Resort (101 Siloso Road,Sentosa, Singapore098970)

Transport would be provided to the banquet venue. The pickup point will be at Traders Hotel and the bus will leave at 1815 hrs.

Return trip to the official hotel, Traders Hotel will be provided as well. The bus will leave from Shangri-La's Rasa Sentosa Resort (Pickup point: Main Entrance) at 2230hrs.

Additional conference banquet can purchase the banquet ticket from the registration counter. Tickets are priced at SGD 75.00 each.

Conference Programme Schedule

Wednesday, 1 December 2004

08:00	Registration
08:15 – 08:30	Opening Ceremony
08:30 - 09:30	Keynote Address 1
09:30 - 10:00	Coffee Break
10:00 – 12:00	Morning Technical Sessions
12:00 – 13:00	Lunch
13:00 – 15:20	Mid-day Technical Sessions
15:20 – 15:50	Coffee Break
15:50 – 17:50	Afternoon Technical Sessions

Thursday, 2 December 2004

08:00	Registration
08:30 - 09:30	Keynote Address 2
09:30 - 10:00	Coffee Break
10:00 – 12:00	Morning Technical Sessions
12:00 – 13:00	Lunch
13:00 – 15:20	Mid-day Technical Sessions
15:20 – 15:50	Coffee Break
15:50 – 17:30	Afternoon Technical Sessions
19:00 – 23:00	Conference Banquet

Friday, 3 December 2004

08:00	Registration
08:30 - 09:30	Keynote Address 3
09:30 - 10:00	Coffee Break
10:00 – 12:00	Morning Technical Sessions
12:00 – 13:00	Lunch
13:00 – 15:20	Mid-day Technical Sessions
15:20 – 15:50	Coffee Break
15:50 – 17:50	Afternoon Technical Sessions

2004 IEEE CIS/RAM Technical Program
Wednesday, December 1, 2004

Track	1	2	3	4	5	6	7	8	9
Room	Temasek 1	Temasek 2	Temasek 3	Temasek 4	Penang 1	Penang 2	Malacca 2	Level 2a Foyer	Level 2a Foyer
8:15-9:30	**The Gallery** **Opening Ceremony + Keynote 1: Intelligent Decoupling Control System of Complex Industrial Process and Application** **Professor Tianyou Chai, Northeastern University, China**								
9:30-10:00	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break
WA 10:00-12:00	**(RAM)** **Teleoperation and web-based robotics**	**(RAM)** **Robotics in dynamic environment**	**(RAM)** **Parallel Mechanisms (INV)**	**(RAM)** **Humanoid robots (INV)**	**(CIS)** **Adaptive Computing**	**(CIS)** **Computer Vision I**	**(CIS)** **Data Mining and Management I**	**(RAM)** **Poster Session 1**	**(CIS)** **Poster Session 3**
12:00-13:00	Lunch at The Gallery (Level 2)								
WM 13:00-15:20	**(RAM)** **Medical Robotics (INV)**	**(RAM)** **Vision and control for mobile robots**	**(RAM)** **Manufacturing systems**	**(RAM)** **Actuators and joints**	**(CIS)** **Agents**	**(CIS)** **Computer Vision II**	**(CIS)** **Automation and Robotics in Biomolecular Computing (INV)**	**(RAM)** **Poster Session 2**	**(CIS)** **Poster Session 4**
15:20-15:50	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break
WP 15:50-17:50	**(RAM)** **Micro-Manipulator components and systems (INV)**	**(RAM)** **Sensing and measurement**	**(RAM)** **Control design for robot systems**	**(RAM)** **Data fusion and vision image**	**(CIS)** **Computational Intelligence**	**(CIS)** **Pattern Recognition**	**(CIS)** **Advances In Intelligent Data Processing (INV)**		

2004 IEEE CIS/RAM Technical Program
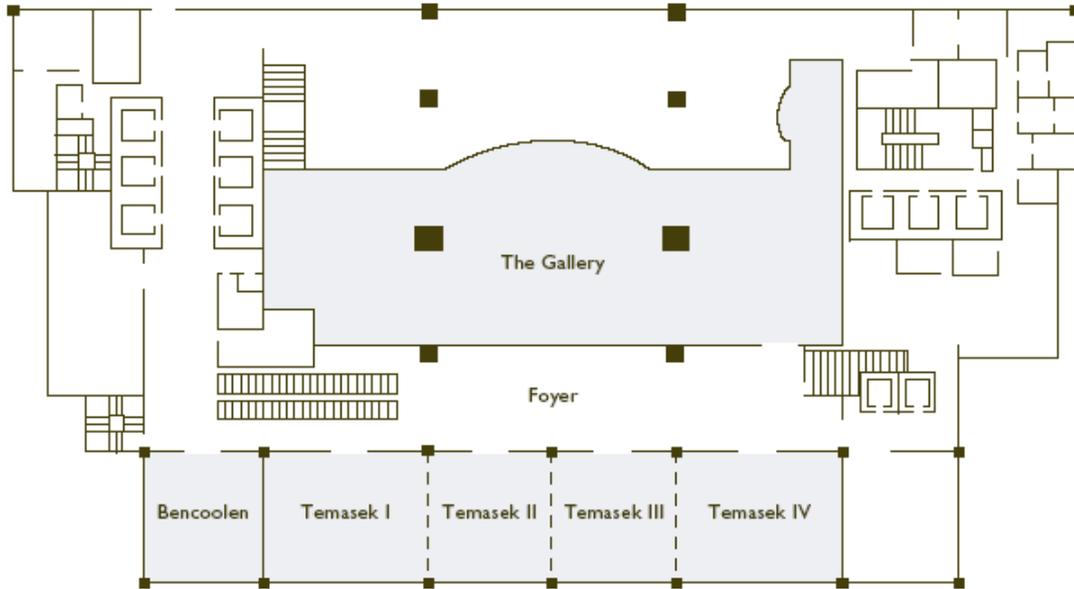## Thursday, December 2, 2004

Track	1	2	3	4	5	6	7	8	9
Room	Temasek 1	Temasek 2	Temasek 3	Temasek 4	Penang 1	Penang 2	Malacca 2	Level 2a Foyer	Level 2a Foyer
8:30-9:30	**The Gallery** **Keynote 2: Brain Motor Control and Robotics: A Control Theorist's Perspective** **Professor Hidenori Kimura, The University of Tokyo, Japan**								
9:30-10:00	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break
TA 10:00-12:00	**(RAM)** **Underwater robotics**	**(RAM)** **Novel actuators (INV)**	**(RAM)** **Multi-robots and swarm**	**(CIS)** **Image Processing I**	**(CIS)** **Data Mining and Management II**	**(CIS)** **Fuzzy Control**	**(CIS)** **Genetic Algorithms - Theory**	**(RAM)** **Poster Session 1**	**(CIS)** **Poster Session 3**
12:00-13:00	Lunch at The Gallery (Level 2)								
TM 13:00-15:20	**(RAM)** **Intelligent control**	**(RAM)** **Robot Control**	**(RAM)** **Humanoid and legged robots**	**(RAM)** **Mobile robot path planning**	**(CIS)** **Evolutionary Computation**	**(CIS)** **Intelligent Systems**	**(CIS)** **Neural Networks - Theory**		**(CIS)** **Poster Session 4**
15:20-15:50	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break
TP 15:50-17:50	**(RAM)** **Control of systems with delay or dead zone**	**(RAM)** **Issues on real time implemetation**	**(RAM)** **Fault diagnosis and maintenance**	**(CIS)** **Particle Swarm Optimization**	**(CIS)** **Advances In Intelligent Data Processing (INV)**	**(CIS)** **Fuzzy Systems**	**(CIS)** **Genetic Algorithms - Application**		

2004 IEEE CIS/RAM Technical Program
Friday, December 3, 2004

Track	1	2	3	4	5	6	7	8	9
Room	Temasek 1	Temasek 2	Temasek 3	Temasek 4	Penang 1	Penang 2	Malacca 2	Level 2a Foyer	Level 2a Foyer
8:30-9:30	**The Gallery** **Keynote 3: Machine Vision for Robotics, Automation and Mechatronics (MV-RAM)** **Professor Kok-Meng Lee, Georgia Institute of Technology, USA**								
9:30-10:00	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break
FA 10:00-12:00	**(RAM) Environment modeling for localization**	**(RAM) Robot design for a functionality**	**(RAM) High performance systems and control**	**(CIS) Multiobjective Optimization**	**(CIS) Intelligent Transportation Systems**	**(CIS) Neuro-Fuzzy Systems**	**(CIS) Soft Computing**		**(CIS) Poster Session 3**
12:00-13:00	*Lunch at The Gallery (Level 2)*								
FM 13:00-15:20	**(RAM) SLAM and localization**	**(RAM) Software and programming for robotics**	**(RAM) Human-robot interaction**	**(CIS) Neural Networks - Application**	**(CIS) Manufacturing Systems**	**(CIS) Human/Computer Interaction**	**(CIS) Knowledge Acquisition and Engineering**		**(CIS) Poster Session 4**
15:20-15:50	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break	Tea break
FP 15:50-17:50	**(RAM) Robot structures and robot cell**	**(RAM) Segmentation and correspondence**	**(RAM) Production scheduling**	**(CIS) Image Processing II**	**(CIS) Systems**	**(CIS) Human/Machine Systems**	**(CIS) Decision Support Systems**		

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Floor Plan of Conference Venue

LEVEL 2

The Gallery

Foyer

Bencoolen | Temasek I | Temasek II | Temasek III | Temasek IV

LEVEL 2A

Foyer

Malacca I | Malacca II | Penang I | Penang II
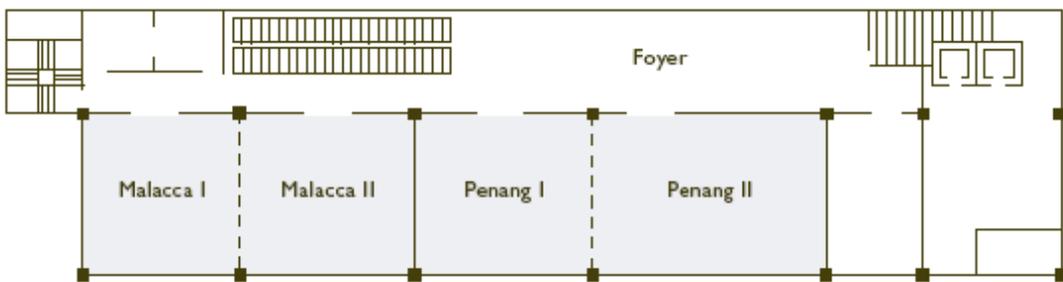
Keynotes Address

Keynote 1:

Wednesday, 1st December 2004, 8:30am – 9:30am   The Gallery

Intelligent Decoupling Control System of Complex Industrial Process and Application

Professor Tianyou Chai
Control Science and Control Engineering
Northeastern University
Director of National Research Center for
Metallurgical Automation Technology
Shenyang, Liaoning Province
China 110004

Abstract

An intelligent decoupling control system has been presented for complex industrial processes. The proposed system consists of a feedback controller, which is designed to eliminate the tracking errors between the system outputs and the setpoints, a decoupling compensator, which is designed to suppress the effects of unmodeled dynamics, and a feedforward compensator with neural network, which is designed to eliminate the coupling among the loops. The proposed control system can be easily implemented using the distributed control system (DCS) to realize decoupling control for industrial processes with compositive complexities including high nonlinearity, strong coupling, higher order, and varying time. This system has been successfully applied to the ball mill pulverizing systems of 200MW power units. Simulation and industrial experiment show the robust performance of the proposed system and its bright future in the industry.

Speaker

Professor Tianyou Chai received the M.B. and PhD degrees from Northeastern University, P.R.China in 1983 and 1985, Since 1985, he has been with Northeastern University where he became professor in 1988 and doctor supervisor of Control Science and Control Engineering in 1990. He has been director of National Research Center for Metallurgical Automation Technology since 1997. He is member of Chinese Academy of Engineering.

Dr. Chai served as Member of Technical Board of IFAC from 1996 to 1999 and Chairman of Coordinating Committee on Manufacturing and Instrumentation of IFAC from 1996 to 1999. He is currently serving as Deputy Director of Experts Committee of Advanced Manufacturing and Automation in High-tech Research and Development Program of China, Chief Scientist of National Key Basic Research and Development Program of China.

His research interests include intelligent decoupling control, adaptive control and integrated automation systems. He has published more than two hundred papers in international journals and international conferences. He developed several integrated automation systems, which have been successfully applied in the process industries in China, such as metallurgy industry, electric power industry and environmental conservation industry.

He was the recipient of two prizes of National Science and Technology Progress Award in 1999 and again in 2001, He was awarded the title of Ho Leung Ho Lee Foundation Technological Science Prize in 2002.

Keynote 2:

Thursday, 2^(nd) December 2004, 8:30am – 9:30am   The Gallery

Brain Motor Control and Robotics: A Control Theorist's Perspective

Professor Hidenori Kimura
Professor of Complex Systems
Department of Complexity Science and Engineering
Graduate school of Frontier Science
The University of Tokyo
7-3-1 Hongo, Bunkyo-ku
Tokyo 113-8656, Japan
http://www.crux.t.u-tokyo.ac.jp/~kimura/

Abstract

From the viewpoint of motion control, human being and robot are in principle indistinguishable. Activation of a motor neuron to contract muscles and driving an electrical motor to rotate a joint angle are considered to be the same sort of control actions. However, there are still insurmountable gaps between what human being can do and what robot can do. Control is a key technology to reduce the gap. It is important, however, to be aware of the fact that control in biological organisms is significantly different in many respects from control of artifacts which has been the target of control theory. Therefore, translations of biological control to control theory framework are not sufficient to get true insight into biological control. Instead, there are many new features of control in living organisms that are really challenges for control theory.

In this talk, different features of biological control are presented such as *coordination*, *robustness*, *objective change during control*, *variable structure*, *intrinsic adaptation*, etc, which are also key issues of creating humanoid robot that behaves *humanly*. Some research directions towards the control theory of brain are suggested which may bridge between human being and robot from control viewpoint.

Speaker

Professor Hidenori Kimura was graduated from the University of Tokyo in 1965. He received the degree of the Doctor of the Engineering from the University of Tokyo in 1970. After he joined the Faculty of Engineering Science and then the Faculty of Engineering, Osaka University, he moved to the Faculty of Engineering, the University of Tokyo in 1995, where he was a professor of control engineering. Currently, he is a Laboratory Head of the Bio-mimetic Control Research Center of RIKEN (The Institute of Physical and Chemical Research). In 1994, he was invited as a Guest Professor at the Technical University of Delft, The Netherlands, and also he was invited as Springer Professor at the University of California, Berkeley. He is now interested in robust control, learning theory, modeling and control of biological control. He has published more than one hundred technical papers and several books. He received the paper award and author's award from SICE several times. He was also a recipient of the George Axelby Paper Award from IEEE CSS in 1985 and the paper Prize Award from IFAC in 1984 and in 1990. He is a Fellow of SICE and IEEE. He was the General Chair of the 35th Conference on Decision and Control held in Kobe in 1996. He is a member of the Science Council of Japan from 2003.

Keynote 3:

Friday, 3rd December 2004, 8:30am – 9:30am   The Gallery

Machine Vision for Robotics, Automation and Mechatronics (MV-RAM)

Professor Kok-Meng Lee
The George W. Woodruff School of Mechanical Engineering
Georgia Institute of Technology, MARC 474
813 Ferst Drive, NW
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Abstract

Over the last two decades, the rapid advancement of computing, communication, and information technologies has drastically lowered the price of vision sensing systems, which have a broad spectrum of applications and impacted nearly all phases of our daily life. Today, modern smart sensors provide the features of a traditional machine vision system at a fraction of the usual price by eliminating the signal-conversion electronics, fixed-frame rates and limited gray-scale quantization. This talk discusses the past, present and future of machine vision in view of the maturing robotics, automation and mechatronics technologies, specifically with focuses on prototyping machine vision for real-time applications. We begin with examining problems associated with traditional machine vision systems for cost-effective real-time applications, novel alternative system design to overcome these problems, and the new trends of modern vision sensors. We also present a physically accurate image synthesis method as a flexible, practical tool for examining a large number of hardware/software configuration combinations for a wide range of parts. Selected examples are given to help illustrate these impacts and yet to cover a wide variety of RAM applications.

Speaker

Dr. Kok-Meng Lee received his B. S. degree in mechanical engineering from State University of New York at Buffalo in 1980 and the M.S. and Ph.D. degrees in mechanical engineering from the Massachusetts Institute of Technology in 1982 and 1985, respectively.

He has been with the Georgia Institute of Technology since 1985. As a Professor of mechanical engineering, his research interests include system dynamics and control, robotics, automation and opto-mechatronics. He holds seven U.S. patents. Dr. Lee has served as an Associate Editor of the IEEE Robotics and Automation Society Magazine from 1994 to 1996, Associate Editor of the *IEEE Transactions on Robotics and Automation* from 1994 to 1998, and as a Technical Editor of the *IEEE/ASME Transactions of Mechatronics* from 1995 to 1999. He has held representative positions within the IEEE Robotics and Automation Society: he has founded and chaired the Technical Committees on Manufacturing Automation (1996 to 1998) and on Prototyping for Robotics and Automation. He served as Chair or Co-Chair for numerous international conferences. He has been awarded with a Presidential Young Investigator (PYI) Award, Sigma Xi Junior Faculty Award, International Hall Of Fame New Technology Award, and the Woodruff Faculty Fellow. He was also recognized as an advisor for six Best Student Paper Awards and a Best Thesis Award.

Wednesday, 1 Dec 2004, 10:00-12:00

SESSION: WA1	Temasek 1
Teleoperation and Web-based Robotics (RAM)	

Chair: Chew Chee Meng
Co-Chair: Heng Wang

10:00
WA1.1: The Use of Teleoperation for Humanoid Walking - A First Look
Wai Yong Sim, Chee Meng Chew, Geok Soon Hong
National University of Singapore, Singapore

In this paper, we present a proposal to extend the rough terrain adaptability by means of teleoperation. In the proposed teleoperation system, a master interface has been designed to map the lower limp joint angles of human operator to those of the humanoid robot. The advantage of such system is that the human operator can control the humanoid naturally, as if he is the humanoid, due to the structural similarity of the interface worn by the human operator and the humanoid robot.

10:20
WA1.2: Online Tuning of Wave Impedance
Neal Tanner, Gunter Niemeyer
Stanford University, USA

Wave variable based controllers ensure the stability of force-reflecting teleoperators with arbitrary and unknown communication delays. The wave impedance provides a fundamental tuning parameter that allows the designer to trade off performance aspects. We suggest and explore automatically tuning this parameter online to capture the best behavior under varying task configurations. In particular, this strategy adjusts force feedback in order to lower resistance during free space motions and strengthen feedback when in contact. Examining the effects of a variable wave impedance, we develop a generalized wave transformation better suited to online changes and propose a tuning rule to maintain system passivity. Our results are illustrated and confirmed in simulation.

10:40
WA1.3: A Novel Teleoperation Paradigm for Human-robot Interaction
Meng Wang, James Liu
The Hong Kong Polytechnic University, China

Internet telerobotics has emerged in recent decade with direct control and supervisory control as the main teleoperation paradigms in the field of wheeled robot navigation. It is however difficult to apply these paradigms in the unknown and dynamic real-world applications, while they do not provide adequate feeling of interaction or a human- friendly control interface to the human operator. This paper proposes a novel interactive control (active supervisory control) Telecommanding, which is used for Internet-based mobile robot teleoperation. Telecommanding involves two parts: basic telecommanding, using joystick commands, and advanced telecommanding, using linguistic commands. Assisted by up-to-date data visualization and media streaming technologies, telecommanding can help a novice operator to simply, easily, and remotely control a robot through the Internet navigating in an unknown and dynamic real world. Telecommanding enables the robot to autonomously handle real-world uncertainty, improves the interactivity of humans and robot, and solve the problems of arbitrary network delays and restricted bandwidth. The experiments, including an Internet-based teleoperation test over 1500 kilometers from Beijing to Hong Kong, have demonstrated the promising performance and the advantages of this paradigm over direct control and passive supervisory control.

11:00
WA1.4: Relative Position-Based Mapping for Telemanipulation of Dexterous Robot Hands
Heng Wang, Kin Huat Low, Feng Gong, *Michael Yu Wang
Nanyang Technological University, Singapore; *The Chinese University of Hong Kong, China

Three methods have been commonly used for telemanipulation: joint angle mapping, pose mapping and fingertip position mapping. However, none of the methods result in satisfactory performance if the robot hand is non-anthropomorphic. This paper introduces a new concept for mapping based on the relative positions between fingertips. A brief implementation of this method for three-fingered robot hand is presented, followed by two case studies. By transferring the information of relative positions from human hand to robot hand, the proposed method is able to produce better results if compared with those of fingertip position mapping.

11:20
WA1.5: Practical Limitations of Wave Variable Controllers in Teleoperation
Neal Tanner, Gunter Niemeyer
Stanford University, USA

Wave variable controllers can make a force reflecting teleoperator insensitive to communication time delays by encoding information before transmission. They are based on passivity and assume no information about the delays or the environment. However, like most robotic control systems, they model the master and slave devices as passive inertias and ignore amplifier and sensor dynamics. We review these modeling assumptions and show that non-idealities of the mechanisms, actuators, and sensors can violate passivity and impose practical limitations on the wave based controllers. We propose a method for quantifying this activeness and dissipating the corresponding energy to restore passivity.

11:40
WA1.6: Robust Multiestimation Based Adaptive Control of Robotic Manipulators Applied to Master-Slave Robotic Tandems
Asier Ibeas, Manuel de la Sen
The University of the Basque Country, Spain

The problem of controlling a tandem of robotic manipulators affected by structural uncertainties is addressed via the introduction of a robust multiestimation-based adaptive control law. Each robot is modeled by a multiestimation scheme composed by a finite set of parameter estimation algorithms including a relative dead-zone running in parallel and a higher order level supervisor which online selects one of them to parameterize an adaptive controller connected in feedback to the plant. The multiestimation scheme allows to improve the behavior of the closed loop response of each robot in practical applications in comparison to classical single model based adaptive controllers as it has been verified through simulation examples. Thus, the transient response of the tandem can be improved in the free motion case as well as in the constrained one when the slave robot interacts with the environment reflecting the interaction force to the master. In this case, the scheme reveals to be promising to improve the ability of the master robot to track the slave constrained trajectory.

SESSION: WA2	Temasek 2
Robotics in dynamic environment	

Chair: Zheng Sun
Co-Chair: Ping Jiang

10:00
WA2.1: Real-Time Navigation for Multiple Mobile Robots in a Dynamic Environment
Harunori GAKUHARI, Songmin JIA, Yoshiro HADA,

Kunikatsu TAKASE
Univ. of Electro-Communications, Japan

This paper proposes a practicable navigation method for multiple mobile robots in a dynamic environment. In the past, many navigation methods have been developed. However, these methods were often limited to single robot or robots with special mobility such as holonomic ones. From the viewpoint of practical applications, it is indispensable that the number of robots, shape and mobility of robots are arbitrary. In this study a deadlock-free navigation for non-holonomic mobile robots in a dynamic environment is given. In the proposed scheme, the information of the environment and robots are fed back to the system in real-time, and global path planning is cyclically executed. The proposed system can be applied to dynamic environment and a reliable deadlock-free navigation of multiple robots. The real-time on-line path planning is performed by an efficient A* search in Configuration Spaces representing the robots and environment. The proposed method is tested by some kind of simulations for typical complicated navigation situations. As a result, the effectiveness of the proposed method is verified.

10:20
WA2.2: A Collaborative-Shared Control System With Safe Obstacle Avoidance Capability
Jian Shen, Javier Ibañez-Guzmán, Teck Chew Ng, *Boon Seng Chew
Singapore Institute of Manufacturing Technology, Singapore; *Nanyang Technological University, Singapore

Tele-operated systems allow humans to extend their physical capabilities and enable them to intervene in hazardous operations or where their presence is not possible. However, the operation of such systems over long periods has proved to be difficult and stressful. Consequently, means to facilitate their use are the subject of much study and experimental work. In this paper, we propose a collaborative-shared control strategy that combines the operator abilities with robotic-based tasks to render these systems more flexible and robust. In our method, the Collaborative Control component is responsible for allowing operator intervention when the robot is facing complex situations, whilst the Shared Control component provides an automatic control mechanism to assist and to monitor-correct irrational operator actions. The paper will demonstrate how collaborative and shared control strategies work together to facilitate the teleoperated control of a mobile platform in a cluttered environment. The experimental results include applications to surveillance and to search & rescue operations. In addition, a key component in the form of a hybrid obstacle avoidance module is introduced that allows the robot to be guided on a task basis by the operator at a distance.

10:40
WA2.3: Randomized Sampling with Fixed and Dynamic Space Decomposition Methods
Zheng Sun
Hong Kong Baptist University, China

In this paper we introduce an adaptive sampling strategy for some of the more advanced probabilistic roadmap planners recently proposed. Each of these planners uses a distinct scheme to judiciously generate only well-positioned milestones that can improve the quality of the roadmap being constructed. However, the cost of generating each milestone for such a planner is usually very high. Our adaptive sampling strategy, using a fixed or dynamic decomposition of the robot's configuration space C, can guide these planners by identifying promising areas of C where (useful) milestones can be efficiently generated. Experimental results show that, for the two planners tested, the adaptive sampling strategy shortens the roadmap construction time by significantly reducing the milestone generation cost.

11:00
WA2.4: On the Tracking and Interception of a Moving Object by a Wheeled Mobile Robot
Fethi Belkhouche, Boumediene Belkhouche
Tulane University, USA

This paper deals with the problem of tracking and interception of an object moving with unknown maneuvers by a wheeled mobile robot. We design a closed loop control law based on a guidance strategy for this purpose. The guidance strategy uses geometrical rules combined with the kinematics equations, where the robot's angular velocity is equal to the rate of turn of the line of sight angle. In some situations it is necessary to use a heading regulation phase in order to put the robot's linear velocity on the line of sight and apply the guidance strategy. In the presence of obstacles, two navigation modes are used, namely tracking mode and obstacle avoidance mode. Simulation examples show the efficiency of the method.

11:20
WA2.5: Social Potentials Based Dynamic Cooperation Chain
Mingwei Yuan, Ping Jiang
Tongji University, China

Cooperation is one of fundamental problems in multi-robot teams. The social potential field can contribute to the organization of different robot roles. This paper proposes a new method to construct a dynamic cooperative chain based on the social potential field. Depending on proper potential functions and conversation among robots, autonomous alliance of multi-robots can be achieved effectively. It is a self- organizing mechanism for multi-robot cooperation such that the robot can construct teams and change their own roles dynamically.

11:40
WA2.6: Multiple Obstacles Avoidance For Mobile Robot in Unstructured Environments
Feng Zhang, *DaLong Tan, Zhenwei Wu
Robotics Lab., Chinese Academy of Science, China;
*Robotics Lab., Chinese Academy of Science, China

This paper focus on multiple obstacles avoidance for mobile robot and presents novel obstacle avoidance maneuvers mainly by defining degree of risk and using fuzzy method. The methods based on the relative coordinates and acceleration space in unstructured environments, where exists not only multiple static obstacles, but also multiple moving ones. The simulation results verify its validity.

SESSION: WA3	Temasek 3
Parallel Mechanisms (Invited Session)	
Chair: Huynh Patrick	
Co-Chair: Guilin Yang	
Organizer: Huynh Patrick	

10:00
WA3.1: Workspace Analysis and Optimal Design of Cable-driven Planar Parallel Manipulator
Cong Bang Pham, Song Huat Yeo, *Guilin Yang
Nanyang Technological University, Singapore; *Singapore Institute of Manufacturing Technology, Singapore

A Cable-Driven Parallel Manipulator (CDPM) possesses a number of promising advantages over the conventional rigid-link manipulators, such as simple and light-weight mechanical structure, high-loading capacity, and large workspace. However, the formulations and results obtained for the rigid link manipulators cannot be directly applied to CDPMs because of the unilateral property of cables. This paper focuses on the workspace analysis and optimal design of a specific type of CDPMs, i.e. a completely restrained symmetric Cable-Driven Planar Parallel Manipulator (CDPPM). The tension plays a key role in building up the

workspace. In the analysis, performance criteria such as tension bound and stiffness condition are considered to construct the feasible workspace. Moreover, simplex search method is employed to obtain the optimal feasible workspace with respect to the locations of the connecting points and suspending points. Computation results have shown that the optimal workspace can be always obtained at configurations where either the base or the platform is degenerated to a line.

10:20
WA3.2: Optimal Kinematic Design of A 2-DOF Planar Parallel Robot
Lining Sun, Qingyong Ding, Xinyu Liu
Harbin Institute of Technology, China

A 2-DOF planar parallel robot including parallelogram linkages is introduced in this paper. A set of closed form parametric relationships of links' length is founded based on kinematic model and optimal configuration analysis. Aimed to achieve good dexterity, high accuracy and high speed, an optimal kinematic design method of 2-DOF planar parallel robot is proposed to optimize the length of links. Dexterity and isotropic configuration are analyzed, which are used in workspace synthesizing. The proposed method can be implemented in two steps. In the first step, under the constraints of dexterity, minimum transmission angle, a workspace with desired kinematic performance is achieved, and a set of possible optimal results is generated by objective workspace searching. In the second step, a global index, which is composed of conditioning index of Jacobian matrix, velocity and motion resolution, is used to filter the most optimal solution from the results of the first step. A design example is given to demonstrate the effectiveness of proposed method.

10:40
WA3.3: Kinematics Analysis of a 6-DOF Selectively Actuated Parallel Manipulator
Yan Jin, I-Ming Chen, *Guilin Yang
Nanyang Technological University, Singapore; *Singapore Institute of Manufacturing Technology, Singapore

This paper presents the kinematics analysis of a novel parallel manipulator termed a Selectively Actuated Parallel Mechanism (SA-PM). The end-effector of the manipulator can produce 3-DOF spherical motion, 3-DOF translation, 3-DOF hybrid motion, or complete 6-DOF spatial motion depending on the types of the actuation (rotary or linear) chosen for the actuators. As the manipulator architecture decouples translation and rotation of the end-effector for individual control, the position and orientation of the end-effector are analyzed separately. The close-form solutions are provided, which shows that there are at most eight solutions for both inverse and forward kinematics.

11:00
WA3.4: Kinematic Hybrid Position/Force Control Of a 3-DOF In-Parallel Actuated Manipulator
Patrick Huynh
Ngee Ann Polytechnic, Singapore

The paper aims to describe kinematic hybrid position/force control for a three-degree-of-freedom (3-DOF) in-parallel actuated manipulator, and its application to peg-in-hole task about 10mm clearance. The control system consists of a low-level position servo driven by force feedback in base coordinates. The computation required for the control is only inverse kinematics, which is very simple for the parallel-link manipulator. Assisted by a human operator, the motion is generated by using force-torque based joystick commands and/or preplanned motion data. In teleoperation mode, the human operator can intervene and superpose corrective motions over the preplanned searching motion.

11:20
WA3.5: A Haptic Device Wearable on a Human Arm
Guilin Yang, Hui Leong Ho, Weihai Chen, Wei Lin, *Song Huat Yeo
Singapore Institute of Manufacturing, Singapore; *Nanyang Technological University, Singapore

In this paper, a novel 7-DOF haptic device wearable on a human arm is proposed. Different from the conventional haptic devices, which employ only mechanical components, the proposed wearable haptic device is formed by both mechanical links/joints and human bones/joints. As a result, such a bio-mechanical design allows the device to always adapt to human arm's anatomical structure rather than having the operator to adapt to the device's configurations. Considering the anatomical structure of a human arm, the 7-DOF wearable haptic device consists of three sequentially connected modules, i.e., the 3-DOF wrist module, the 1-DOF elbow module, and the 3-DOF shoulder module, which are designed to adapt to the motions of the human arm's skeletal joints at the wrist, elbow, and shoulder respectively. Because of the modular design, these three functional modules can also be dismantled separately for single joint operations. Moreover, this wearable haptic device has three operating modes: passive, resistive, and active modes for various applications, e.g., tele-operation, virtual reality, and rehabilitation.

11:40
WA3.6: The Stability Analysis of the Gough-Stewart Parallel Mechanism On Vibration Control
Peiqing Ye, Qian Zhou, Guanghong Duan, Gexue Ren
Tsinghua University, China

This paper studies the stability of the Gough-Stewart Parallel Mechanism on vibration isolation. The problem comes from a large radio telescope in which the astronomical equipment is mounted on a feed stabilized platform to be stabilized by adjusting six actuators, while the base platform of the mechanism itself is carried by a vibrating cable-car that moves along flexible cables. The characteristic of the Stewart parallel mechanism in this application is that the two platforms are coupled. The control law of the system is presented and a mathematical model is established. The stability of the system is analyzed based on the mathematical model. The results show the relations between the stability of the system and the property of the Stewart platform, such as the mass and the radius of the base platform.

SESSION: WA4	Temasek 4
Humanoid robots (Invited Session)	

Chair: Changjiu Zhou
Co-Chair: J.P. Bandera
Organizer: Changjiu Zhou

10:00
WA4.1: A Model-based Humanoid Perception System for Real-time Human Motion Imitation
Juan Pedro Bandera Rubio, Luis Molina-Tanco, Rebeca Marfil Robles, Francisco Sandoval Hernández
University of Malaga, Spain

This paper presents real-time human motion analysis based on hierarchical tracking and inverse kinematics. Our goal is to implement a mechanism of human-machine interaction that permits a robot to learn from human gestures, and, as a first stage, we have developed a computer-vision based human upperbody motion analysis system. This application requires to develop a real-time human motion capturing system that works without special devices or markers. Since such a system is unstable and can only acquire partial information because of self-occlusions, we have introduced a pose estimation method based on inverse kinematics. This system can estimate upper-body human postures with limited perceptual cues such as position of head and hands. The method has been tested using a HOAP-1 humanoid robot.

10:20
WA4.2: Ground Reaction Force Analysis of Biped Locomotion
Basak Yuksel, *Changjiu Zhou, Kemal Leblebicioglu
Middle East Technical University, Turkey; *Singapore Polytechnic, Singapore

This paper aims to analyze the ground reaction force in terms of smooth transition and landing impact under the parametric change of frontal gait trajectory that is realized by inverted pendulum model and the parametric change in the proportional gain of PID feedback controller. Using a dynamic simulator, namely, SL Simulator, the ground reaction force analysis is realized and the simulation results and comparison of them are presented. Keywords—biped locomotion, ground reaction force (GRF), controller gain parameter adjustment, dynamic simulation, landing impact and smooth transition.

10:40
WA4.3: Balance of Penalty Kicking for a Biped Robot
Zhe Tang, Changjiu Zhou, *Zengqi Sun
Singapore Polytechnic, Singapore; *Tsinghua University, China

Penalty kicking is a specific task for humanoid robots, which is defined by the robotic soccer community. An effective and powerful kicking is a challenging task because of balance. During the period of kicking, the kicking leg moves very quickly and therefore the dynamics should not be ignored. Furthermore, during the kicking, the center of gravity of the robot moves to the front. These two factors greatly influence the balance of the humanoid robot. In this paper, we keep the robot balanced through adjusting the stance leg's ankle joint, both the dynamics and CG changes are considered. The performance and applicability of the proposed method are illustrated both through simulation and real-time control of a humanoid robot developed by the Humanoid Group (www.robo-erectus.org) at Singapore Polytechnic.

11:00
WA4.4: Dynamically Stable Ggait Planning for a Humanoid Robot to Climb Sloping Surface
Changjiu Zhou, Pik Kong Yue, Jun Ni, *Shan-Ben Chan
Singapore Polytechnic, Singapore; *Shanghai Jiao Tong University, China

In this paper, we formulate gait synthesis of humanoid biped locomotion as an optimization problem with consideration of some constraints, e.g. zero-moment point (ZMP) constraints for dynamically stable locomotion, internal forces constraints for smooth transition, geometric constraints for walking on an uneven floor, e.g. sloping surface and etc. In the frame of gait synthesis tied with constraint functions, computational learning methods can be incorporated to further improve the gait. The effectiveness of the proposed dynamically stable gait planning and learning approach for humanoid walking on both even floor and sloping surface has been successfully tested on our humanoid soccer robots named Robo-Erectus, which won first place in the RoboCup 2003 Humanoid League Free Performance competition and got 4 silver awards in the RoboCup Humanoid League 2004.

11:20
WA4.5: A Stochastic Optimization Method of CPG-based Motion Control for Humanoid Locomotion
Yoshihiko Itoh, Kenta Taki, Shohei Kato, Hidenori Itoh
Nagoya Institute of Technology, Japan

In this paper, we propose a motion control method for bipedal humanoid locomotion. The motion control is based on the Central Pattern Generator (CPG), and is optimized by Simulated Annealing. The motion control for robot locomotion is a multi-objective optimization problem. The aim of this research is to generate various gaits so as to meet the objectives; there may be a bias, such as stability or speed. Therefore, we consider plural evaluation functions for each of the objectives, and the motion control and the parameter optimization are designed to be conscious of the bias. To optimize all parameters simultaneously may cause explosion of search space. The optimization process, thus, has two phases; optimizing the parameters of lower body and then optimizing the parameters of upper limb. In the experiments, our method performed some typical gaits, which respects stability, speed and both the two elements.

11:40
WA4.6: Conceptual Framework for Designing Humanoid Locomotion Control System
KIAN TIONG YAP, ROMYALDY TAUFIK
Nanyang Technological University, Singapore

This concept paper proposes a conceptual framework to guide the development of humanoid locomotion control system. It is built on the formal definition of stable and smooth humanoid locomotion [19]. The current proposal is part of steps towards a "generic" framework for the realization of any humanoid locomotion in any environment. Some related works is also reported.

SESSION: WA8	Level 2a Foyer
	Posters

WA8: Place Recognition Based on Gabor fileters and SVMs for Mobile Robot Self-Localization
Guizhi Li, *Chengwan An, Jie Pang, *Min Tan, Xuyan Tu
University of Science and Technology Beijing, China; *Institute of Automation, Chinese Academy of Sciences, China

This paper proposes a novel appearance-based place recognition approach for mobile robot localization. The multi-channel Gabor filters is used to extract the global texture features of the scene images which are associated with the corresponding locations, and then these texture features are fed to support vector machine classifiers to determine the location of mobile robot. The algorithm has been tested on our designed and developed autonomous mobile robot CASIA-I. The experiment results indicate that the algorithm can reach up to 91.11% correct location rate, be robust to the various illumination and contrast, and satisfy the real-time self-localization demand of mobile robot.

WA8: Fuzzy Variable Structure Control for an Inverted Pendulum
Wang Xingcheng, Li Aiguo
Dalian Maritime University, China

The design of a fuzzy variable structure controller for an inverted pendulum is considered in this paper. The method is based on fuzzy sets and variable structure control. Simulation results show that the fuzzy variable structure controller is robust to uncertain factors and external disturbance.

WA8: Locating Ceramics System Based on Computer Vision
Haifeng Wang, Wenjuan Lu, *Chuan Feng, **Zengqi Sun
Tsinghua University, China; *Arizona State University, USA; **1134

In this paper, a locating ceramics system based on computer vision is introduced. The system is used to indirectly measure the ceramics' poses on the automatic product line of the robot spraying unburned ceramics. The structure, locating principle and method of the system are described and some application results are given. The locating principle of the system adopts the camera calibration, image segmentation through finding the valley at an image saturation histogram, and the image morphological operation. The Locating Ceramics System based on computer vision has been applied in practice.

WA8: System Identification using Transfer Matrix
Jayesh Barve, *VSS Rameshkumar Junnurri
Engineering Technology Development, Engineering and Industrial Services, Tata Consultancy Services Limited, Pune, India; *Electrical Engg. Dept., College of Engineering Pune, India

A new approach is proposed for multivariable system identification in the deterministic model framework. In the proposed approach, MIMO system is represented using transfer function (TF) matrix whose elements are the standard, fixed structure TFs like FOPDT, SOPDT etc. These model structures are capable of well approximating very large class of systems found in practice. The system identification problem is then considered as the problem of simultaneously estimating the parameters of all TFs in the TF matrix. This is posed mathematically as the constrained optimization problem, which minimizes the error between simulated and actual response. A genetic algorithm is used to solve the proposed optimization problem. The proposed approach is tested on several benchmark system identification test data sets. Results for two DaISy benchmark data sets, SISO example of flexible robotic arm and a MIMO example of an industrial dryer are discussed.

WA8: Analysis of Locomotion of a Planetary Rover on a Slope
He xinyuan, *Ma Shugen, **Li Bin, ***Wang Yuechao, **Ye Changlong
Graduate School of the Chinese Academy of Sciences, China; *Ibaraki University, Janpan; **Robotics Laboratory, Shenyang Institute of Automation, China; ***Robotics Laboratory, Shenyang Institute of Automation, China

For improvement of planetary rover locomotion, a new type of tracked vehicle was designed for planetary exploration based on the concept of reconfigurability. By applying the planetary wheel principle, the system can give output in different forms under various constraint conditions. As a reconfigurable module, the vehicle can be integrated into a larger system using two basic configurations. As a stand-alone rover, it has two moving modes. The whole design was analyzed by conducting dynamics simulations and experiments.

Wednesday, 1 Dec 2004, 13:00-15:20

SESSION: WM1	Temasek 1
Medical Robotics (Invited Session)	

Chair: Louis Phee
Organizer: Louis Phee

13:00
WM1.1: A Review of Master-Slave Robotic Systems for Surgery
Soon Chiang Low, Louis Phee
Nanyang Technological University, Singapore

For decades, men have used robots to overcome their natural limitation in their dealing with the environment. In recent years, robots have been developed to assist surgeons in performing surgeries. Since these robots are meant for surgeons' use, the design and considerations for safety, reliability and human-robot interface become important. One of the most common modes of controlling surgery robots is using a master and slave layout. This paper explores the latest development in the area of master-slave robotic system for surgery.

13:20
WM1.2: System Integration of NeuroBot - A Skull-Base Surgical Robotic System
DILLA HANDINI -, MING YEONG TEO, *CHARLES VUI HONG LO
Nanyang Technological University, Singapore; *National Neuroscience Institute, Singapore

Skull-base surgery is a tedious operation that takes up to 8 hours just to complete the bone removal task. This is due to the fact that the skull base is one of the most complex regions of where vital blood vessels and major cranial nerves pass through the skull base. In view of this problem, NeuroBot, a skull-base surgical robotic system, has been developed to assist the surgeon in performing the bone removal task, reducing the bone removal task to 2 hours. This paper discusses the integration work of the NeuroBot system, starting with the overview of the NeuroBot system, its objective, features, and surgical robotics aspects. Subsequently, the system analysis comprising of the analysis to the surgical robotic procedure workflow and the details of every tasks are presented as well. An architectural design for the integration, derived based on the analysis stage, is then discussed, followed by some description on the existing developed modules and applications. This paper concludes with the explanation on the current state of the development work.

13:40
WM1.3: Literature Review on Needle Guidance in Soft Tissue and Preliminary Work on Smart Needling
Kaiguo Yan, Wan Sing Ng, *Tien-I Liu, Keck Voon Ling, **Yan Yu Yu
Nanyang Technological University, Singapore; *California State University, Sacramento, USA; **University of Rochester, New York, USA

Precise needle placement is important for a number of percutaneous interventions. However insertions into soft tissues can be difficult to learn and to perform, due to tissue deformation, needle deflection and limited visual feedback. Complications associated with poor placement have been studied. Yet to date, little quantitative information is known about the interaction between needles and soft tissues during penetration, and few effective physically-based needle guidance systems exist for such procedures. In this paper, some important works dealing with needle guidance in soft tissue were first reviewed. Then a "Smart Needling" system was proposed and some preliminary work was described.

14:00
WM1.4: Tracked Arm Manipulator for Lumpectomy
Md Irwan Md Kassim, Ruoyun Wu, Fan Shao, Wan Sing Ng, *Siew Bock Wee
Nangany Technological University, Singapore; *Tan Tock Seng Hospital, Singapore

In this paper, we present a tracked and semi-motorized arm manipulator system aiming to provide accurate positioning information for breast biopsy tool to be used as a treatment device. The system is integrated with Augmented Reality (AR) and Visual Reality (VR) visualization. Two tracking systems were used on the arm, camera tracking and encoder tracking to simultaneously track the ultrasound probe and surgical tool. Stereo-camera is used to track an optical marker, which is temporary mounted. The marker is removed once the initial location of the arms is computed and encoder-based tracking takes over. On each passive joint of the arm system, a rotary encoder is installed which tells the angle of each joint. Therefore the positions of both ultrasound probe and surgical tool is known. The surgical tool is fitted onto a motorized 2 degree of freedom (DOF) with motorized cutting sequence, which enables cutting planning, probe positioning and controlled tissue cutting procedure. The prototype of the system proved the concept and future work is expected to improve the accuracy.

14:20
WM1.5: Interactive Navigation Control with Haptic Rendering for Endovascular Treatment
Moulay Brahim El Khalil Ghembaza, Yacine Amirat
Université de Paris12, France

This paper presents a virtual guidance technique for the micro-robot's reactive navigation in order to increase the precision and the safety of the surgeon gesture in endovascular treatment of abdominal aortic aneurysms. We describe in particular the active compliant micro-robot that has been developed to improve the endovascular technique. From an analysis of the requirements of a virtual environment dedicated to this technique, we present the proposed approach based on the artificial potential field method for virtual guidance of the micro-robot's distal extremity. Finally, an algorithm for contact detection between the non active catheter body and the aortic walls is proposed for haptic rendering synthesis. This approach is based on pre-calculated cartography of the aorta's inside, in order to minimize the calculation time.

14:40
WM1.6: Control of a High Dexterity Micro-robot Based Catheter for Aortic Aneurysm Treatment
Yan Bailly, Anatole Chauvin, Yacine Amirat
Paris 12 University, France

Endovascular aortic aneurysm treatment is a minimally invasive surgery (MIS) which requires high dexterity for stentgraft delivering. In this paper, we propose and develop a new active catheter with a multi micro- robots stack arranged inside its external sheath. That serial-parallel type of robot is constituted by three bellows disposed 120° apart, providing three additional degrees of freedom. This paper deals with a brief design overview of the new micro-robot based catheter focusing on its inverse modeling. A cartesian orientation control algorithm is then presented and an integration of multi purpose criterions is demonstrated.

15:00
WM1.7: Learning and Control in Assistive Robotics for the Elderly
Qinggang Meng, Mark Lee
University of Wales, Aberystwyth, UK

The worldwide population of elderly people is rapidly growing and is set to become a major problem in the coming decades. This phenomenon has the potential to create a huge market for domestic service robots that can assist with the care and support of the elderly. Robots that are able to help the user with specific physical tasks are likely to become very important in the future, but so far, unlike industrial robots, assistive robots are still under-developed and are not widely used. We analyse the nature of the requirements for assistive robotics for the elderly and argue that traditional "industrial" robot design and control approaches are inappropriate to tackle the key problem areas of safety, adaptivity, long-term autonomy of operation, user-friendliness and low costs. We present a novel approach to the control of autonomous assistive robots for the home, with emphasis on the special requirements for in-situ learning, including software compensation for low precision hardware components. Our system consists of a modified behaviour-based architecture with integrated knowledge representation and planning abilities. Automatic error-recovery is implemented as an activation spreading mechanism and is distributed across the behaviour repertoire. Context-based experience is learned during both error recovery and normal action and assimilated into the behaviours. This allows reuse across different tasks, and facilitates gradual but life-long improvements in system performance. To evaluate our approach, an experimental laboratory testbed was constructed using low-cost, low-precision components. Our system was implemented in software and a series of experiments were performed in order to investigate a range of tasks. The tasks were selected to face some of the key issues identified and the results show the potential for intelligent software solutions to help overcome the barriers to successful assistive robotics for the elderly. The methods, experiments and results are described in this paper.

Chair: Trevor Taylor
Co-Chair: M. J. Yazdanpanah

13:00
WM2.1: Vision-based Pirouettes using the Radial Obstacle Profile
Trevor Taylor, Shlomo Geva, Wageeh Boles
Queensland University of Technology, Australia

Mapping algorithms commonly use "radial sweeps" of the surrounding environment as input. Producing a sweep is a challenging task for a robot using only vision. With no odometers to measure turn angles, a vision-based robot must have another method to verify rotations. In this paper we propose using the Radial Obstacle Profile (ROP) which gives the radial distance to the nearest obstacle in any direction in the robot's field of view. By matching the ROPs before and after a turn, the robot should be able to verify that the expected angle of rotation matches the actual angle. Combining successive ROPs then produces a radial sweep.

13:20
WM2.2: New Visual Feedback Guidance of a Mobile Robot via Vanishing Point
LILI SUN, Shigeru Uchikado
Tokyo Denki University, Japan

We consider a problem about navigation of a mobile robot with a camera in indoor environment. A new visual control method using a vanishing point of parallel lines at both sides of the corridor is introduced, and we call this the vanishing point visual control method. This method gives a lot of useful information on the design. Therefore we can't need a priori information except both widths of the corridor and the robot, but we can easily design the visual feedback system for guidance and obstacle avoidance by using this method. The idea is based on perspective geometry such as perspective projection, epipolar geometry, vanishing point, and projective transformation.

13:40
WM2.3: Robot Docking by Reinforcement Learning in a Visual Servoing Framework
Tomas Martinez-Marin, *Tom Duckett
University of Alicante, Spain; *Orebro University, Sweden

This paper presents an image-based visual servoing approach for a mobile manipulation task, in which a mobile robot has to move towards an object located on a table (docking) and then pick up that object with its gripper. The robot's vision system consists of a pan-tilt camera that is used to keep track of the object and the edge of the table. A minimal number of state variables are extracted from the vision system, and a reactive controller is used to implement the docking behaviour, without requiring any geometric model of the scene. The main aim of the work was to develop a practical reinforcement learning scheme to automatically acquire a high-performance controller in a short training time (less than 1 hour) on the real robot. We compare a number of control algorithms, including a hand-designed linear controller, a novel reinforcement learning algorithm for mobile robots, and a scheme using the linear controller as a bias to accelerate reinforcement learning. By experimental analysis of the controllability and docking time, we found that the biased learning system could improve on the performance of the linear controller, while requiring substantially lower training time than unbiased learning.

14:00
WM2.4: Graspless Coordinated Transportation over Natural Flat Terrain
Carlos Velasquez, Takayuki Takahashi, Eiji Nakano
Tohoku University, Japan

This work presents preliminary considerations in the development of a multirobot system for transportation of

load with no exchange of information between robots and no force sensing under the assumptions that the load has a uniform distribution of mass and that motion is performed over natural flat terrain. The robots in the team are homogeneous machines with non holonomic limitations and passive suspension mechanisms. Each robot adjusts its velocity by sensing the position of the load through an on-board passive arm, so that a global coordination scheme can emerge from local control. Experiments with two and three robots cooperating are reported.

14:20
WM2.5: The Application of Disturbance Observer in Two-Wheeled Mobile Robot
Jun Zhou, Bo Ding, Zong-yang Zhang, Wei Wu
Hohai University, China

Analyzing the motion features of two-wheeled mobile robot, the corresponding function is built and the disturbance observer is used in the control of robot. The control system of two-wheeled mobile robot adopts the disturbance observer, parameters of which are Figured out by practicing feedback control theory. By simulation, it is showed that the system has better ability to restrain disturbances and improved motion capabilities.

14:40
WM2.6: Tracking Control of A Mobile Robot Using A Genetically Tuned Mixed H2/H-Infinite Adaptive Technique
Adel Akbarimajd, MohammadJavad Yazdanpanah, *Ghader Karimian
University of Tehran, Iran; *Amirkabir University of Technology, Iran

There are two major methods for motion control of non-holonomic mobile robots when the knowledge about the model is not complete: adaptive control and robust control. The combination of two methods allows tuning of the robust controller and assures a satisfactory performance in practical situations. In this paper, a mixed H2/H-infinite PID controller incorporated with an adaptive term is developed for tracking control of a mobile robot. The controller's parameters are optimally tuned to minimize the energy of control signals via a genetic algorithm. The proposed control technique is numerically simulated on a mobile robot and the results are compared with two other methods: an adaptive method and a robust H-infinite method. The simulation results show that the proposed technique results in the smallest control energy. Also, it may tolerate uncertainties up to 99% in comparison to the corresponding values of 85% and 94% for the previously proposed methods, respectively.

15:00
WM2.7: Control Strategies for a Haptic Device Interacting with Virtual Environment
Mehrdad H. Zadeh, Kash Khorasani
Concordia University, Montreal, Canada

This paper presents several strategies for maintaining and improving the stability margins and achievable performances for a haptic rendering subject to interaction with virtual objects. Two classes of control strategies are investigated here. The first is a Lead-Lag compensator designed based on classical control and the second scheme is a Linear-Quadratic-Gaussian (LQG) controller designed from modern control theory. A detailed comparative performance and evaluation of the proposed controllers are developed to illustrate the advantages and disadvantages of these methods.

SESSION: WM3	Temasek 3
Manufacturing systems	

Chair: Swee Mean Mok
Co-Chair: Min Huang

13:00
WM3.1: Multi Level Contract Net Protocol based on Holonic Manufacturing System Implement to Industrial Networks

Taweepol Suesut, Phongchai Nilas, Vittaya Tipsuwanporn, Prapas Rerngreun, Arjin Numsomran
King Mongkut's Institute of Technology Ladkrabang, Thailand

This paper presents a flexible manufacturing system (FMS) that cooperated the holonic manufacturing system (HMS) with automatic material handling devices via industrial networks. The HMS is described as an intelligent manufacturing system that employs multi-agent system with negotiation protocols. The traditional HMS's negotiation protocol usually used the contract net protocol (CPN) and multi-level contract net protocol (MCPN). This paper develops a cooperative system that applies the concept of HMS to implement a distributed control system for automatic warehouse and FMS. Results from simulation indicated that our approach is able to improve the overall system flexibility. The system is able to reconfigure the re-order points, increase the system fault tolerances, and provides the dynamic rescheduling.

13:20
WM3.2: Product Coding Assembly/Disassembly Tree for Product Evaluation
Swee Mean Mok, *Chi-haur Wu
Motorola Labs, Motorola Inc., Schaumburg, Illinois, USA; *Northwestern University, USA

The impact of product design on manufacturing cost is significant. A product that is difficult to assemble will increase its production cost. An accurate process for identifying problematic parts before they are released for manufacturing is needed. In this paper, we will present a method for generating structured product coding system (SPCS) product assembly tree. The SPCS is part of an integrated design-to-manufacturing system for analyzing and calculating products' manufacturing cost in a virtual environment. It models assembly and disassembly operations of both parts and tools used in manufacturing a product. By using the system, a product designer is able to estimate the impact of every part used for building a product before production.

13:40
WM3.3: Integrating of Event Detection and Mode Recognition in Hybrid Systems by Fuzzy Petri Net
Abolfazl Jalilvand, Sohrab Khanmohammadi
University of Tabriz, Iran

Control of hybrid systems is an area that is currently attended by world control communities. One of the main stages in control of hybrid systems is the recognition of the operating modes and the discrete events in the system. In this paper a method for identifying the operating modes and events is introduces in threshold event driven hybrid systems [1]. The method is constructed based on fuzzy Petri net and the concepts of fuzzy ordering relation. Then the proposed method is used for control of an illustrative hybrid system example. The simulation results show that the proposed approach satisfies the expected demands.

14:00
WM3.4: Task scheduling in Manufacturing Systems Based on an Efficient Branch and Bound Algorithm
Abolfazl Jalilvand, Sohrab Khanmohammadi
University of Tabriz, Iran

The Branch and Bound (BB) algorithm is one of the common used methods in solving the task scheduling problems in manufacturing systems. In this paper, we introduced a new method to apply the Branch and Bound algorithm with a reduced memory size. By this method the running time decreases considerably. The algorithm is applied to a combinational discrete job shop scheduling system, where a Petri net is used for modeling.

14:20

WM3.5: The System Dynamic in the Simulation Analysis of a CONWIP Controlled Lamp Production Line
Min Huang, *W.H. Ip, *C.K. Kwong, Xingwei Wang, Dingwei Wang
Northeastern University, China; *The Hong Kong Polytechnic University, China

Production inventory control is essential problem of manufacturing systems. System Dynamic(SD) is more suitable for simulation analysis of the manufacturing. In this paper, the system dynamic is used for modeling and analysis the CONWIP controlled lamp production line. The description of the problem is proposed, the SD model is elaborated and the simulation analysis is evaluated. The results demonstrate the effectiveness of the SD model.

14:40

WM3.6: Design and Implementation of a Low Cost Control System for a Manufacturing Cell
Gilvan Costa, *Brunno Tortelli, Eduardo Santos, Marco Busetti
Pontifical Catholic University of Parana, Brazil; *PPontifical Catholic University of Parana, Brazil

This paper presents the design, generation and implementation of low cost control system for a manufacturing cell. The modeling and control of manufacturing systems using Supervisory Control Theory (SCT) is discussed. Using the technique of SCT, controllers can be built according to operational specifications. A structure control implemented in low-cost physical platforms is presented. According to the level of control, micro-controllers or small-size PLCs are used. A communication interface is proposed to establish rules of sending and receiving of events among different hardware. In order to demonstrate the usefulness of this approach, an educational testbed is used to simulate an automated manufacturing system.

15:00

WM3.7: Reconfigurable User Interface's to Support Monitoring and Diagnostic Capabilities within Agile Automated Manufacturing System's
Edward Mellor, Robert Harrison, Andrew West
Loughborough University, UK

This paper presents a novel approach for the configuration and runtime usage of user interfaces or Human Machine Interface (HMI) systems based on research being conducted at the MSI Research Institute, Loughborough University. In collaboration with Krause GmbH and Lamb Technicon UK Ltd two full size demonstrator machines have been commissioned to evaluate a Component Based control system and its associated design environment. The Krause machine consists of a transport system and a tappet assembly station, the Lamb Technicon machine consists of a single station from a transfer line machine for cylinder head machining. The framework for HMI System's described in this paper meets the requirements that automated manufacturing production machines face from the emerging agile manufacturing paradigm. Machines must be able to respond quickly to continuous change by many globally distributed engineering partners. This facilitates visibility of the system common model to all the globally distributed engineering partners involved in a given project. Within the C-B framework, HMI systems are composed from instances of reusable software templates that are targeted at specific user types. User targeted operator interfaces offer a common look and feel that improves usability. The machine's configuration is achieved by populating a series of HMI templates to produce a complete machine HMI system. A thin-client architecture is used based on server / client internet technologies that allow the machine HMI to be executed on any internet enabled computer using a standard web browser.

SESSION: WM4   **Temasek 4**
Actuators and joints

Chair: Tadanao Zanma
Co-Chair: Jason Gu

13:00

WM4.1: A Small Iron Ball Position Control by Symbolic Input and Output
Tadanao Zanma, Yosuke Takei, Muneaki Ishida
Mie University, Japan

This paper concerns a control problem for a specfication which requires a finer description than the resolution of available sensors and actuators. Such a situation may arise when the sensors are kind of limit switches and actuators are on/off control architecture while control specification is to be achieved as accurate as possible. An experimental setup is taken to clarify our problem setup. The experimental setup is a ball position control system in which a small iron ball rotates on a beam. For the experimental setup, we propose a control algorithm based on discrete input and output and continuous state estimation. Finally, the proposed method is applied to the experimental setup to demonstrate its effectiveness as well as numerical simulation.

13:20

WM4.2: Optimal Control of Permanent Magnet Motors Using Dynamic Programming
Jean Quirion, *Eldon Gunn, *Jason Gu
International Rectifier Automative, Canada; *Dalhousie University, Canada

Firstly, Dynamic Programming is employed in the development of an optimal torque controller for sinusoidal permanent magnet synchronous motors (PMSM). In particular, a solution that can handle non-zero state tracking is of interest. Secondly, it is shown that the resulting optimal control solution converges to that of linear quadratic regulators (LQR). An LQR is then presented as an alternative control method for PMSM. A Comparison of the performance of the LQR with that of traditional proportional and proportional-integral controllers is made using time and frequency domain techniques.

13:40

WM4.3: A Robust Sensor Fault Tolerant Control Scheme Implemented on a Flexible Joint
Chee Pin Tan, Maki Khalil Habib
Monash University Malaysia, Malaysia

This paper presents a flexible joint system with a sensor fault tolerant control scheme applied to it. Sensor faults affect the system's performance in the closed loop when the faulty sensor readings are used to generate the control input. In this paper, the measured outputs are separated into potentially faulty and non-faulty components, and the latter are injected into a linear observer to reconstruct the faults. The reconstruction is subtracted from the faulty sensors to form a compensated `virtual sensor' and this signal is then used to generate the control input. A design method for the observer is also presented in which the reconstruction signal is made as insensitive as possible to any uncertainties or non-linearities present in the system. Several fault conditions were tested; step, ramp and total failure of the sensor. Excellent results have been obtained; the system performance is almost identical to the fault-free scenario.

14:00

WM4.4: Transverse Flux Machine for Direct Drive Robots: Modelling and Analysis
Amir Babazadeh, Nejila Parspour, Arezoo Hanifi
University of Bremen, Germany

This paper presents a new analytical model for high-torque and low-speed transverse flux machines with flux collecting permanent magnet type. The model is developed based on

approximating the permeance distribution in the air gap between rotor and stator using quasi-flux tubes with boundaries determined by straight lines and semicircular segments. Three kind of produced torques are achieved analytically and the results are compared to the three dimensional finite element simulation results.

14:20
WM4.5: Development of Flexible Pneumatic Spherical Joint
Guanjun Bao, Libin Zhang, Qinghua Yang, Jian Ruan
1085

A flexible pneumatic spherical joint is mainly composed of three columnar elastic shells which are reinforced and restricted by embedded spiral metal wire. It is driven directly by compressed air. Following a brief introduction of the structure and working principles of the flexible pneumatic spherical joint, the static model is constructed to describe its properties. From this model, it can be seen that the bending angles can be obtained by controlling pressures of air inside the joint. Analysis, simulation and experiment are carried out for this joint. The static model is proved to be feasible by the comparison between experimental and simulating results. The spherical joint has advantages such as low price, simple structure and perfect flexibility. It can be applied to multi-fingered hand design.

14:40
WM4.6: Research on Novel Flexible Pneumatic Actuator FPA
Qinghua Yang, Libin Zhang, Guanjun Bao, Sheng Xu
Zhejiang University of Technology, China

A novel flexible pneumatic actuator FPA is proposed in this paper. The structure and properties of FPA are described. Based on FPA, flexible pneumatic bending joint, flexible pneumatic torsion joint and flexible pneumatic spherical joint are developed. The mathematical models of flexible pneumatic bending joint and flexible pneumatic spherical joint are establibed. Experiments are carried out to investigate the characteristics of these two joints by utilizing intelligent control techniques. Experimental results demonstrate that flexible pneumatic bending joint and flexible pneumatic spherical joint can meet the designed requirement of application. Finally, the aim and direction of the future work are forcasted.

15:00
WM4.7: Acceleration Feedback Control of A Harmonic Drive Parallel Robot
Yanjie Liu, Lining Sun, Qingxin Meng
Harbin Institute of Technology, China

This paper presents a new 2-DOF planar parallel robot with high speed and high precision. Harmonic drive is adopted between an AC servomotor and its driven link in each drive joint, and at the same time a rotary encoder feeds the driven link angle into the position controller of each drive joint. Thus, the resolution of the drive joint is improved greatly. However, flexibility of harmonic drive during high-speed motion causes the sharp elastic vibration. Therefore, an acceleration feedback controller is especially designed to increase the damping coefficient and restrain the elastic vibration. Furthermore, the stability of the entire system including the drive joint's position controller and the acceleration feedback controller is proved using a Lyapunov approach. The experiments of trajectory tracking are conducted on the robotic system, and the results validate the proposed control algorithm, contrasted with that obtained by classical PD control without the acceleration feedback loop.

SESSION: WM8   **Level 2a Foyer**
Posters

WM8: Hydra Control System
Nitiwat Sanornoi, Thossaporn Thossansi, Boonchana

Purahong, Pitikhate Sooraksa
KMITL, Thailand

This paper reveals Hydra Control System, a control system that contains the parallel and mixture attributes all in oneself. The system is composed of two main principles, Hydra Controller and Waterfall Actuator. Hydra Controller is consisted of various Sub–controllers functioned together. While the Waterfall actuator will be functioning as a signal selector, it will detect the most appropriate signal and transfer to the actual Actuator. The most outstanding of this functioning is the capability of structured adaptation automatically, which enable the system to continue working even with some failure in the subcontrollers or any signal destructed. The system will fail only under circumstance that all sub-controllers are destroyed or failed to its function simultaneously. From this concept, we have carried out an experiment of actual application by the demonstration in the design and the function of this new system which is based on the original algorithm.

WM8: Walking, Running and Kicking using Body-Mounted Sensors
Arosha Senanayake
Monash University Malaysia, Malaysia

The aim of the research is to analyze gait pattern of a soccer player using body mounted sensors. The system developed is primarily concerned lower extremety of the human body in order to use effectively in sportsmedicine. The in-shoe data logger equipped with force sensing resistors has been constructed to provide the interface to the human body such a way that online testing of a soccer player can be done. The medical and orthopedic instruments so far developed generally make use of vision techniques based on fixed monitoring equipment. This is expensive and inconvenient for many applications. The prototype product developed is a low cost integrated, interactive and intelligent system, which can be carried with the person being monitored. This will consist of a data logging computer and force sensing resistors built into a shoe.

WM8: Neuro-Fuzzy Network Control Strategy for Electric Discharge Machining Process
Yun ZHANG, *Xiao-lin WANG
Zhejiang University of Science and Technology, China; *Jiliang University of China, China

In this paper, the viewpoint of human-machine system is used to study the optimizing design scheme in implementing the fuzzy control in the EDM (Electric Discharge Machining) process by means of human-machine combination. A new type of the neuro-fuzzy network control system structure in the EDM process is designed which is composed of three parts of neural network predicting and evaluating, neuro-fuzzy network monitoring and polling list controlling. The new method of training data acquisition, off-line study and on-line study of the new type controller has been studied. Finally, experiment results show that this system has good self-adaptability and high reliability, which will result in the higher productivity.

WM8: Efficient Dynamic Equations of 3-RPS Parallel Mechanism through Lagrange Method
Hodjat Pendar, Mohammad Vakil, Hassan Zohoor
Sharif University of Technology, Iran

In this paper, by an efficient method the generalized reduced order dynamic equation for 3-RPS parallel mechanism through Lagrange method will be derived. Kinematic constraints accompanying Lagrange method for the constrained set of generalized coordinates, will introduce Lagrange multiplier into dynamical formulation. To omit the Lagrange multipliers the natural orthogonal complement matrix of kinematic constraints' matrix should be found. To reach to the natural orthogonal complement matrix, inverse

of a square matrix having order equal to the rank of kinematic constraints' matrix should be found. For a system having many kinematic constraints like 3-RPS the rank of the aforementioned matrix will be high In this research it will be shown that for 3-RPS parallel manipulator rearranging matrix derived from the kinematic constraints on constrained coordinates in a special way will simplify the inverse calculation. Instead of inversion of a high order matrix, only inversion of some very low order matrices should be evaluated. Therefore the natural orthogonal complement matrix could be reached without the need of inversion of a high order matrix and Lagrange multipliers could be omitted again very easily.

WM8: A PDA-Based High-Level Human-Robot Interaction
Phongchai Nilas, Taweepol Suesut, *Kazuhiko Muguruma
King Mongkut's Institute of Technology, Thailand; *Toshiba Co., Japan

This paper describes an innovative architecture for a highlevel interaction between a human and a robot via a Personal Digital Assistant (PDA). PDA is a design to provide small and lightweight mobile interaction devices. This interface architecture differs from previous PDA human-robot interfaces in that it uses high-level task decomposition, and adaptive user interface (UI) than teleoperation interfaces. Adaptive user interface typically refers to a flexible interaction strategy between a human and a computer to contribute what is best-suited at the most appropriate time. We extended this concept to human-robot interaction (HRI) [1] and employed the architecture into mobile devices (i.e. PDA and PocketPC). Such devices could provide mobility and durability for robot operations. This work implemented an agent-based high-level human-robot interface on PDA to provide interactions with robots. Four PDA user interfaces were developed: a Map-Based robot control screen, a Laser Range Finder screen, a Sonar Sensor screen, and Camera View with object selection screen. The proposed framework has been implemented to develop a prototypical PDA- based human-robot interaction system. The initial results are encouraging and demonstrate the capabilities of such a human-robot framework.

WM8: An Improved Tightly Coupled Approach for GPS/INS Integration
Wei Wang, Zongyu Liu, Rongrong Xie
Northwestern Polytechnical University, China

GPS/INS integration system has been widely applied for navigation due to their complementary characteristics. And the tightly coupled integration approach has the advantage over the loosely coupled approach by using the raw GPS measurements, but hence introduces the nonlinearity into the measurement equation of the Kalman filter. So the linearization is usually used. Consequently, the errors of linearization may make Kalman filter unstable or even divergent, especially under the situation that the low quality inertial devices are included. To solve this problem, an improved tightly coupled approach by adding the second-order derivative information to retain some nonlinear characteristics is proposed in this paper. Simulation results indicate that the nonlinear terms included in the filtering process have the great influence on the performance of integration, especially in the case that the low quality INS is used in the integrated system.

Wednesday, 1 Dec 2004, 15:50-17:50

SESSION: WP1	**Temasek 1**
Micro-Manipulator components and systems	
(Invited Session)	

Chair: Wenjie Chen
Co-Chair: Wenhai Chen
Organizer: Wenjie Chen

15:50
WP1.1: Vision Based Micromanipulation Using Planar Features: A Multiple View Approach
Wenting Sun, Teck Chai Chin
Nanyang Technological University, Singapore

In this paper, we describe a multiple view visual servo system using a perspective view camera and a microscope that controls a 3DOF stage so that the interested area can be positioned precisely as desired under the microscope. First, we extend the existing visual servo techniques in micromanipulation to the case of eye-to-hand multiple view vision sensors (one conventional CCD camera forms the perspective view, one microscope forms the microview) working in com- plimentary. Second, the image processing and homog- raphy estimation based partitioned image based visual servo approach is proposed to derive the control law of the stage based on planar features acquired from the scene.

16:10
WP1.2: Design of a Flexure-based Gripper Used in Optical Fiber Handling
Wenjie Chen, Wei Lin
SIMTech, Singapore

In optical fiber handling, a major requirement for the handling tools is to avoid introducing flaws on the cladding surface or excessive stress in the core. Conventional tools built with bearing-based mechanisms are difficult to meet the requirements because they cannot precisely control their motion and the gripping force due to backlash and Coulomb friction in their joints. The flexure-based tools however, due to absence of Coulomb friction and backlash in their motion, can provide a solution to the challenges. The paper presents a design method for a flexure-based gripper used in fiber handling. A prototype of the gripper developed by means of the method is described as well.

16:30
WP1.3: Development of Embedded Integrated Servo-controllers
Weihai Chen, Tat Joo Teo, Wei Lin, Guilin Yang
Singapore Institute of Manufacturing Technology, Singapore

This paper focuses on the development of an embedded integrated servo- controller (EISC) for servomotors. Consisting of mainly servo-controller and servo-amplifiers, this EISC is capable of controlling a wide range of servomotors to perform complicated tasks. Hence, integration of this EISC with a servomotor forms an intelligent modular actuator (IMA) that is widely used in modern manufacturing industries. The development of such an EISC involves two major tasks. First, designing the hardware of a compact-sized and cost effective. Second, developing the software functions to facilitate its functionalities and capabilities. The developed EISC hence forms an integrated-servo-control module, which determines the capability, functionality, flexibility and responsiveness of these IMAs.

16:50
WP1.4: Dynamic Analysis of A 3-DOF Flexure Parallel Micromanipulator
Xueyan Tang, Huy-Hoang Pham, Qing Li, I-Ming Chen
Nanyang Technological University, Singapore

This paper presents an analytical approach for dynamic modeling of a three-degree-of-freedom _exure parallel micromanipulator based on the pseudo rigid-body model approach. The motion equation is established using Lagrangian method. The dynamic characteristics such as natural frequencies and transient responses are also investigated. The modeling using analytical approach is proved to be accurate through a validation based on a _nite element analysis. The dynamic analysis has also proved that

the micromanipulator in this study possesses high natural frequencies and decoupled dynamics.

17:10
WP1.5: Motion and Scene Interpretation from Two Views of An Optical Switch
Hong Luo
Singapore Institute of Manufacturing Technology, Singapore

In an attempt to assemble an MEMS optical switch, two views, a microscope view (MV) and a perspective view (PV), are used to observe the scene. This paper presents both the out-of-view reconstruction and motion estimation technologies for the assembly process. For out-of-view reconstruction, a homography capable of transforming feature points and feature lines between an MV image and a CAD model is implemented. The homography between two sequential images is decomposed and factorized for motion estimation. Optical flow has also been explored to provide rough estimation of rotation center and angle. After non-linear optimization, accuracy for estimation of rotation angle and rotation center can reach 0.05 degree and pixel level respectively.

17:30
WP1.6: Control of two-link flexible manipulators via generalized canonical transformation
XU BO, KENJI FUJIMOTO, YOSHIKAZU HAYAKAWA
Nagoya University, Japan

Since the two-link flexible manipulator is an underactuated system which provide a challenge to control engineers and researchers. In order to control this kind of systems more effectively, many new control theories and methods are explored to use to design controller. Among these methods, the energy-based control design method has gained a lot of attentions in these years, which can provide more physical insights in nonlinear control. Especially, the port-controlled Hamiltonian system and generalized canonical transformation has some advantages on the modeling and control design of these nonlinear systems. In this paper, we proposed a control design for two-link flexible manipulators via generalized canonical transformation, and the simulation results are shown to prove the effectiveness of the controllers.

SESSION: WP2	**Temasek 2**
Sensing and measurement	

Chair: Xiaoqi Chen
Co-Chair: Tao Liu

15:50
WP2.1: Calculation of Deformation of a Flexible Contact Sensor
Naoki Saito, Toshiyuki Satoh, Hideharu Okano
Akita Prefectural University, Japan

This paper describes the calculation of deformation of a flexible contact sensor. Approximate expressions to calculate the deformation of a flexible sensor are derived using Castigliano's theorem. Deformation of the flexible sensor is calculated in real-time with the use of measured contact forces. Measurement accuracy is confirmed experimentally. The experimental results show that the calculated deformation agrees approximately with the actual deformation. With the aim of applying this calculated deformation to certain robot tasks, the flexible sensor is attached to a robot hand, and the mechanical impedance parameters of a grasped object are estimated with the use of a Kalman filter. This grasping experiment demonstrates that these parameters are estimated exactly.

16:10
WP2.2: Identification & Super-Precision Control of a Linear Stage driven by a Voice Coil Motor
Jianfa Wang, Wensheng Yin, Yu Zhu, Guanghong Duan
Tsinghua University, China

Identification and Control of an air bearing linear stage driven by a Voice Coil Motor are considered. The load of the stage is more than 5Kg, and the model has to include the mode of mechanism for high bandwidth and high precision motion control. Identification based on normalized coprime factors is introduced for this purpose. A precise model with high order can be derived from the identification, but the order of the model is too high to control design, therefore, model reduction is performed. Finally, a polynomial pole-placement combined with sensitivity function shaping is carried out. The experimental result shows the stage can achieve 10nm position step easily.

16:30
WP2.3: Hybrid Linear Compensation and Improved Hermite Interpolation for Optical Measurement of 3D Airfoil Surface
Xiaoqi Chen, *Dan Wei Wang, *Songlin Bai, Wen Jong Lin
SIMTech, Singapore; *NTU, Singapore

Non-contact optical measurement systems such as laser scanner have been widely used to measure 3D profiles. In the case of measuring a polished turbine airfoil, however, specular reflection on the surface causes "non-measurable" gaps in each optical scan. Conventional techniques like linear interpolation and Spline interpolation become ineffective in reconstructing the surface from such "corrupted" measurement data sets. This work develops a hybrid technique that combines piecewise cubic Hermite interpolation with linear compensation. The technique preserves the shape well, and generates smooth curvature in the specular reflection gap. In comparison with Spline interpolation, it achieves better and more accurate profile fitting.

16:50
WP2.4: Development of Touch Sensor with Optical Positional Sensor
Yoshihiro Tabuchi, Norihiro Abe, Kazuaki Tanaka, *Hiroaki Taki
Kyushu Institute of Technology, Japan; *Wakayama University, Japan

Recently, the news relation the robot is often taken up. The research on the mechanism of the robot and its hand finds constant directionality by the average. A good method is not proposed for controlling them. If a robot with the complete independence is required to produce, it is necessary to incorporate a variety of sense organs into them such as a visual system to recognize the environment, auditory one to react to the voice and sense of touch to detect contact with an object. It is, however, difficult to equip a robot for these five feelings like a human. Then, it is preferable to apply a necessary sensor responding to the system requirements. Thus, It is very important to consider which types of sensors should be applied to the robot. The accuracy of the sensor is very important but the cost and size must be regarded to make the robot install and control them. Then, a new touch sensor is introduce in this paper which is the most important for the robot to grasp an object and manipulating it, and the effectiveness of the sensor is shown. And we have succeeded in reducing more than 90% of traditional sensors.

17:10
WP2.5: A Six-dimension Parallel Force Sensor for Human Dynamics Analysis
Tao LIU, Yoshio INOUE, Kyoko SHIBATA, Yohei YAMASAKI, Masafumi NAKAHAMA
Kochi University of Technology, Japan

In this paper, parallel support principle of force sensor is discussed, and a six-dimension parallel force sensor is presented for human dynamics analysis. The force sensor with parallel support mechanism was designed to measure six-axis reaction forces during human walking. Finite element method was adopted to optimize mechanism

dimension of the force senor. Sensitivity of force sensor was improved by distributing strain gages on the maximum strain positions. A three- direction drag mechanism was designed for calibrating load cells in the parallel force sensor, and method of least squares was used to calculate calibration coefficients.

17:30
WP2.6: Visual Object Tracking by a Camera Mounted on 6DOF Industrial Robot
Nabil Aouf, Hani Rajabi, Nadim Rajabi, Harith Alanbari, Claude Perron
Aerospace Manufacturing Technology Center, National Research Council Canada

In this paper, a visual servoing module based on look and move concept is presented. A Motoman UPJ industrial robot is used to track an object (laser beam projection), which moves within a 2D plane workspace. An industrial controller drives this UPJ robot using non-accessible control architecture. A serial communication protocol, a suitable way to transfer information from and to the robot controller, is used for the proposed visual tracking setup. This setup shows acceptable tracking performance, which is improved by a multi-iteration implementation strategy based on a continuous tracking.

SESSION: WP3   **Temasek 3**
Control design for robot systems
Chair: CC. Cheah
Co-Chair: Pisit Phokharatkul

15:50
WP3.1: Floating Robots by Fuzzy Algorithm
Montri Chatpoj, Boonchana Purahong, Thossaporn Thossansi, Pitikhate Sooraksa
King Mongkut's Institute of Technology Ladkrabang, Thailand

This paper is talking about using Fuzzy PI controller in order to help controlling the gap in magnetic levitation system (Maglev). The details of this paper concerns about the model of maglev system which is applied to floating robot; it is also about how to use Fuzzy PI controller for assisting the maglev system in order to make this system more accurate and faster. From the simulation which compared the reactions between Fuzzy PI and the original PI, it showed that Fuzzy PI had faster response without swaying the output values while it was reaching the setpoint values. Therefore, the Fuzzy PI is suitable for using to control the Maglev system in floating robot.

16:10
WP3.2: Mobile Robot Control Using Type-2 Fuzzy Logic System
Pisit Phokharatkul, Supachai Phaiboon
Mahidol University, Thailand

This paper presents a type-2 fuzzy logic system can be applied to a mobile robot which is a project associated with using infrared sensor as distance sensors, DC motor control system, knowledge of multiplex, RS- 232 interface line, knowledge of microcontroller and knowledge of intelligent system. Infrared sensors are used to measure distance between a robot and obstacle. The type-2 fuzzy logic controller will process data output to control the direction of the mobile robot movement. The behavior-based control for mobile robot was designed, which consists of two tasks, Obstacle avoidance and corridor following. The results obtained demonstrate the efficiency of type-2 fuzzy logic control system and the ability to solve the problems. From the experimental results show the better performances than those using on- off and type-1 fuzzy logic controls.

16:30
WP3.3: Position and Force Control of Robot Manipulators Using Neural Networks
Yu Zhao, Chien Chern Cheah

Nanyang Technological University, Singapore

Most research on force control of robot manipulators has assumed that the kinematics and constraint surface are known exactly. In this paper, the position and force control problem of robots with uncertain kinematics, dynamics and constraint is addressed. An adaptive setpoint control law based on neural networks is proposed. Sufficient conditions for choosing the feedback gains are presented to guarantee the stability. Simulation results are presented to demonstrate the effectiveness of the proposed controller.

16:50
WP3.4: A New Hierarchical Approach for Optimal Control of Robot Manipulators
Nasser Sadati, *Amir Babazadeh
Sharif University of Technology, Iran; *Bremen University, Germany

In this paper, a new approach for optimal control of robot manipulators is presented. For this purpose, the system is considered as a two-level large-scale system, where a gradient based coordination strategy is used to coordinate the overall system. This is achieved within a decomposition-coordination framework, where the robot manipulator is first decomposed into several sub-systems in such a way that each sub- system consists of several consecutive links and joints. With the aim of optimization, the control problem is first decomposed into m sub- problems, at the first level, where each sub-problem is solved using a gradient optimization method. Then, by using a new methodology, which is based on the gradient of interaction prediction errors, at the second level, the coordination of the overall large-scale system is done. This approach provides a new scheme for hierarchical control of robot manipulators with high degree of freedom and the results fairly illustrate the effectiveness of the proposed coordination strategy.

17:10
WP3.5: Optimal Control of Multiple-Arm Robotic Systems Using Gradient Method
Amir Babazadeh, *Nasser Sadati
Bremen University, Germany; *Sharif University of Technology, Iran

Optimal control frameworks are very important in optimization of multiple-arm robotic systems, although complexity, non-linearity and having large scales usually cause some computational problems in the capacity and time needed. In this paper, coordination of multiple-arm robotic systems in order to carry a rigid object is considered and the state space equations for the overall system are developed. Coordination of the robot arms is done through minimizing a related cost function based on the gradient method. This method is simple and easy to be used.

17:30
WP3.6: Immunology-based Control Framework for Multi-jointed Redundant Manipulators
Henry Y. K. LAU, Alex K. S. NG
The University of Hong Kong, China

Artificial Immune System (AIS) has recently been actively researched with a number of emerging engineering applications that has capitalized from its characteristics including self-organization, distributive control, knowledge mapping and fault tolerance. This paper reports the development of an AIS paradigm for the distributive control of a multi- jointed, redundant manipulator. Traditionally, manipulator control is achieved by analytical solutions. By adopting a multiagent-based control paradigm, a multi-jointed manipulator can be thought of as a group of separately controlled agents. In this paper, we investigate the viability of a multiagent immunology–based control framework for the trajectory control of a multi-jointed redundant manipulator.

SESSION: WP4   **Temasek 4**
Data fusion and vision image

Chair: Chellali Ryad

15:50

WP4.1: A Single-lens Trinocular Stereovision System Using a 3F Filter
Yong Xiao, Kah Bin Lim
National University of Singapore, Singapore

This paper describes a passive trinocular stereovision system, which employs only one real camera and a 3F filter. The image captured by this system can be divided into three sub-images, which can be taken as the images captured by three virtual cameras. Two different approaches used to understand this system are presented: one is based on camera calibration technique and another is based on geometrical analysis on ray sketching. The later approach provides an interesting way of understanding this system as it does not require complex camera calibration but one field point test process would be enough to determine this system if pin-hole camera model is used to simulate the virtual cameras, which greatly saves the effort of system determination and implementation. Experiments are conducted to test the feasibilities of both approaches.

16:10

WP4.2: Superquadrics Model Recognition from Stereo Image
Tsuyoshi Shimizu, Makoto Obi, Nobuyuki Furuya, *Shigeki Toyama
University of Yamanashi, Japan; *Tokyo University of Agriculture and Technology, Japan

This paper presents the process of recognition of the three dimensional object and calculation of similarity. The object is recovered from stereo image and superquadrics function is used as the model. The superquadrics is parametric and volumetric model. It is represented by expanded elipse function. And genetic algorithm is used for recovering of an object shape. A fitness function of genetic algorithm is defined using texture features of object on the stereo image. The features are shared area and difference of intensity among the left image and the right image. Parameters of superquadrics which replaced by parameters of genetic algorithm are optimized and the superquadrics form fits to a solid body object. In the case of multiple body object, the object is divided on the image, and each solid body is recovered. The objects used in experiment are a cube, a cylinder and an eliptic column. The algorithm is useful for the recovery of the object under stereopsis. After recovery, the similarity between the recovered object and the model in the computer is calculated.

16:30

WP4.3: A Benchmark For Measuring Mobile Robot Environment Modelling Performance
Simon Egerton, Victor Callaghan
University of Essex, United Kingdom

This paper presents a novel benchmarking toolkit suitable for quantitatively evaluating the performance of mobile robot environment modelling methods, thus allowing comparisons to be made. The benchmark measure is based on re-localisation, itself a practical navigation task and is demonstrated on a biomimetic survey navigation model developed within our research group and implemented on an autonomous mobile robot. The results show that the benchmark can usefully quantify an implementation of the model, based on predefined criteria, and can be used to find optimal model parameters.

16:50

WP4.4: Study on a SVM-Based Data Fusion Method
Xizhe Zang, jie Zhao, chen Wang, Hegao Cai
Harbin Institute of Technology, China

A new two-stage SVM-based data fusion strategy is proposed and it is applied to obtain the accurate information of the robot gripper state. Support vector machines (SVM) operate on the principle of structure risk minimization which not only keeps the empirical risk minimal but also control VC confidence of discriminate functions, hence better generalization ability is guaranteed. In this paper, the basic principles of SVM are discussed first and then a classified and graded data fusion strategy is proposed according to the features of the problem of gripper information data fusion. Finally, experimental results demonstrate the advantages and efficiency of the proposed approach.

17:10

WP4.5: The Desargues Theorem to Build Matching Graph for N Images
Chellali ryad, *maaoui choubeila, *fontaine jean-guy
Ecole des mines de nantes, France; *Ensi Bourges, France

In this paper, we propose a new approach for matching image points by exploiting minimal geometric knowledge and in a correspondanceless way. The idea underlying our approach is to use a generalization of the Desargues theorem in images sequence context. This approach allows the matching image points over a sequence without using correlation techniques. The corresponding points are calculated directly using the Desargues invariants. Examples on real and synthetic images are presented. Results are illustrated and discussed.

17:30

WP4.6: Scan Matching for Flooded Subterranean Voids
David Silver, David Bradley, Scott Thayer
Carnegie Mellon University, USA

This paper presents a new technique for scan matching with sparse, noisy sensors such as sonar range finders. This method allows an underwater vehicle to estimate its position within a 2-D plane. When combined with other sensors typically used on such vehicles, full 6 degree of freedom pose estimation is possible in flooded subterranean environments. Our approach uses a particle filter and an approximation of the likelihood of sensor readings, based on nearest neighbor distances, to approximate the probability distribution over possible poses. We present simulated results based on field-collected data, demonstrating our approaches advantages over traditional scan matching techniques.

Thursday, 2 Dec 2004, 10:00-12:00

SESSION: TA1	Temasek 1
Underwater robotics	

Chair: Thomas Braunl
Co-Chair: Leslie Fife

10:00
TA1.1: Identification and Control of Underwater Vehicles with the Aid of Neural Networks
Pepijn van de Ven, Colin Flanagan, Daniel Toal, Edin Omerdic
University of Limerick, Ireland

In this paper the use of neural networks for the identification of underwater vehicle dynamics is studied. A flexible way of identifying dynamics is desirable for several reasons. The dynamics of underwater craft are highly non-linear and cross coupling between various degrees of freedom normally exists. To date at best empirical models are available to describe these phenomena. On top of this the underwater environment can change drastically as a result of e.g. weather conditions. Due to their ability to adapt for changing circumstances in an online fashion, neural networks offer an interesting alternative for more conventional means of identification. This paper details an identification process using neural networks. To illustrate the performance of this identification process, these neural networks are then used directly or indirectly in a feedforward loop to control the craft in a simulation study.

10:20
TA1.2: Adaptive Setpoint Control of Underwater Vehicle-Manipulator Systems
Yeow Cheng Sun, Chien Chern Cheah
Nanyang Technological University, Singapore

In this paper, we propose a class of simple adaptive setpoint controllers for underwater vehicle-manipulator systems (UVMS). The proposed controllers do not require any knowledge of the inertia matrix, Coriolis and centripetal force, and hydrodynamic damping except the gravity regressor. In addition, we also address the problem of uncertainty in manipulator kinematics, which has not been considered in the literature of control of UVMS. By using Lyapunov's direct method and LaSalle's invariance principle, we characterize the class of controllers and provide simple explicit conditions on the controller gains to ensure stability. Simulation results are presented to demonstrate the effectiveness of the proposed controllers.

10:40
TA1.3: A Regional Point Descriptor for Global Topological Localization in Flooded Subterranean Environments
David Bradley, David Silver, Scott Thayer
Carnegie Mellon University, United States

A regional point descriptor for global localization using natural landmarks in flooded subterranean environments is presented. Global localization in underwater environments is complicated by a lack of sensors that land robots depend on for position estimation such as GPS, LADAR, and wheel odometry. This descriptor, the slide image, is designed to take advantage of orientation references available in subterranean voids while tolerating expected pose estimation errors in the horizontal plane. It will serve as the basis of a robust topological navigation system for Minefish, an untethered, borehole deployable AUV designed to map flooded mines. Results are presented from tests on sonar data collected in the Wakulla springs tunnel system in Florida.

11:00
TA1.4: The Autonomous Underwater Vehicle Initiative – Project Mako
Thomas Braunl, Adrian Boeing, Louis Gonzales, Andreas Koestler, Joshua Petitt
University of Western Australia, Australia

We present the design of an autonomous underwater vehicle and a simulation system for AUVs as part of the initiative for establishing a new international competition for autonomous underwater vehicles, both physical and simulated. This paper describes the competition outline with sample tasks, as well as the construction of the AUV and the simulation platform.

11:20
TA1.5: AUV Neuropsychological Architecture with BDI
Haibo Liu, Guochang Gu, Jing Shen, Xingce Wang
Harbin Engineering University, China

Most of the previous researches on AUV (Autonomous Underwater Vehicle) architecture focused on the autonomy and reactivity of AUV, so the researchers spent most time on the physical structure of AUV, but ignored the psychological (or mental) model of AUV. However, the psychological model is very important for AUV to act in an unexpected and ill-structured undersea environment. In this paper, we propose an AUV neuropsychological architecture (ANPA) based on BDI (Belief-Desire-Intention) and neuropsychological theories. ANPA consists of three units: thinking unit, reflex unit and perception unit, and each unit is composed of three cortices. ANPA combines the mental model of agent with the neural structure of AUV. Based on ANPA, we have developed a simulated AUV with more proactiveness, autonomy and sociability without debasing reactivity.

11:40
TA1.6: TOUCH: A Robotic Vision System for Underwater Object Tracking
Anuj Sehgal, Jason Kadarusman, Leslie Fife
Brigham Young University Hawaii, USA

TOUCH is a real-time computer vision system that has been developed in order to aid the operation of autonomous underwater vehicles (AUVs) and remotely operated vehicles (ROVs). The algorithm is based on a modified 4-connectivity approach that scans the incoming frames for a target hue range and based upon the largest connected blobs of hue, tracks an object and provides the two dimensional Cartesian coordinates of the desired object. Since few algorithms exist for tracking and recognizing objects in underwater environments, this algorithm provides a way for AUVs and ROVs to acquire, track or recognize objects by using a relatively fast and inexpensive vision system. This paper presents the details on TOUCH, its testing, some areas that warrant improvement and possible course of action for the future.

SESSION: TA2	Temasek 2
Novel actuators (Invited Session)	

Chair: Guilin Yang
Co-Chair: Kok-Meng Lee
Organizer: Guilin Yang

10:00
TA2.1: A Hybrid Approach for Magnetic Field Analysis
Liang Yan, Chee Kian Lim, I-Ming Chen, *Guilin Yang, *Wei Lin
Nanyang Technological University, Singapore; *Singapore Institute of Manufacturing Technology, Singapore

A new form of 3-DOF spherical actuator having a rotor mounted with rare-earth-magnet poles is developed. Since the air-core coils are used in this actuator, the magnetic flux distribution is different from that of conventional electromagnetic devices. In this paper, the solution of the Laplace equation is used to derive the general form of the magnetic field, and a curve fitting approach is proposed to obtain the mathematic expression of the magnetic field. This mathematical representation of the 3D magnetic field can be

applied to the torque modelling of the 3-DOF spherical actuator. Experimental studies have been conducted to determine the critical parameters and verify the effectiveness of the proposed approach.

10:20
TA2.2: Mechanical Design & Numerical Electromagnetic Analysis of a DC Spherical Actuator
Chee Kian Lim
Nanyang Technological University, Singapore

The focus of this research is to design and develop a spherical actuator for robotics applications. Unlike prior works, this project proposes a new type of DC spherical manipulator that operates from the forces generated between pairs of air core electromagnetic coils and permanent magnets. The novelty of the proposed design is demonstrated by utilizing air core coils as stator poles. This eliminates the drawbacks of existing spherical electromagnetic device where the performance is significantly hindered due to inherent detent an force, hysteresis and saturation issue that arises from the ferromagnetic component. The ability to be able to accurately model the electromechanical phenomenon and predict the output torque is essential for high precision motion control. Numerical analysis of the electromechanical forces is performed using FEM software. Design experience in spherical actuators, unlike that of single DOF electromagnetic motors, has been limited and intricate due to the three dimensional nature of the output motion. This paper aims to present the design methodology and electromechanical analysis in a concise and orderly manner that may serve as a starting point for design optimization and research.

10:40
TA2.3: Design Method for Prototyping a Cost-effective Variable-reluctance Spherical Motor (VRSM)
Kok-Meng Lee, Jeffry Joni, Hungsun Son
Georgia Institute of Technology, USA

In this paper, we present a CAD/CAE procedure for designing a VRSM. The procedure offers an effective way to optimize key parameters that could significantly affect the torque performance of a VRSM. Specifically, the analytical procedure streamlines the design process using a conceptual design as an input to create 3D solid models, upon which FE analyses are performed to optimize key parameters. As an illustrative example, we introduce the design concept of a Spin-VRSM capable of open- loop orientation control while its rotor spins continuously and demonstrate the concept feasibility experimentally

11:00
TA2.4: Parametric Study on Pole Geometry and Thermal Effects of a Variable-reluctance Spherical Motor (VRSM)
Kok-Meng Lee, Zhiyong Wei, Jeffry Joni
Georgia Institute of Technology, USA

The variable-reluctance spherical motor (VRSM), which offers some attractive features by combining pitch, roll, and yaw motions in a single joint, is essentially a brushless, direct-drive actuator. Unlike a multi-axes actuating mechanism where the number of electrical inputs typically equal to its number of controllable degrees of freedom, the VRSM offers a large number of distributed electrical inputs as compared to the number of controllable DOF. Since larger number of small coils is used, it not only effectively increases the surface area for heat dissipation, but also allows a small amount of current to flow through each of the coils. This distributed actuation offers an effective means to overcome heat dissipation problems commonly associated with direct- drive actuators for high torque applications. To exploit the advantages offered by this unique feature that provides a greater flexibility in design and control, a good understanding of the key parameters that could significantly

influence the motor performance is essential. For this reason, we present in this paper some results of a detailed parametric study on the effects of pole geometry on the thermal and torque performance of a three degrees-of-freedom (DOF) VRSM.

11:20
TA2.5: Sensor-less Fusion of Speed for Permanent Magnet Synchronous Motors
Jean Quirion, *Jason Gu
International Rectifier Automative, Canada; *Dalhousie University, Canada

In the field of electric motor control, extensive efforts have been devoted to the development of position sensor-less motor drives. In this paper, a novel fusion algorithm is proposed. The algorithm seamlessly fuses the information generated by a high and a low-speed sensor-less technique. The resulting sensor-less drive, based on novel fusion algorithm, permits position sensor-less operation over the entire speed range. Simulation results show minimal error between the estimated and actual motor position. Furthermore, it is shown that the novel fusion algorithm resolves the position polarity problem, which characterizes low-speed sensor-less techniques.

11:40
TA2.6: Property Analysis for Series MR-Fluid Damper Actuator System
Wei Zhou, Chee-Meng Chew, Geok-Soon Hong
National University of Singapore, Singapore

This paper presents a model for a series Magneto-Rheological (MR) fluid damper actuator (SMRDA). In this model the higher order dynamics caused by the MR fluid damper is considered. The effect of the MR fluid dynamics on the system properties, in term of system bandwidth and output impedance, for the recently proposed series damper actuator (SDA) is analyzed and simulated. It is then compared with the series Newtonian viscous damper actuator (SNVDA).

SESSION: TA3	Temasek 3
Multi-robots and swarm	

Chair: Michael Schluse
Co-Chair: Adel Al-Jumaily

10:00
TA3.1: Pheromone Communication: Implementation of Necrophoric Bee Behavior in a Robot Swarm
Anies Hannawati Purnamadjaja, R. Andrew Russell
Monash University, Australia

Currently, there is great interest in learning about the behaviour of social insects, because of the valuable inspiration that they can provide in the area of swarm robotics. This paper reports the current progress of an investigation into the possibility of using pheromones as a means of communication between members of a robot swarm. In this project, interaction between members of a robot swarm is modeled on one form of pheromone communication that is used by social bees. In social bees this necrophoric behaviour is used to recognize a bee corpse within the nest and to remove it. In the context of a robot swarm one of the proposed applications for this behaviour is to locate and rescue disabled robots that release a pheromone as a form of distress signal. This paper describes the swarm robots used in this project, the robot control algorithm and results of practical experiments.

10:20
TA3.2: Intelligent Control in Dynamic System
Ariuna Damba, Shigeyoshi Watanabe
University of Electro-Communications, Japan

This paper presents a method for obtaining optimal policies

which allow for action planning and optimal control in non-communicating multiagent system. In this system homogeneous agents have the same structure and domain but act and are situated differently in the world. Lack of information about each other's internal state and observation inputs may lead to non-desirable prediction in planning and control, since they may not be able to predict the world change. To cope with missing knowledge, agents simulate each other's behavior as part of environment dynamic and build their own policy based on the local data from the simulation episodes. Reinforcement learning method is applied to derive the policy of future actions, where agents compute and update the result repeatedly towards the goal. The Monte Carlo approach is used in solving the reinforcement problem from simulated experiences. Since each agent learns to adapt it's policy to environment changes, the global picture is supposed to appear as multiagent coordination. Multiple vehicles domain, where there is no communication among the vehicles and sensing of vehicle is limited, is considered under simulation model.

10:40
TA3.3: Supervisory Control Methods for Model Based Control of Multi Agent Systems
Eckhard Freund, Jürgen Rossmann, Michael Schluse, Christian Schlette
Institute of Robotics Research, Dortmund, Germany

The development of control systems for multiple cooperating robot manipulators with redundant kinematics still is a demanding task. This task becomes even more challenging if the robots to be controlled operate in at least partly unknown environments which vary over time and which may be thousands of kilometers away from the operator, for example in space. To solve this task, the Institute of Robotics Research (IRF) combines Supervisory Control methods in the form of the newly developed State Oriented Modeling methodology with latest robot simulation technology, realizing an absolutely new approach for robot control purposes. This approach regards the robots manipulators from a Discrete Event System point of view. Using the State Oriented Modeling methodology, supervisors and controllers for those systems can be developed in a nearly intuitive way resulting in robust, fault-tolerant robot controllers. Using 3D simulation technology for model based robot control, the robot controller knows not only its own kinematic chain but also all the objects in its environment. This simplifies the task of object oriented robot programming, sensor information processing, environment model update, etc. once more. On the other hand, this allows for a smooth transition from robot simulation to robot control, because the same algorithms simulate the virtual and control the physical robots.

11:00
TA3.4: Swarm Formations using the General Formation Potential Function
Shuzhi Sam Ge, Cheng-Heng Fua, Wei-Ming Liew
National University of Singapore, Singapore

This paper presents a method for synthesizing classes of potential functions, which corresponds to commonly used formations, from a general formation potential function by altering the values of a fixed set of parameters. These potential functions may then be used for formation control in swarms of agents. The properties of the potential functions are also examined in this paper. In addition, obstacle avoidance and target tracking behaviors are also implemented on the individual agents. Simulation studies have been carried out to verify the effectiveness of our approach.

11:20
TA3.5: Behavior Based Multi Robot Cooperation by Target/Task Negotiation

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Adel AL-JUMAILY, Serge Kozak
University of Technology, Sydney, Australia

A multi agent approach and robotics behaviors can be classify as a type of distributed intelligence. This distributed intelligence has an advantage to solving particular problems through benefiting from "Divide and Conquer" approach. Inherent parallelism of multiple agents can do many, perhaps different things, at the same time. Multiple agents are able to be in different places at the same time and can achieve different goals at the same time. Our paper is presenting achieving of static and dynamic goals completion through agent negotiation. The robotic agents shall assist each other in goal acquisition. This can be achieved in any environment with no map or determined damnation. The agents in our work do not necessarily know it's location in the environment during its goal acquisition. Our work is allowing easy location communication between agents in indoor environment.

11:40
TA3.6: An Efficient Strategy Integrating Grid and Topological Information for Robot Exploration
Menglei Jia, Guangming Zhou, Zonghai Chen
University of Science and Technology of China, China

Efficiency is an important issue to robot's autonomous exploration of unknown environments, which is the focus of this paper. When exploring, usually, robot evaluates the candidate observation points according to a utility function, and the point that maximizes this utility function is selected. This paper advances a grid-topological utility function for decision making of the next observation point. Our strategy whose core is this utility function can be used in the exploration by single robot system or multi-robot system. A new path-planning algorithm— Cost Overflow— is also proposed, which enables our strategy run on line. Experiment with real robot system and simulation results show that our strategy is efficient in both time and energy.

SESSION: TA8   **Level 2a Foyer**
                        Posters

TA8: Application of Fuzzy Controller for a Special Triangle Robot with Two Degrees of Freedom
Sohrab Khanmohammadi, Ali Aghagolzadeh, Majid Amjadi, Rasoul Esmaeilzadeh, Ahmad Ghanbari
University of Tabriz, Iran

In this paper a new robot with two degrees of freedom is designed and the dynamic model of the system, based on precise mathematical equations, is determined. It is shown that this new triangle robot can be used in filling taking and sketching application in industry. A simple controlling rule, based on Fuzzy theory, is introduced for applying in a robotic system. This robot can be used with different applications in automobile industry. The laboratory sample, that is designed in this work can be developed and used in different production lines, specially in hierarchical and hybrid systems as a pointer, dyer and filings taker robot. The computer based simulation results show that application of Fuzzy rules for controlling this type of robot leads to better results than the classical PID methods. In the following sections; the characteristics of the introduced robot is studied.

TA8: Color Image Clustering Segmentation Based on SMCL for Mobile Robot
An Chengwan, Xiong Xiaoming, Yang Yuequan, Tan Min
Institute of Automation, CASIA, China

For conventional clustering segmentation of color image, it is necessary to predetermine the number and centers of color-clusters. To fulfill unsupervised clustering segmentation of visual color images for mobile robot, this paper proposes multiprototypes-take-one-cluster (MPTOC)

strategy and splitting-merging competitive learning (SMCL). Based on MPTOC, SMCL can adaptively detect appropriate clusters' number of an input dataset. Experiment on mobile robot CASIA-1 validates MPTOC and SMCL.

TA8: Development and Control of BLDC Motor using Fuzzy Models
Junhyuk Choi, Chang-Woo Park, Sehyun Rhyu, Hagyeong Sung
KETI, Korea

This paper presents the design and control of a small Brushless DC (BLDC) Motor. In order to control the developed BLDC motor, Adaptive Fuzzy Control (AFC) scheme via Parallel distributed Compensation(PDC) is developed for the multi- input/multi-output plant model represented by the Takagi-Sugeno(TS) model. The alternative AFC scheme is proposed to provide asymptotic tracking of a reference signal for the systems with uncertain or slowly time-varying parameters. The developed control law and adaptive law guarantee the boundedness of all signals in the closed- loop system. In addition, the plant state tracks the state of the reference model asymptotically with time for any bounded reference input signal. The suggested design technique is applied to the velocity control of a developed small BLDC motor.

TA8: Fuzzy Control Scheme for Dual-Acting Magnetic Bearing Actuator System
Maki Habib
Monash University Malaysia, Malaysia

Active magnetic bearings are increasingly being utilized in rotating machinery applications as an alternative to the conventional rolling- element and fluid-film bearing types. Magnetic bearing is an open-loop unstable system, and in most practical applications, a PID controller is utilized to ensure stable operation of the rotating machinery. The PID controller, however, becomes ineffective when the machine operates in highly nonlinear regimes. This paper develops a fuzzy logic control scheme to improve the performance of a dual-acting magnetic bearing actuator system operating in nonlinear regimes. The nonlinearity in this system is due to the relationship between the forces generated in the electromagnetic actuator and the coil current and the air gap between the rotor and the stator. The dynamic response of the magnetic bearing actuator system based on the fuzzy logic scheme proposed in this work was found to be much better as compared to the response of the system based on the conventional PD controller. The fuzzy logic control scheme presented in this work may be used for the nonlinear control of systems that operates in nonlinear regimes.

TA8: Mobile Robot Localization using Optical Mice
Sooyong Lee
Hongik University, Korea

Open-loop position estimation methods are commonly used in mobile robot applications. Their strength lies in the speed and simplicity with which an estimated position is determined. However, these methods can lead to inaccurate or unreliable estimates. Two position estimation methods are developed in this paper, one using a single optical flow sensor and a second using two optical sensors. The first method can accurately estimate position under ideal conditions and when wheel slip perpendicular to the axis of the wheel occurs. A second method can accurately estimate position even when wheel slip parallel to the axis of the wheel occurs. Location of the sensors is investigated in order to minimize errors caused by inaccurate sensor readings. Finally, the method is implemented and tested using a mobile robot with sensors. Estimates of position were found to be as accurate as dead-reckoning in ideal conditions and much more accurate in cases where wheel slip occurs.

TA8: H-Infinite Control of Ship Steering
Wang Xingcheng, Ren Ying
Dalian Maritime University, China

This paper is concerned with an investigation into the use of Two Degree of Freedom(TDF) H-infinite control theory [6] to a ship autopilot design. The method can overcome computation difficulty of classical H-infinite optimization method due to the origin pole of ship model. The presented TDF H-infinite robust controller can guarantee the robustness and the performance of closed-loop. The autopilot is being used to control the yaw dynamics of "DaQing-233" ship model. Simulation results presented show the viability of such an approach. It is shown that the designed TDF H-infinite controller of autopilot can steadily keep and quickly change ship course under various navigation.

Thursday, 2 Dec 2004, 13:00-15:20

SESSION: TM1	Temasek 1
Intelligent control	

Chair: Zhenyu Yang
Co-Chair: Ping Jiang

13:00
TM1.1: Online Evolutionary Control using A Hybrid Genetic Based Controller
Somyot Kaitwanidvilai
Naresuan University, Thailand

Servo system controlled by the proposed hybrid GA based controller is presented in this paper. Due to their powerful optimization property, genetic algorithms are currently being investigated for development of a learning controller. However, because of time consuming in evolutionary process and the unstable response during learning period, most of genetic based controllers are implemented on off-line learning problems. To investigate this controller for the online learning, in this paper, a hybrid control architecture that integrates bang-bang controller with a genetic based controller is proposed. Bang-bang control is applied in the case of the actual output is far away from the set point (high error range). In such mode, bang-bang control is required to avoid the unstable response. In medium and small error ranges, a genetic based controller is applied as a learning controller. Simulation results demonstrate the effectiveness and learning ability of the proposed controller.

13:20
TM1.2: Design of Active Noise Control Using Feedback Control Techniques for An Acoustic Duct System
Zhenyu Yang
Aalborg University Esbjerg, Denmark

The design of Active Noise Control (ANC) using feedback control techniques for a one-dimensional acoustic duct system is explored. The complex-value-based mathematical model of the total system is developed and verified. The sensitive parameter - acoustic terminal impedance is estimated using the system identification method. The ANC design is formalized into a set of standard control design problems with respect to specific requirements. Some simple PID controllers are developed for the considered ANC system. The simulation and test results show a bright potential to use feedback control techniques for a simple but efficient ANC design.

13:40
TM1.3: Design of an Ultra-precision Vibration Isolation System by Imitating the Special Organic Texture of Woodpecker's Brain
Mei De-qing, Yang Ke-ji, Chen Zi-chen
Zhejiang University, China

In this paper, a bionic structure model of ultra-precision vibration isolation system is presented by imitating the special organic texture of woodpecker's brain. The vibration isolation system mainly consists of giant magnetostrictive actuators, air-springs, a pedestal and a rubber layer. The air-springs are used to reduce high frequency vibrations, and the giant magnetostrictive actuators are used to reduce low or ultra-low frequency vibrations. In order to reduce thermal distortion caused by temperature rise of coil, a constant temperature cooling system is developed for giant magnetostrictive actuator. In consideration of complex vibration environment and self-nonlinearity of vibration isolation system, a two dimensional fuzzy active control system with two regulation factors is designed. The experiment results show that the bionic vibration isolation system has good performance against floor disturbances. It can be applied to the vibration isolation system of the ultra-precision measuring and manufacturing devices.

14:00
TM1.4: Design of a Mode-based Controller for 3-DOF Vibration Isolation System
Md. Emdadul Hoque, Masaya Takasaki, Yuji Ishino, Takeshi Mizuno
Saitama University, Japan

This paper presents an active suspension technique for a three-degrees- of-freedom (3-DOF) vibration isolation system using negative stiffness. A mode-based digital controller is designed based on a theoretical model to generate negative stiffness by active suspension. The active suspension mechanism, in conjunction with a conventional spring in series, can generate infinite stiffness against direct disturbances on the isolation table. Three-axis motions of the isolation table in the vertical directions are actively controlled by the proposed system. Experimental results show that the active suspension system using the proposed controller well evaluates and describes the zero-compliance against direct disturbances.

14:20
TM1.5: On Learning Transient and Cutoff Frequency Tuning in ILC
Bin Zhang, Danwei Wang, Yongqiang Ye
Nanyang Technological University, Singapore

Many iterative learning control (ILC) design methods employ a low-pass filter to guarantee good learning behavior. To determine the cutoff frequency of the filter, a system model is often required. Because the inaccuracy of system model in practice, the learnable bandwidth obtained from the model is often chosen as a conservative value. This can severely underachieve in learning performance. In this paper, we address the learning transient and cutoff frequency tuning. Based on this, the learnable bandwidth of system can be tuned automatically so that the balance can be reached between good learning transient and tracking accuracy. The attractive properties include that the system model is not necessary and that the tracking error during this process is kept in an acceptable level. Experiments on a SCARA robot are carried out to illustrate the tuning process.

14:40
TM1.6: Iterative Learning Control of MIMO Systems with Less Model Knowledge
Ping Jiang, *Huadong Chen
University of Bradford, UK; *Tongji University, China

To design a stable iterative learning control, it often requires some prior knowledge about the unknown systems. In some applications, such as uncalibrated visual servoing, the knowledge is too hard to be gained. This paper proposed an iterative learning control for a class of MIMO systems. The controller consists of a Nussbaum-type gain selector for roughly probing proper control gain matrix and a refined

compensator learned through repetitive tracking. It is able to guarantee convergence of the learning control even without any knowledge about the system. Stability of the proposed controller is proved and simulations are carried out to verify the proposed method.

15:00
TM1.7: Robust Output Tracking of Transverse Flux Machines Using RBF Neural Network
hamidreza karimi, *amir babazadeh, *N. Parspour
University of Tehran, Iran; *University of Bremen, Bremen, Germany

This paper presents an application of Radial Basis Function (RBF) in identification and control design of Transverse Flux Machines as nonlinear systems with unknown nonlinearity part. The technique of feedback linearization and H_infinity control are used to design an adaptive control law for compensating the unknown nonlinearity part, such the effect of cogging torque as a disturbance will be decreased onto the angle and angular velocity tracking performances.

SESSION: TM2	Temasek 2
Robot Control	

Chair: Susumu Hara
Co-Chair: Jiamei Deng

13:00
TM2.1: Adaptive NN Control of Uncertain Nonholonomic Systems in Chained Form
Zhuping Wang, Shuzhi Ge, Tong Heng Lee
National Unversity of Singapore, Singapore

In this paper, adaptive neural network (NN) control strategy is presented to solve the control problem of nonholonomic systems in a chained form with unknown virtual control coefficients and strong drift nonlinearities. The adaptive NN control laws are developed using state scaling and backstepping. The proposed control is free of control singularity problem. Adaptive control based switching strategy is adopted to overcome the uncontrollability problem associated with $x\_0 (t\_0)=0$. Uniform ultimate boundedness of all the signals in the closed- loop are guaranteed, and the system states are proven to converge to a small neighborhood of zero. The control performance of the closed-loop system is guaranteed by appropriately choosing the design parameters.

13:20
TM2.2: Different Structure Based Control System of the PUMA Manipulator with an Arm Exoskeleton
Can-Jun Yang, Bin Niu, Jia-Fan Zhang, Ying Chen
Zhejiang University, China

In this paper, we proposed a novel approach to control the famous PUMA manipulator with an arm exoskeleton which has been developed to enable force-feedback teleoperation and has totally different structures and dimensions from PUMA. We presented the hardware configuration and software implementation of the whole system, and then a particular issue was associated with workspace matching, which proved to be the key step for different structure based master/slave manipulator control. Finally, the conclusion was discussed, as well as the prospect of future work.

13:40
TM2.3: A Precise Multi-location Riveting System Using Remote Monitoring and Control
Hsiung-Cheng Lin
Chien Kuo Technology University, Taiwan

Today, Programmable Logic Controllers (PLC) are widely used at the modern manufacturing automation. With an increasing demand for a natural, intuitive man-machine interaction in automated industry, the graphical

programming with PLC is gaining much attention nowadays. In this paper, a PC-based virtual instrument (VI) that can carry out a remote monitoring and control for a precise PLC based riveting system via the Internet is developed. The real-time implementation shows its well performance and presents the illustrative demonstration.

14:00
TM2.4: Application of constrained predictive control on a 3D crane system
Jiamei Deng, *Victor Becerra
University of Reading, UK; *University Of Reading, UK

This paper describes the SIMULINK implementation of a constrained predictive control algorithm based on quadratic programming and linear state space models, and its application to a laboratory-scale 3D crane system. The algorithm is compatible with Real Time Windows Target and, in the case of the crane system, it can be executed with a sampling period of 0.01 s and a prediction horizon of up to 300 samples, using a linear state space model with 3 inputs, 5 outputs and 13 states.

14:20
TM2.5: Positioning of a Cart by Means of a Smooth Switching from Servo Access Control to Impedance Control
Susumu Hara
Toyota Technological Institute, Japan

Power-assist system technology and its applications to manufacturing systems, rehabilitation and welfare services have attracted special interest recently. In the field of manufacturing systems, automobile assembly processes utilizing power-assist systems exist. Many power-assist systems for industrial uses possess simple power-assisting function only. Conveyance of controlled objects is generally processed by another system. However, it seems that the progress of such actuators as linear motors produces single actuator which realizes both the functions. Taking the above expectation into account, this fundamental study proposes a positioning method of a cart with motor by means of a smooth switching from the servo access control for the conveyance function to the impedance control for the power-assisting function. We apply the idea of the nonstationary optimal control method to obtaining the smooth switching. The controller is formulated as a state feedback style utilizing time-varying feedback gains. The effectiveness of the method is verified by experiments.

14:40
TM2.6: Neuro-Sliding Mode Control of Robotic Manipulators
Shubhi Purwar, *Inder Narain Kar, *Amar Nath Jha
National Institute of Technology, Allahabad, India; *Indian Institute of Technology, Delhi, India

This paper considers neuro-adaptive control of robotic manipulators based on sliding mode technique. Since robotic manipulators are inherently nonlinear systems, neural network (NN) based controllers have been proposed as a feasible technique to achieve consistent performance, owing to the adaptive nonlinear learning capabilities of NNs. Chebyshev neural network (CNN) is employed to approximate the unknown nonlinearities associated with robotic manipulators. The design basically consists of a neural controller which implements the equivalent control law associated with sliding mode technique for the manipulator with unknown dynamics and an adaptive switching gain which provides robustness and compensates for the neural approximation errors and the disturbances in the system. A single layer CNN is used to realize the proposed controller whose weights are updated online and the Lyapunov stability theory is used to prove the ultimate uniform boundedness of the tracking error. Simulation results illustrate the effectiveness of the proposed method to achieve desired performance in the presence of bounded disturbances.

15:00
TM2.7: A DSP-based Permanent Magnet Linear Synchronous Motor Servo Drive Using Adaptive Fuzzy-Neural-Network Control
Faa-Jeng Lin, Po-Hung Shen
National Dong Hwa University, Taiwan

An adaptive fuzzy neural network (AFNN) control system is proposed to control the position of the mover of a field-oriented control permanent magnet linear synchronous motor (PMLSM) servo drive system to track periodic reference trajectories in this study. In the proposed AFNN control system, a FNN with accurate approximation capability is employed to approximate the unknown dynamics of the PMLSM, and a robust compensator is proposed to confront the inevitable approximation errors due to finite number of membership functions and disturbances including the friction force. The adaptive learning algorithm that can learn the parameters of the FNN on line is derived using Lyapunov stability theorem. Moreover, to relax the requirement for the value of lumped uncertainty in the robust compensator which comprises a minimum approximation error, optimal parameter vectors, higher-order terms in Taylor series and friction force, an adaptive lumped uncertainty estimation law is investigated. Furthermore, all the control algorithms are implemented in a TMS320C32 DSP-based control computer. The experimental results due to periodic reference trajectories show that the dynamic behaviors of the proposed control systems are robust with regard to uncertainties.

SESSION: TM3	Temasek 3
Humanoid and legged robots	

Chair: Catherine Lyons
Co-Chair: Zhenwei Wu

13:00
TM3.1: Bipedal Motion Estimation with the Human Odometer
Catherine Lyons, William Ommert, Scott Thayer
Carnegie Mellon University, USA

The problem of human localization presents unique challenges, particularly in areas where GPS satellite signals may be blocked for a significant period of time. Presented here is a new approach to localization based on a physical model of human motion. Data is taken from inertial measurement units on the limbs, and gait analysis is used to detect and measure different modes of human motion from this data. This approach produces an accurate form of dead reckoning that is less prone to drift than current inertial navigation systems and more adaptable then current pedometry systems.

13:20
TM3.2: A Framework for the Coordination of Legged Robot Gaits
Joel Weingarten, *Richard Groff, Daniel Koditschek
University of Michigan, USA; *University of California, Berkley, USA

This paper introduces a framework for representing,generating, and then tuning gaits of legged robots. We introduce a convenient parametrization of gait generators as dynamical systems possessing designer specified stable limit cycles over an appropriate torus. This parametrization affords a continuous selection of operation within a coordination design plane, inspired by biology, spanned by axes that determine the mix of "feedforward/feedback" and "centralized/decentralized" control. Tuning the gait generator parameters through repeated physical experiments with our robot hexapod, RHex, determines the appropriate operating point, the mix of feedback and degree of control decentralization, to achieve significantly increased performance relative to the centralized feedforward operating point that has governed its

previous behavior. The present preliminary experiments with these new gaits suggest that they may permit for the first time locomotion over extremely rough terrain that is almost as reliable, rapid, and energy efficient as the very fastest or most efficient outcomes centralized feedforward gaits can achieve on level ground.

13:40
TM3.3: Design and inverse dynamic analysis of a humanoid robot
Li Yanjie, Tan Dalong, wu zhenwei, zhong hua
Shenyang Institute of Automation, China

In this paper, we first present the mechanism system configuration, basic control structure of a humanoid robot constructed by our laboratory .The human-sized robot has an all-orientation wheel mobile vehicle with 3-DOF, two 7-DOF arms, one 2-DOF neck and one 2-DOF waist (totally 21 DOF). As follow, we build the humanoid's dynamic model based on the Newton-Euler method. Using the model, we simulate and analyse the dynamic characters of the humanoid. The simulation results are presented and the results will be the significant basic for the stability analysis and control of the humanoid in the future works. The humanoid is expected to be a common tested in experimental and discussion for various aspects of intelligent humanoid robotics.

14:00
TM3.4: Real Time Obstacle Detection and Navigation Planning for a Humanoid Robot in an Indoor Environment
Edward T.P. Wong, Ray Jarvis
Monash University, Australia

This paper describes a stereo vision guided humanoid that can perform real time obstacle detection, path analysis and navigation planning on a carpet floor. The real time obstacle detection algorithm uses the two dimensional disparity gradients approach to detect the obstacle on the floor without constructing the floor plane and affine adjustment even though the baseline of the camera system is not parallel with the floor. The size of the obstacle that can be detected is as small as 30mm in diameter. The navigation planning is performed by using a Distance Transform method in which a shortest path is found and then the number of footsteps required to reach the destination is calculated.

14:20
TM3.5: Motion Generation for Bipedal Robot Using Neuro-musculo-skeletal Model and Simulated Annealing
Kenta Taki, Yoshihiko Itoh, Shohei Kato, Hidenori Itoh
Nagoya Institute of Technology, Japan

In this paper, we propose a stochastic approach to CPG-based motion generation of bipedal robot. We make an extension to a motion control system based on Neuro-musculo-skeletal model into three dimensions, and give an optimization of control parameter by Simulated Annealing. We do not only obtain walking montion by our approach but provide some empirical verification of various walking patterns adaptive to different link structures. In addition to straight walk, this paper gives the performance results of turning walk to right and left.

14:40
TM3.6: Open-Loop Stability - A New Paradigm for Periodic Optimal Control and Analysis of Walking Mechanisms
Katja Mombaur, Georg Bock, Johannes Schlöder, *Richard Longman
IWR, University of Heidelberg, Germany; *Columbia University, New York, USA

The present paper deals with the numerical solution of periodic optimal design and control problems, such that the resulting optimal trajectories are open-loop stable. This means that under small perturbations the real process will asymptotically converge back to the periodic orbit without any feedback corrections. Open-loop stability is defined in terms of the spectral radius of the monodromy matrix which is a difficult non-standard optimization criterion. In particular we consider applications in one- and two-legged walking robots with point feet, which can not stand still stably, but will be shown to be able to walk or run in an open-loop stable way given the right configuration and control. This class of problems is characterized by discontinuous dynamics with impact, multiple motion phases and changing degrees of freedom. The numerical results which are obtained by a two-level optimization approach not only suggest that walking robots can be built without sophisticated feedback devices, but may also have an impact on understanding biomechanical motions and their stability.

15:00
TM3.7: Online Generation of Stable Gait for Biped Robots with Feedback Loop Algorithm
Konstantin Kondak, Guenter Hommel
Technische Universitaet Berlin, Germany

The paper is devoted to the problem of stable gait generation for bipeds. The presented algorithm enables an online generation of stable gait patterns with minimal computational effort. The gait patterns are specified by the user with few task parameters: step size, step duration and walking speed, which can be changed in the generation process or during the movement of the robot. The algorithm is based on feedback loop scheme, composed of linearized and decoupled non-linear model of the biped and time synchronized controllers. The closed form solution of the gait generation problem for a simplified model was considered to derive formulas for parameters required by the algorithm. The balancing/stabilization of the robot is achieved by appropriate change of the joint accelerations. The algorithm is applied to the 3D model of the biped. The performance of the algorithm was studied and demonstrated in a simulation. The algorithm can be used as gait patterns generator, as a high level controller as well as for balancing/stabilization of existing movement trajectories.

SESSION: TM4	Temasek 4
Mobile robot path planning	

Chair: David Hsu
Co-Chair: Harry Chia-Hung Hsu

13:00
TM4.1: Online Path Searching for Autonomous Robot Navigation
Meng Wang, James Liu
The Hong Kong Polytechnic University, China

"Blind" goal reaching, a common autonomous robot navigation task, is applied in highly dynamic and unknown environments. In this it differs from "heuristic" goal reaching, which makes use of a geometrical or topological environmental map. Traditionally, blind goal reaching combines both obstacle-avoidance (OA) and goal-seeking (GS) behaviors, yet this is not a sufficient way to obtain a smooth path. And even more seriously, if the robot meets a dead end, the "OA+GS" approach may cause the dead-cycle (or local minimum) problem. This paper proposes a novel approach, Memory Grid (MG), which imitates the human memory and decision making functions. MG-based online Path Searching (PS) behavior provides a novel alternative to blind goal reaching. The experiments, including tests on a real sonar-based robot navigating in dead ends, have demonstrated not only that the performance of the "OA+GS+PS" approach is superior to that of "OA+GS" navigation algorithms, but also that, unlike the traditional "OA+GS" approach, it can solve the dead- cycle problem.

13:20
TM4.2: A Pseudo Random (PR) Code Based Ultrasonic Navigation System (UNS)

Wan-Li Yao
DSO National Laboratories, Singapore

An Ultrasonic Navigation System (UNS) has been designed and tested for marker-less AGV navigation. This solution is based on Pseudo Random (PR) coding on the transmitter side and coherent correlation on the receiver side, to achieve higher positioning accuracy, much longer detection range and better robustness to the environment acoustic noise, compared to a traditional short pulse UNS. The system concept is quite similar to a GPS pseudolite system, except that RF propagation is replaced by ultrasonic waves here. Such a change makes the UNS easier to implement, and thus more cost-effective for the proposed application, compared to a GPS pseudolite solution. Prototypes have been built to verify the design concept and performance capability. 0.72cm pseudo range measurement error and 30m detection range have been achieved in the lab testing.

13:40
TM4.3: Task Based Approach on Trajectory Planning with Redundant Manipulators, and Its Application to Wheelchair Propulsion
Hiroki Miura, Goro Obinata, *Makoto Sasaki, *Takehiro Iwami, Atsushi Nakayama
Nagoya University, Japan; *Akita University, Japan

In this paper, we introduce an optimization method for the trajectory planning of redundant manipulators, which achieve a given task with high efficiency, and apply the method to wheelchair propulsion problem. GA is used to optimize the redandant variables of manipulator. Additionally, the procedure of the method does not use any forward dynamics computation. The effectiveness of the proposed algorithm has been shown by applying the method to wheelchair propulsion.

14:00
TM4.4: Comparing Harmonic Functions and Potential Fields in the Trajectory Control of Mobile Robots
Gedson Faria, Roseli Romero, *Edson Prestes, **Marco Idiart
University of Sao Paulo, Brazil; *Unilasalle, Brazil; **UFRGS, Brazil

Potential Field is a reactive method that has been used for trajectory control of mobile robots. In this method the robot behaves like a particle moving under the influence of an artificial potential produced by the target and the obstacles. This method has lower computacional cost than others that utilize maps as a world model. However, one problem of this method is that it can generate regions of local minima. In these regions the driving force vanishes due to specific obstacle and goal configurations and the robot gets trapped. The use of harmonic functions for the potential calculation can solve this problem. In the Harmonic Function method the environment is represented by a grid, in which cells with an obstacle have their potential value set to 1 whereas cells that contain the target have their potential value set to 0. A relaxation algorithm is then employed to calculate the harmonic potential among the obstacles and the target. In this work, these two techniques have been applied in robot soccer environment to develop game strategies. Results obtained show that both techniques present better results when compared to the standard strategy of FIRA Simulator. Further, a comparison of these techniques is presented for showing the advantages and disadvantages existing in each one of them.

14:20
TM4.5: A Robot Path Planning Approach Based on Generalized Semi-infinite Optimization
Han Liu, Qianying Tang, *Yongji Wang
University of Toronto, Canada; *Institute of Software, Chinese Academy of Sciences, China

This paper inherits the fundamental ideas of inequality and optimization techniques from the previous work and converts the real-time obstacle avoidance problem into a semi-infinite constrained optimization problem with the help of a delicate mathematical transformation, which leads to an efficient real-time robotics' path planning approach. Motivated by the practical requirements of obstacle representation, a generalized semi-infinite optimization problem (GSOP) with not only intersection but also union operations was proposed and a mathematical solution to it was developed. Simulation results in 3D space have been presented to show its merits.

14:40
TM4.6: Adaptively Combining Multiple Sampling Strategies for Probabilistic Roadmap Planning
Daivd Hsu, *Zheng Sun
National University of Singapore, Singapore; *Hong Kong Baptist University, China

Several sophisticated sampling strategies have been proposed recently to address the narrow passage problem for probabilistic roadmap (PRM) planning. They all have unique strengths and weaknesses in different environments, but in general, none seems sufficient on its own. In this paper, we present a new approach that adaptively combines multiple sampling strategies for PRM planning. Using this approach, we describe an adaptive hybrid sampling (AHS) strategy using two component samplers: the bridge test, a specialized sampler for narrow passages, and the uniform sampler. We tested the AHS strategy on robots with two to eight degrees of freedom. These preliminary tests show that the AHS strategy achieves consistently good performance, compared with fixed-weight hybrid sampling strategies.

15:00
TM4.7: Platoon Lane Change Maneuvers for Automated Highway Systems
Harry Chia-Hung Hsu, Alan Liu
National Chung Cheng University, Taiwan

The research in automated highway systems (AHS) is gaining attention within the research fields of intelligent transportation systems. Based on the PATH AHS architecture, when a follower wants to change lanes, it needs to use split maneuvers first. A ``lane change within platoons'' maneuver can improve the efficiency of a lane change maneuver. However, platoon lane change (PLC) maneuvers are needed in some situations for an entire platoon to change lanes, but little research focuses on this topic. In this paper, we describe three PLC maneuvers and we use SmartAHS to simulate them.

Thursday, 2 Dec 2004, 15:50-17:50

SESSION: TP1	Temasek 1
Control of systems with delay or dead zone	

Chair: Abdullah Al Mamun
Co-Chair: Zhuping Wang

15:50
TP1.1: Hybrid and Stochastic Stabilization Analysis and H-Infinite Control for Networked Control systems
Yuequan Yang, De Xu, Min Tan, *Xianzhong Dai
Institute of Automation, Chinese Academy of Sciences, China; *1009

In this paper modeling for the setup of time driven sensor node and actuator node, and event driven controller node, is made with network-induced time-delay longer than one sampling period. Based on hybrid theory and LMI method, a sufficient condition of hybrid stabilization analys is obtained. Then a stochastic stabilization condition for this networked control system is given. Finally we further to

propose an H- infinite control scheme for this class of networked control system.

16:10
TP1.2: Developing IEC 61499 Compliant Distributed Systems with Network Enabled Contorllers
Tanvir Hussain, Georg Frey
University of Kaiserslautern, Germany

Advances in hardware and fieldbus communication have brought modern industrial automation systems at a place where the developers of that field found the modeling and development too complex to be solved with the existing tools. IEC 61499 evolved principally to provide a generic distributed modeling platform which can on one hand simplify the modeling of distributed systems and on the other hand diminish the differences between business system and industrial system software modeling. This paper shows how IEC 61499 can model a flexible and reconfigurable distributed application. A particular realization of the application deployed on a network-enabled controller is also shown. A prospective generalization of the developed system is depicted consisting of network-enabled controllers on which implemented codes of the IEC 61499 model can be deployed.

16:30
TP1.3: Adaptive Backstepping Control of a Class of Uncertain Nonlinear Systems with Unknown Dead-Zone
Zhou Jing, Wen Changyun, *Zhang Ying
Nanyang Technological University, Singapore; *Singapore Institute of MAnufacturing Technology, Singapore

In this paper, we consider a class of uncertain dynamic nonlinear systems preceded by unknown dead-zone nonlinearities, in the presence of bounded external disturbances. By using backstepping technique, robust adaptive backstepping control algorithms are developed. Unlike some existing control schemes for systems with dead-zone, the developed backstepping controllers do not require the uncertain parameters within known intervals. Also no knowledge is assumed on the bound of the `disturbance-like' term, a combination of the external disturbances and a term separated from the dead-zone model. It is shown that the proposed controllers not only can guarantee global stability, but also transient performance.

16:50
TP1.4: Digital Stabilization of Fuzzy Systems with Network-Delay
Jongbae Lee, Chang-Woo Park, Joongki Chung, Hagyeong Sung
KETI, Korea

This paper presents the design methodology of digital fuzzy controller (DFC) for the systems with time-delay. We propose the fuzzy feedback controller whose output is delayed with unit sampling period and predicted. The analysis and the design problem considering time-delay become easy because the proposed controller is synchronized with the sampling time. The stabilization problem of the digital fuzzy system with time-delay is solved by linear matrix inequality (LMI) theory. Convex optimization techniques are utilized to solve the stable feedback gains and a common Lyapunov function for designed fuzzy control system. To show the effectiveness the proposed control scheme, the network control example is presented.

17:10
TP1.5: Combined Direct and Indirect Adaptive Control of Robot Manipulators Using Multiple Models
Kemal Ciliz, *Ahmet Cezayirli
Bogazici University, Istanbul, Turkey; *Kultur University, Istanbul, Turkey

In this paper a novel methodology is proposed for the adaptive control of rigid robotic manipulators. The proposed method utilizes multiple adaptive models for the identification and control of the manipulator. The present work is an extension of our previous work which utilized an indirect adaptive control approach with multiple models. The proposed scheme in this paper uses a composite approach where both prediction and tracking errors are used in a combined direct and indirect adaptive control framework. Simulation results are given to demonstrate the efficient use of the methodology.

SESSION: TP2	**Temasek 2**
Issues on real time implemetation	

Chair: Jorge Cabrera-Gámez
Co-Chair: Mohammed Bani Younis

15:50
TP2.1: Experimental Study of Hybrid Cam Mechanism
Avinash Panga, Bhartendu Seth
Indian Institute of Technology, Bombay, India

In this paper we have presented a programmable hybrid mechanism (PHM) capable of producing various types of translatory profiles while carrying loads of upto 5 kilograms. The output is driven by a five bar mechanism, which, in turn, is driven by a servo input and a reference input. By choosing the correct trajectories of the servo input and the starting position, the torque sharing characteristics can be improved, such that the lowest rating servo motor will sufice. Thus providing flexibility at a reduced cost. Also the reference input which can be a constant speed motion can be derived from some other source, thus not needing a dedicated motor. Such a device can replace cams in applications where the functional relationship between the input and the output motions changes from time to time, such as packaging equipment and control of valve timings of IC engines. The PHM setup has been designed and fabricated. Simulation of the mechanism is carried out using ADAMS, to determine the size of servo motor. An approach to determine optimal control input to the mechanism for a given output profile is discussed. The experimental setup allows users to generate various cam profiles and study the deviations. Various profiles were generated within reasonable accuracy. A typical cam profile has been considered and optimization of control trajectory results in RMS torque reduction of 57%.

16:10
TP2.2: Formalization of PLC Programs to Sustain Reliability
Mohammed Bani Younis, Georg Frey
University of Kaiserslautern, Germany

The complexity of existing PLC programs precludes dealing with or modifying them. The interest in the formalization of PLC programs has increased in recent years to overcome this problem. Formal methods can provide for the development of PLC programs, since they serve as a medium to analyze and verify them due to increased awareness of safety and quality. This is done by performing what is known as Verification and Validation (V&V). Moreover formal methods support re-use of already implemented PLC programs to meet new production demands. This paper examines different possibilities to formalize PLC programs. It explains the pros and cons of these different alternatives. The paper outlines a formal description of timers and counters used in PLC programs according to the alternative that fulfills the criteria best.

16:30
TP2.3: Implementation of Fuzzy Control Approach for MIMO Robotics Systems
Touati Youcef, Amirat Yacine
University of Paris Val de Marne, France

This paper proposes an effective approach of Fuzzy logic

controller (FLC) design and optimization methodology for Cartesian robot control. The FLC is based on a Takagi Sugeno (TS) model. It consists on MISO- controllers sub- sets decomposition. The FLC optimization methodology is implemented off-line and proceeds in three phases: A first set of rules is extracted automatically from training data using Rapid Prototyping algorithm (RPA). In the second phase, the positioning of all membership functions in the universe of discourse is then optimized by Solis and Wetts method in conjunction with RPA algorithm. Finally, a stochastic gradient method is implemented to modify the conclusions and then to increase the optimization quality and performances. Once the resulting FLC is generated and optimized, it is implemented, on line, in an external position/force control structure and tested on an experimental cell following circular trajectory under force constraints. In this case, a Back-Propagation (BP) method is implemented. To show the effectiveness of the proposed approach, the methodology and experimental results are described and discussed.

16:50
TP2.4: Research on An Integrative System for Automatic Dynamic Balancing Emendation Based on PCI Bus
Yang Ke-ji, Wu Er-yong
Zhejiang University, China

According to the dynamic balancing emendation application state in our country and the development direction of this technique, an integrative automatic dynamic balancing emendation system for motor rotor of electric tools, comprising dynamic balancing measurement module, machining module, workpiece transferring manipulator and using PCI bus to exchange information between them, is established in this paper. Meanwhile, a kind of universal computer board, which can be simultaneously applied to above three composing parts of this system for measuring and controlling, is studied and developed, some key techniques about the signal integrity and intelligent, fast input or output data transferring methods for this board are solved. This system has been applied to electric tool industry successfully, its application results testify that the computer board developed in this paper possesses reasonable function setup, steady and reliable performance, wider space for renewal and renovation; Moreover, the system established using this board also characterizes compact structure, high reliability, strong flexibility and high ratio of performance to price, etc.

17:10
TP2.5: Integrating Systems in Robotics
José L. Fernández-Pérez, Antonio C. Domínguez-Brito, José D. Hernández-Sosa, Jorge Cabrera-Gámez
IUSIANI, Universidad de Las Palmas de Gran Canaria, Spain

Developing software for controlling robotic systems is costly due to the complexity inherent in these systems. There is a need for tools that permit a reduction in the programming efforts, aiming at the generation of modular and robust applications, and promoting software reuse. The techniques which are of common use today in other areas are not adequate to deal with the complexity associated with these systems. This document presents CoolBOT, a component oriented framework for programming robotic systems, based on a port automata model that fosters controllability and observability of software components. A simple demonstrator illustrates the benefits of using the proposed approach.

SESSION: TP3	Temasek 3
Fault diagnosis and maintenance	

Chair: Xiaodong Liu
Co-Chair: Daniel Racoceanu

15:50
TP3.1: A Remote Diagnosis System for Rotating Machinery

Using Virtual Reality.
Moez Bellamine, Norihiro Abe, Kazuaki Tanaka, *Peng Chen, **Hirokazu Taki
Kyushu Institute of Technolgy, Japan; *Mie University, Japan; **Wakayama University, Japan

It is important to look for alternative forms of physical movement of people and equipment in order to assure diagnosis and maintenance tasks, especially in an environment where workers are subject to danger. An evident and classical solution is the use of the tele- operation and tele-robotics. If the tele-operation helps to solve a lot of real and technical problems, it still remains insufficient to assure an appropriate remote diagnosis and maintenance. The use of virtual reality techniques with the tele-operation can be the solution for an effective remote maintenance and diagnosis. In this paper we show the inefficiency occurred with the use of only tele-operation in the remote maintenance, we introduce our original new system where we use 2D-3D matching and virtual reality techniques with tele-operation to remotely collect machinery vibration data. We explain its structure, implementation and its advantages. We finished by experimenting the system, measuring the different operating times and precision and discuss the results.

16:10
TP3.2: Evaluating the use of Multimedia Tool in Remote Maintenance of Production Machinery in the Automotive Sector
Min Huey Ong, Szer Ming Lee, Andrew A. West, Robert Harrison
Loughborough University, UK

Remote maintenance offers several advantages to manufacturing. However, it is also important to understand the challenges and changes that such an implementation will bring to the enterprises and the stakeholders, from the business and human perspectives. This paper looks into a method for evaluating the effectiveness of remote maintenance based on the implementation of a component based control system in the automotive sector. The paper first provides a general view of the automotive industry and the current remote maintenance procedure. It will then highlight the Component-Based Approach which is the underlying architecture for the remote maintenance services reported in this paper. A method for evaluating remote maintenance is explained and an example of the test is described. The paper concludes with the identification of the issues associated with remote maintenance.

16:30
TP3.3: The Decomposition Algorithm of AFS Structure and Its Applications to Failure Diagnosis
Xiaodong Liu, *Yibing Wang, **Wanquan Liu
Dalian Maritime University, China; *Shenyang University of Technology, China; **Curtin University of Technology, Australia

A new fuzzy model for pattern recognition in failure diagnosis has been established by AFS(Axiomatic Fuzzy Sets) theory. But the complexity of systems brings this difficulty in analysis. By the analysis of the AFS structure for systems, the independent components for AFS structures is studied, and an algorithm of searching for the independent sub-AFS structures is proposed. The complexity of real world application system can be greatly reduced by this algorithm with failure diagnosis as an example. So the speed and accuracy of failure diagnosis can be improved. The example of failure diagnosis for a marine diesel engine demonstrates the advantages of this approach.

16:50
TP3.4: Hierarchical Fault Diagnosis: Application to an Ozone Plant

Abdolrasul Mohammadi Idghamishi, Shahin Hashtrudi Zad
Concordia University, Canada

A framework for on-line passive fault diagnosis in hierarchical finite- state machines (HFSM) is presented and applied to an ozone generation plant. This approach takes advantage of system structure to reduce computational complexity. Here, the system model is broken into simpler substructures called D-holons. A diagnoser is constructed for each D-holon. At any given time, only a subset of the diagnosers are active, and as a result, instead of the entire model of the system, only the models of D-holons associated with active diagnosers are used for diagnosis. Furthermore, a set of sufficient conditions is provided under which the diagnosis process becomes semi-modular. The ozone generation plant under study, consisting of two units, is modeled as an HFSM. It is shown that a proper choice of sensors results in modular diagnosis (one diagnoser for each unit). Following the proposed framework, a hierarchical fault diagnosis system is designed for the plant. It is shown that the proposed approach significantly reduces the complexity of constructing and storing the diagnosis system.

17:10
TP3.5: Overview on Diagnosis Methods Using Artificial Intelligence
Maxime Monnin, Daniel Racoceanu, *Noureddine Zerhouni
Université de Franche-Comté - Besançon, France; *Ecole Nationale de Mécaniques et Microtechniques de Besançon, France

This paper studies diagnosis-aid systems that use Artificial Intelligence tools. This kind of systems becomes very interesting in an uncertain industrial environment especially for flexible production systems. An overview of the most important artificial intelligence diagnosis tools is given. For each tool, we focus on diagnosis principles and on its advantages and disadvantages. That allows us to extract four important points that a diagnosis tool should fulfilled. Using these results, we propose a tool based on fuzzy Petri nets which allows to make a diagnosis using a model easy to build and that take into account the uncertainties of maintenance knowledges. This tool provides abductive approaches of fault propagations system with an efficient localization and a characterization of the fault origin. At the end, we apply our tool on an illustrative example of a flexible system diagnosis is presented.

Friday, 3 Dec 2004, 10:00-12:00

SESSION: FA1	Temasek 1
Environment modeling for localization	

Chair: Ray A. Jarvis
Co-Chair: Sang-Chul Lee

10:00
FA1.1: A Fast Algorithm to Plan a Collision-Free Path in Cluttered 2D Environments
Kai Wing TANG, Ray JARVIS
Monash University, Australia

Planning collision-free paths in 2D environments is not a new problem in the field of robotics. Methods to plan paths which are optimal in the sense of either length or safety tolerance were well reported decades ago. However, most, if not all, of these algorithms require extensive computational resources, i.e. long computing time, large amount of memory or complex data structures to calculate, especially in highly cluttered environments. This paper presented a simple but fast algorithm, which provides a close to optimal path between any two points in highly cluttered 2D environments. It can find a path whenever one exists and can indicate when none exists. The cost of pre-processing is relatively light and the data structure is simple. Comparisons have been made against the conventional distance transform and we find that this new algorithm is twenty times faster in average.

10:20
FA1.2: Development of a 3D LADAR System for Autonomous Navigation
Teck Chew Ng, Javier Ibanez Guzman, *Jin Chang Tan
Singapore Institute of Manufacturing Technology, Singapore; *Nanyang Technological University, Singapore

A novel approach for the development of a 3D Laser Radar (LADAR) system for vehicle guidance is presented. A rotating mirror assembly is used to deflect the beam scan of a 2D laser to obtain the 3rd dimension. The mirror assembly is constructed by joining six mirrors to form a hexagon-shaped reflector. By rotating this mirror assembly in front of the 2D laser, 3D range images of the scene in front of LADAR are obtained. The data is processed to detect obstacles; the purpose-built user interface shows a top and front view of the 2D obstacle map, plus the 3D modeling of the environment. The system has been tested in both indoor and outdoor environments and the results are presented. The deployment of this perception system, on a mobile platform, has been implemented to guide an autonomous mobile platform.

10:40
FA1.3: Omnidirectional Vision-based Mapping by Free Region Sweeping
Sang-Chul Lee, *David Kriegman
University of Illinois at Urbana-Champaign, USA; *University of California, San Diego, USA

This paper addresses the problem of systematic exploration of an unfamiliar environment to build a qualitative map by searching for recognizable targets. While exploring, a map is constructed which contains a set of regions of free space delineated by recognizable targets (landmarks) and the connectivity (adjacency and overlap) of these regions. As the robot moves along a trajectory while tracking a landmark, a region of free space is swept out. By representing a collection of free regions and their region-to-region connectivity as a graph, path planning amounts to graph search, and execution of the plan by a robot amounts to local movements to enter into the next free region. Both for exploration and for navigation, no metric information about the robot's path nor absolute coordinates of its position or of

landmark locations are required or recorded. After exploring, the robot produces a compact map which covers a large area, and provides information for fast self-localization and flexible path planning.

11:00
FA1.4: Covert Robotics: Hiding in Known Environments
Mohamed Marzouqi, Ray Jarvis
Monash University, Australia

This paper is an extension to a previous work on our research in path planning: Covert Robotics. In this paper, a new application is introduced where the aim is to allow a mobile robot in a known environment to escape the observation of moving sentries. Whether the initial sentries' locations are known or can be predicted, our hiding strategy insures the overall robot co-vertness for the longest possible time by planning a covert path to an appropriate hiding position in the environment. The Time-to-Exposure algorithm, that is introduced here, is our approach to achieve the hiding strategy. The algorithm gives a value for each free cell specifying the maximum guaranteed time before possible observation by one or more sentries. The same strategy has been tested on a different situation where the robot has continuous information about the moving sentries' locations. The hiding technique was tested using a simulator, which shows promising results. A number of test cases are presented.

11:20
FA1.5: On the Control of a Wheeled Mobile Robot Goalkeeer
Fethi Belkhouche, Boumediene Belkhouche
Tulane University, USA

This paper deals with the control of a wheeled mobile robot goalkeeper, where the goalkeeper's task is to intercept the ball before it goes inside the goal. The control law is based on the use of the kinematics equations and some geometrical rules. In our control strategy, the goalkeeper moves in a predefined path, which corresponds to a rendezvous course. The goalkeeper is controlled in the linear velocity to intercept the ball. We consider various simulation examples.

11:40
FA1.6: Visual Odometry for an Outdoor Mobile Robot
David Fernandez, Andrew Price
Monash University, Australia

This paper presents an alternative solution to the problem of estimating the motion of an outdoor mobile robot through odometry. The solution consists of the use of vision and pseudo-optical flow techniques to make motion estimates of a camera attached to the robot chassis. The use of vision makes the system independent of locomotion (for example, the differences between a robot with wheels and one with legs) and is shown to be applicable to a variety of outdoor ground surfaces, such as tarmac, gravel, grass and dirt. Finally, the simplified calculations result in high processing speeds on moderate equipment, with experiments showing that high speed motion (approximately 300 degree per second rotations and 350 millimetre per second translations) can be reliably estimated.

SESSION: FA2	Temasek 2
Robot design for a functionality	

Chair: Abdullah Al Mamun
Co-Chair: Jacky Baltes

10:00
FA2.1: To Naively Smell As No Robot Has Smelt Before
Gideon Kowadlo, R.Andrew Russell
Monash University, Australia

This paper presents a new intelligent odor localization strategy, which enables a robot to locate the source of an odor in a cluttered indoor environment. Traditionally, work in this area has focused on open areas free of obstacles and having no walls or possessing walls without openings. Existing solutions predominantly use reactive algorithms to navigate along the entire length of the odor plume to the source. Not only is this slow, but in a cluttered indoor environment it may not be possible. In a constrained environment, airflows tend to circulate in sectors and well-defined plumes that lead upwind to the odor source do not exist. We have developed a sense-map-plan-act style control strategy to model the airflow in the environment using naïve physics, then use the model to reason about odor dispersal, move to key positions gathering information, and make a prediction of the most likely location for an odor source. The control strategy has located the odor source for a variety of room configurations. This paper describes details of the control strategy, practical experiments, and results.

10:20
FA2.2: Design and Fabrication of a Gyroscopically Stabilized Single Wheeled Robot
Abdullah Al Mamun, Tanveer Saleh, Haw Hann Yap, Zhu Zhen, Prahlad Vadakkepat
National University of Singapore, Singapore

Conventional design of mobile robot ensures its stability by keeping the gravity vector through the center of mass inside the structure's polygon of support determined by the contact points between the structure and the ground. This assumption of quasi-static stability fails to hold when the robots moves at high speed as the inertial forces become significant compared to the static gravitational force. On the other hand, the momentum of the moving structure can be exploited to enhance stability if it is dynamically controlled. This principle was used exploited to build a gyroscopically stabilized single-wheeled robot by the researchers at Carnegie Melon University (CMU). Our design follows the same principle for stability but uses a different mechanism to effectuate the forward and reverse motion.

10:40
FA2.3: Reinforcement Learning for a Snake-like Robot Controlled by a Central Pattern Generator
Shuichi Fukunaga, *Yutaka Nakamura, **Kazuaki Aso, ***Shin Ishii
Nara Institute of Science and Technology, Japan; *CREST, JST, Nara Institute of Science and Technology, Japan; **Future Project Division, Toyota Motor Corporation, Japan; ***Nara Institute of Science and Technology, CREST, JST, Japan

A snake has large potential to move in various environments by drastically changing its 'gait' pattern, in spite of its simple body. We configured a control scheme for a snake-like robot, using a central pattern generator, and developed a learning algorithm to acquire a good control rule in a changing environment. Although the snake-like robot has a large degree of freedom, a computer simulation showed that a control rule that allows the robot to move to a target direction on an inclined ground or in a changing environment is obtained by our scheme.

11:00
FA2.4: Development of Stretcher Component Robots for Rescue Activity
Yuki IWANO, Koichi OSUKA, *Hisanori AMANO
University of Kobe, Japan; *National Research Institute of Fire and Disaster Japan, Japan

We discuss a conceptual design of rescue robots against nuclear-power plant accidents. We claim that the rescue robots in nuclear-power plants should have the following properties. (1) The size is small. (2) The structure is simple. (3) The number of the robots is large. This paper studies the rescue robots to rescue people in an area polluted with radioactive leakage in nuclear power institutions. In particular, we propose the rescue system which consists of a group of small mobile robots. First, small traction robots set the posture of the fainted victims to carry easily, and carry them to the safety space with the mobile robots for the stretcher composition. In this paper, we confirm that the stretcher component robots could transport and convey a 40kg dummy doll. And, we also show an application usage of stretcher robot.

11:20
FA2.5: Practical Ego-motion Estimation for Mobile Robots
Shawn Schaerer, Jacky Baltes, John Anderson
University of Manitoba, Canada

Accurate ego-motion estimation is a difficult problem that humans perform with relative ease. This paper describes two methods that are used in conjunction to estimate the ego motion of an intelligent autonomous vehicle from vision alone. First, a cross-correlation method is used to select a promising patch in the image. The optical flow information for this patch is used to determine linear and angular velocity of the intelligent autonomous vehicle. Lines in the image are then used to provide an estimate of the ego motion of the vehicle. The gradient of the line as well as the distance to the line allow the computation of current wheel velocities. Both methods have been implemented on real robots and have been tested in a treasure hunt competition. These methods greatly improved the exploration as well as accuracy of the generated maps of the environment.

11:40
FA2.6: Behavior Implementation in Autonomous Agents using Modular and Hierarchical Neural Networks
Flávio Silva, Mauro Roisenberg, Guilherme Bittencourt, Renato Vieira, Jorge Barreto
Federal University of Santa Catarina, Brazil

This paper describes the development of a modular and hierarchical Artificial Neural Network (ANN) control architecture that is capable to implement behavior in Autonomous Agents (AAs). We make considerations about biological paradigms, as evolutionary mechanisms and animals' behaviors, trying to find solutions that, once applied to the development of artificial devices, provide more robust and useful autonomous agents to operate in the real world. This work investigates the relations between structure and function in both artificial and natural neural networks, and how increasingly complex behaviors can be achieved through the interaction of these neural structures, from the simple reflexive behavior to the most complex behaviors that need mapping and planning capabilities. The paper also proposes a special module for conversion of the inputs of the sensorial and control networks into propositional symbols to be processed at the highest level of the architecture, the symbolic level (in development).

SESSION: FA3	Temasek 3
High performance systems and control	

Chair: Kay Soon Low
Co-Chair: Jing-Sin Liu

10:00
FA3.1: A High Performance Precision Machine
Kay Soon Low, *Meng Teck Keck
Nanyang Technological University, Singapore; *Ngee Ann Polytechnic, Singapore

In the area of precision engineering industries, high performance positioning precision machines are increasingly employed to improve the productivity and to lower the manufacturing cost. In many applications such as the photonics or biomedical products, there are increasingly demands for machines that have positioning accuracy of several micrometers. In this paper, we present a prototype precision machine that has a positioning accuracy of 1 μm and a peak speed above 1 m/s. The precision positioning machine uses a three phase permanent magnet linear motor as the actuator. As it is capable of producing linear motion directly, it eliminates the needs of mechanical transmission from the rotary to the linear motion. High closed loop performance has been achieved by using a state space based model predictive controller and a dynamic friction compensation system. The friction and the control system have been optimally identified and tuned using the genetic algorithm. Experimental results have verified the effectiveness of the developed approach.

10:20
FA3.2: Comparing Classical and Optimal Control of 3D Hovering
Thanis Nuchkrua, Nattachai Juthong
Rangsit University, Thailand

This paper presents the design, construction, simulation and implementation of a three degree of freedom (DOF) hovering device, 3D-hoering, capable of a pitch, roll and yaw directions motion control. The controller employs the linear quadratic regulator (LQR) combined with Kalman filter. Simulations shows that our proposed controller outperform the conventional controller terms of position tracking, speed and stability. Moreover, the system is implemented on Pentium PC in order to support from which preliminary simulation results are presented.

10:40
FA3.3: Design of Critical Control Systems Using Genetic Algorithm and LMI-based Regional Pole Assignment Technique
Toshiyuki Satoh, Naoki Saitoh
Akita Prefectural University, Japan

A methodology for designing critical systems subject to magnitude- and rate-limited reference inputs is proposed. The worst-case tracking error is minimized under the constraint on the control effort. The LMI-based technique developed by Chilali and Gahinet is utilized to assign the resulting closed-loop poles into the intersection of vertical strips and a conic sector. The optimal pole region is searched by means of the simple genetic algorithm. An illustrative design example of the position control system for a two-inertia system is provided to demonstrate the proposed design methodology.

11:00
FA3.4: A Rank Condition for Rho-exponential Stabilization of Dynamic Caplygin Systems
Ti-Chung Lee, *Jing-Sin Liu
Ming Hsin University of Science and Technology, Taiwan; *IIS, Academia Sinica, Taiwan

The paper investigates the global rho-exponential stabilizability of dynamic nonholonomic Caplygin systems, which is composed a double integrator cascading nonholonomic constraints. A novel decomposition of state is assumed first so that the constraints are linear in certain state variables. A simple and easily verified rank condition for the global rho-exponential stabilizability of Caplygin systems is derived. A feature of our design is that all parameters can be

explicitly determined from the constraint function. For an important class of Caplygin systems which one of the decomposed state is scalar, the rank condition can be explicitly represented as the conditions relating to the degree and non-zero property of the lowest degree polynomials of Taylor series expansion of constraint function at the origin. Moreover, an alternative form of Caplygin system in different coordinates is presented so that the proposed coordinate-dependent criterion can be applied. Examples such as extended power form, the rolling wheel and hopping robot systems are shown to belong to this class of Caplygin systems and thus their rho-exponential stabilizability can be checked by the proposed test.

11:20
FA3.5: Sliding Mode Neural Controller for Nonlinear Systems with Higher-order and Uncertainties
Tri Nguyen, Hung Nguyen, Quang Ha
University of Technology, Sydney, Australia

In this paper, we propose a new neural controller architecture which is derived from adaptive sliding mode control framework for SISO nonlinear system with higher-order and uncertainties. This neural controller can overcome some disadvantages inherent in sliding mode controllers such as chattering problem, complex calculation of the equivalent control term and unavailable knowledge of the upper bounds of system uncertainties. Experimental results for a Coupled Drives CE8 system show that a real-time neural controller has been implemented successfully.

11:40
FA3.6: Collision Control of a Single-link Flexible Arm
Yuichi Sawada
Kyoto Institute of Technology, Japan

Damage avoidance of the flexible manipulators in collision phenomenon with unlooked-for obstacle is a significant problem in industry and space programs. This paper presents a method of control for minimizing damage and/or undesirable vibration of a single-link flexible arm due to collision using a collision detection function based on an innovation process of a Kalman filter constructed for a system without the collision input term. When the collision detection function exceeds an appropriate threshold, it is interpreted that a collision occurs. The controller is constructed for rotating the arm to the desired position in normal operations and interrupting its motion when the collision is detected.

Friday, 3 Dec 2004, 13:00-15:20

SESSION: FM1	Temasek 1
SLAM and localization	
Chair: Gu Fang	
Co-Chair: G.Q. Huang	

13:00
FM1.1: Towards Exteroceptive Based Localisation
Dorian Spero, Ray Jarvis
Monash University, Australia

The intelligent application of a mobile robot, outside the experimental laboratory, requires a robust locomotive strategy that is rarely conducive to stringent kinematic modeling. Localisation methods that rely upon such modeling often fail, as model boundaries succumb to unpredictable events. This paper presents the development of a self-contained localisation system that purposely obviates the need for odometric information, and an associated kinematic model, to provide robot anonymity. Without odometry, the system is oblivious to the non-systematic vagaries of the robotic platform interacting with a natural

domain. The proposed system hypothesises about the robot's absolute pose by algorithmically solving the kidnapped robot problem using exteroceptive based perception. Since no a priori information is assumed, long-term pose fixes are derived within a simultaneous localisation and mapping (SLAM) framework. Preliminary results were gathered using a skid steering mobile robot, equipped with a scanning laser rangefinder, in an outdoor environment. This novel localisation approach was found to be efficient and robust, while exhibiting the capacity for widespread applicability.

13:20
FM1.2: Path Planning for Bearing-only Simultaneous Localisation and Mapping
N.M. Kwok, D.K. Liu, *G. Fang, G. Dissanayake
University of Technology, Sydney, Australia; *University of Western Sydney, Australia

Simultaneous localisation and mapping (SLAM) is the process of estimating the pose of a mobile robot and the locations of landmarks by using sensors. When SLAM is cast as an information extraction procedure, its quality can be defined as the amount of uncertainty contained in the resultant estimation. Due to the characteristic of the bearing-only sensor and the geometry of the environment, the estimation uncertainty relies critically on the amount of information obtained from measurements and the efficiency of information extraction by the estimator. These quantities are dependent on the relative position between the robot and the landmarks, i.e., the path of the robot motion. Therefore, a well planned path of motion for the robot can significantly improve the SLAM quality. A genetic algorithm is adopted in this research to design a near-optimal one-step-ahead robot path subject to a multiple of planning objectives. The use of genetic algorithm together with a Pareto set is proved to be efficient in reducing the estimation uncertainty and improving the quality of SLAM by simulation results.

13:40
FM1.3: SLAM with MTT: Theory and Initial Results
G.Q. Huang, A.B. Rad, Y.K. Wong, Y.L. Ip
The Hong Kong Polytechnic University, China

To make a robot to work for and with human, the ability to simultaneously localize itself, accurately map its surroundings, and safely detect and track moving objects around it is a key prerequisite for a truly autonomous robot. In this paper, we explore the theoretical framework of this problem, i.e. Simultaneous Localization and Mapping (SLAM) with Multiple Target Tracking (MTT), and propose to employ Sequential Monte Carlo Methods (SMCM) as robust and computationally efficient algorithm. After mathematically formulating the problem, we apply a Rao-Blackwellized particle filter to solve SLAM which is partitioned into robot pose and feature location estimations and a conditioned particle filter to solve MTT which is partitioned into robot pose and moving object state estimations, both filters conditioned on robot pose. In detail, we propose Sampling Importance Resampling (SIR) method to estimate robot pose, Extended Kalman Filter (EKF) to estimate feature location, and Hybrid Independent/Coupled Sample-based Joint Probability Data Association Filter (Hyb-SJPDAF) to solve tracking and data association problem. We present some preliminary experimental results to demonstrate the capabilities of our approach.

14:00
FM1.4: A Hough-based Method for Concurrent Mapping and Localization in Indoor Environments
Jose Manuel Pérez, Ricardo Vázquez-Martín, Pedro Núñez, Eduardo Pérez, Francisco Sandoval
University of Malaga, Spain

This paper proposes a method to solve the Simultaneous Localization and Map Building problem based on segments extracted from local sonar based occupation maps. These segments are categorized as new obstacle boundaries of a simultaneously built global segment-based map or as prolongations of previously extracted boundaries. The method is adequate for indoor office-like environments, specially for those environments that can be suitable modelled by a set of segments. The method has been proved in several experiments in the same indoor environment with successful results.

14:20
FM1.5: A Vision Based Road Detection Algorithm
Minghao Hu
Nanjing University of Science and Technology, China

Road detection is one of the basic tasks for automatic guidance. In this paper, a new approach to detect the road is proposed, which firstly segments the images into three classes of regions (road, non-road, uncertain regions) by some features and rules described in the paper, then uses hypothesis and verification strategy to amalgamate the uncertain regions to road or non-road correctly. The algorithm has been applied in an ATRV made by Irobot Company, and experiments show that it is fast and robust for roads detection at a park of our campus.

14:40
FM1.6: Localization of Mobile Robot Based on ID Tag and Web Camera
Weiguo Lin, *Songmin Jia, *Takafumi Abe, *Kunikatsu Takase
The Beijing University of Chemical and Technology, China; *University of Electro-communications, Tokyo, Japan

Localization is one of the most important fundament for mobile robot. A localization system with low cost, easy accomplishment, simplicity, effectiveness and robustness is the aim of researchers all the time. Here, we proposed a novel method for localization of mobile robot using ID tag and WEB camera. In our method, the path map in an indoor environment is expressed with node tree, every node is represented with two landmarks: ID tag and card with the same colour. Pairs of two landmarks are affixed to ceiling of distinct locations, and the middle point of every pair of landmarks in a node indicates the absolute position of the node because of the unique ID of tag, the absolute position of mobile robot can be expressed with the absolute position of node and, position and orientation relative to this node. Localization is implemented with two steps: detecting ID tag in one node with RF communication and measuring position and orientation of mobile robot relative to this node with camera. In this paper, related works are summarized and the advantages of our method are introduced, the scheme of system is described in detail, a fast image processing algorithm for extracting landmarks from background and strategies for system robustness are discussed. Localization experiments show that with this method the errors of relative position and orientation are less than 2.5 cm and 2.5 degree. Navigation showed us that localization with ID tag and WEB camera is feasible for navigation in indoor environment.

15:00
FM1.7: An Approach to Appearance-Based Simultaneous Localization and Map Building (SLAM)
Chun-Fan Lee, Arcot Sowmya
University of New South Wales, Australia

Current robotic localization and SLAM algorithms are restricted to simple geometric features such as lines and

corners as landmarks. The richness of the information provided by visual perception has not been fully explored. This paper presents a vision based SLAM algorithm which utilizes visual information with minimal prior assumptions.

SESSION: FM2	**Temasek 2**
Software and programming for robotics	

Chair: Robert Smith

13:00
FM2.1: Software reuse in robotics: Enabling portability in the face of diversity
Robert Smith, Glenn Smith, Aster Wardhani
Queensland University of Technology, Australia

Software development for robotics applications is characterised by a high degree of specialisation. The reasons for this may centre on the diversity of robotic hardware, limitations on performance, and the need to perform complex and diverse tasks. The result of using such specialised software is an almost non-existent level of software portability. It is proposed that the use of abstraction can enable the use of component software and bring with it the benefits of reuse. Abstraction of robotic hardware and software is difficult, and it is clear that a single robot abstraction is not practical due to the degree of diversity. It is proposed that some middle ground between specialisation and complete abstraction can be found. A second level component framework using fuzzy logic techniques is presented to illustrate how a significant degree of abstraction can be achieved, facilitating software portability, while accommodating the diversity of robotics.

13:20
FM2.2: Query Generation for Helper Robots to Recognize Objects
Rahmadi Kurnia, Md. Altab Hossain, Akio Nakamura, Yoshinori Kuno
University of Saitama, Japan

We are developing a helper robot that carries out tasks ordered by users through speech. The robot needs a vision system to recognize objects appearing in the orders. However, conventional vision systems cannot recognize objects in complex scenes. They may find many objects and cannot determine which is the target. This paper proposes a method of using a conversation with the user to solve this problem. The robot asks a question to which the user can easily answer and whose answer can efficiently reduce the number of candidate objects. It considers the characteristics of features used for object recognition such as the easiness for humans to specify them by word, generating a user-friendly and efficient sequence of questions. Experimental results show that the robot can detect target objects by asking the questions generated by the method.

13:40
FM2.3: Robot Open Structure Link Interconnection (ROSLI)
PREMANAND KUSALAVAN, JONAS DJUANDA, CHOT HUN LIM
Multimedia University, Malaysia

This paper reviews various types of robotic architectures based on their advantages, disadvantages and its relevance for sci-ence and engineering. The main concern would be the 'openness' of the architecture as a whole to the public. A new architecture called ROSLI which is based on the well known 7 layer OSI protocol is suggested and presented. ROSLI integrates useful components from previous robotic architectures while maintaining openness and modularity to its design. Multiple layers that exist in ROSLI is illustrated and described on their functions and necessity. Examples of robot that would fit into the criterion of ROSLI are also depicted.

14:00
FM2.4: PC-Base Off-Line Programming using VRML for Welding Robots in Shipbuilding
Chang-Sei Kim, *Keum-Shik Hong, Hans Yong-Sub Han, Soo-Ho Kim, Soon-Chang Kwon
Daewoo Shipbuilding and Marine Engineering, South Korea; *Pusan National University, South Korea

In this paper, a PC-based off-line programming (PC-OLP) method for welding robots in shipbuilding is proposed. Also, this paper explains the methodology of 3D simulations for new type robotic systems. The proposed OLP system consists of a robot's 3D simulation, a block arrangement simulation, an optimal path planning by genetic algorithm (GA), an automatic robot program generation, and a Tribon CAD interface. The strength of the developed OLP system lies in its flexibility in handling the changes in the robot's target objects. Also, by use of the developed OLP, the operator can generate robot programs very easily and quickly. We employ Visual C++, Open Inventor, Virtual Reality Modeling Language (VRML), and Windows 2000 system. The VRML makes the developed OLP possible to extend to an internet-base OLP. The developed OLP can also be used for other robot applications such as painting or grinding robots in shipbuilding industry.

14:20
FM2.5: Study on "Virtual Robot in Network Environment—Softman"
Pang Jie, *Li Guizhi, Zhang Wei, Tu Xunyan
University of Science and Technology Beijing, China; *Beijing Institute of Machinery, China

The concept, essence, theory foundations, characteristics and models of softman are discussed in this paper. Finally a realizable individual softman overall model is given.

14:40
FM2.6: Formal Languages Aspects as a Tool for Representation and Implementation of Behavior-Based Robotics
Renato Vieira, Mauro Roisenberg, Olinto Furtado
Federal University of Santa Catarina, Brazil

The Behavior-Based Robotics has its foundations on the emergence of robotic behaviors, and aims to providing intelligence and autonomy to actions performed by agents in search of their goals. Although there is a great variety of researches in this field, there are not many works about the formalization of the concepts related to the cognitive entity of the autonomous agents (AAs). This paper makes an effort to establish a parallel with natural models in order to achieve insights of how the robotic behaviors can be represented and set up. The Chomsky Hierarchy Automatas are taking into account as sufficient models to represent the features of the live beings memory. In this way, we consider that a Pushdown Automata (PDA) can represent the short-term memory, as well as, the Turing Machine (TM) can work as a long-term memory. Besides, in order to implement in AAs the concepts concerning to these automatas, a new robotic control architecture is proposed, which has its building blocks in the modular and hierarchical functioning of the brain.

15:00
FM2.7: Real-time Control of AHU Based on a Neural Network Assisted Cascade Control System
Chengyi Guo, Qing Song, Wenjian Cai
Nanyang Technological University, Singapore

In this paper, we propose a novel neural network assisted proportional- plus-integral (PI) control strategy to improve the supply air pressure control performance of variable air

volume (VAV) system. The neural network is trained on-line with a normalized training algorithm, which eliminates the requirement of a bounded regression signal to the system. To ensure the convergence of the training algorithm, an adaptive dead- zone scheme is employed. Stability of the proposed control scheme is guaranteed based on the conic sector theory. To demonstrate the applicability of the proposed method, real-time tests were carried out on a pilot VAV air-conditioning system and good experimental results were obtained.

SESSION: FM3   **Temasek 3**
Human-robot interaction

Chair: Benno Lammen
Co-Chair: Dieter Zoebel

13:00
FM3.1: ROBOLEO - An Interactive Seeing Robot
Benno Lammen, Arno Ruckelshausen
University of Applied Sciences, Osnabrück, Germany

A robotic system that serves as a platform for research in human-robot interaction, robot vision, model based planning, and automation of flexible production processes is introduced. A robot equipped with a vision system and distance sensors interacts with a human in a non- planned variable environment. As an application, a mechanical balance game between a robot and a human player is presented.

13:20
FM3.2: Entrainment Based Human-Agent Interaction
Takashi TAJIMA, *Yong XU, *Toyoaki NISHIDA
University of Tokyo, Japan; *Kyoto University, Japan

In this paper we proposed a novel method of establishing the human- agent interaction basing on entrainment approaches. By building dynamical system through approach of synchronization and modulation for human and agent respectively, it allows a human user to convey his tacit intentions to an agent by repetitive operations and adjust finely his operations while watching the reactions of the agent. A robot cleaner simulation system was implemented to evaluate the efficiency of the proposed method. The experimental results proved that the proposed system can work effectively. Furthermore the results suggest that the user's psychological burden can be reduced by using proposed method.

13:40
FM3.3: Function of Human-oriented Compensator for Human Dynamics with Uncertainties
Koki SHIBASATO, Hirofumi OHTSUKA, *Shigeyasu KAWAJI
Kumamoto National College of Tech., Japan; *Kumamoto University, Japan

In a human-machine system, the operator skill is required considerably in order to realize a meaningful operation. In this paper, a new concept of human-oriented compensator is proposed for improving the control performance of human-machine system. The system aims to support a human work and not to obstruct the operational feeling. The compensator called ``collaborater'' has two degree of freedom. When such a compensator is applied to a human-machine system, it is worried that the bad influence on a system occurs due to the adaptation of a human operator to the environment. But the collaborater keeps the control performance of human-machine in spite of variation of human dynamics.

14:00
FM3.4: Dynamic Proxy Objects in Haptic Simulations
Probal Mitra, Gunter Niemeyer

Stanford University, USA

Haptic simulations aim to provide users with realistic renditions of increasingly complex virtual environments. These may involve multiple users, multiple hands, and complex virtual tools. For example, in surgical training, simulators must recreate a tool in each hand of the user, interacting with each other as well as with the surrounding tissue. To further such developments, we introduce and demonstrate the concept of dynamic proxy objects. Proxies represent the physical master devices in the virtual world. Associating dynamics with these proxies allows greater control over the proxy motion and behavior, in particular in the context of collisions with fixed objects and between multiple proxies. We utilize first order velocity based dynamics, so that the proxies remain massless. Geometric constraints are implemented in terms of velocity limits, as are dynamic interactions such as collisions. Complex tools, kinematic relationships, and even closed kinematic chains are incorporated, through Jacobian matrices. This approach is demonstrated in a simple experiment simulating interactions between two straight, slender virtual manipulators on a two handed haptic console.

14:20
FM3.5: Active Motion Vision for Distance Estimation in Autonomous Mobile Robots
Maxim Mikhalsky, Joaquin Sitte
Queensland University of Technology, Australia

Estimation of distance to nearby landscape features is an essential navigation capability for an autonomous mobile robot. The ability to track targets in real time, combined with the concept of motion vision, allows a robot to rely on vision–based navigation techniques and provides an alternative to using active sensors or sophisticated stereo imagers for distance measurement. In this work, we present a real–time vision system capable of estimating distance to objects by tracking their apparent motion, which relies on adaptive temporal motion scaling and optimized tracking algorithms. The vision system is designed for implementation in a chip–level parallel computer architecture and synchronous work with an imager at very high frame rates. The test results demonstrate low sensitivity to noise and interference.

14:40
FM3.6: Maneuver-based Assistance for Backing Up Articulated Vehicles
Dieter Zoebel, Elisabeth Balcerak, Jacek Schikora, Philipp Wojke
University Koblenz-Landau, Germany

The kinematic behavior of articulated vehicles is complex and hard to control. This coincides with the perception of unskilled drivers, e.g. when they back up their vehicle and the attached camping trailer. Typically, such situations are stressful and adequate forms of assistance would be experienced as a welcome relief. This paper proposes a simple but efficient assistance system which on one hand focusses on the kinematic properties of certain maneuvers and on the other hand is modularized in a way that it can be retrofitted to any articulated vehicle with one-axle trailer. The assistance system has been implemented in a real vehicle and first experiences are already available.

15:00
FM3.7: Conceptual Design for Robotic Arm Wrestling
Chul-Goo Kang, Eun-Jun Park, Ik-Xu Son, Young-Wo Kim, Ki-Seon Ryu
Konkuk University, Korea

Senior welfare problems become more and more serious in modern civilized societies. It is important to assist the senior to keep their physical and mental health in order to lessen social welfare cost and to improve the quality of life of them. This paper presents the conceptual design of a robotic arm wrestling system that is an intelligent exercise machine to help the senior physically and mentally. This robotic machine is intended to perform arm wrestling games with seniors on a table. The robotic machine will determine randomly the winner (robot or human) and the scenario. The proposed scenario generates game process that the arm-wrestler cannot predict in advance and arm wrestler's will influences it.

Friday, 3 Dec 2004, 15:50-17:50

SESSION: FP1	Temasek 1
Robot structures and robot cell	

Chair: Michael Schluse
Co-Chair: Shahram Jafari

15:50
FP1.1: Object Oriented Discrete Event Based Simulation and Control of Complex 3D Systems
Eckhard Freund, Michael Schluse
Institute of Robotics Research, Dortmund, Germany

The combination of Discrete Event Systems with 3D simulation and control technology seems to be at the first glance a contradiction in terms because of mixing up two totally different application classes. But here, the newly developed State Oriented Modeling methodology comes into play providing a comprehensive and flexible object oriented framework for the development of complex Discrete Event Systems. State Oriented Modeling establishes a link between these two worlds using object oriented Petri Nets for the discrete part as well as application specific mappings between continuous and discrete state variables. Integrated in a versatile 3D simulation system, State Oriented Modeling enables the efficient realization of a large class of applications ranging from industrial automation through a variety of new Virtual Reality applications up to controller synthesis for multi robot manipulator workcells.

16:10
FP1.2: Integrated Structure and Controller Design of Machine Tools
Chin-Yin Chen, Chi-Cheng Cheng
National Sun Yat-Sen University, Taiwan, ROC

The machine design process usually covers two different engineering domains: structure design and system control. The relationship between these two domains is very closed. In order to reduce the disturbance caused by parameters in either one, the domain knowledge from those two different fields needs to be integrated. So the technique of multi-object optimization will be applied to achieve multiple design objectives. To investigate the method for integrated optimization, we will use the machine tools, which are the most output in our country, as a design platform. First of all, application software of Pro/E and AnSys will be used to build the 3D model to analyze and design structure parameters based on their effect and sensitivity to the controller. Therefore, physical properties of the machine tool will be obtained. Beside, the Matlab will also be applied to determine proper control parameters for the system. Finally, the technology of multi-object optimization design for machine tools will be fully established and the corresponding production competitivity is expected to be greatly raised.

16:30
FP1.3: A Behaviour-based Optimisation Strategy for Multi-

robot Exploration.
Gu Fang, *Gamini Dissanayake, *Haye Lau
University of Western Sydney, Australia; *University of Technology, Sydney, Australia

To efficiently explore an unknown environment with a team of robots, a coordinated strategy that maximises the exploration area is required. This is a difficult optimisation problem, as there may exist many suboptimal solutions. In order to reduce the search space to a region that is near the optimal, a behaviour-based exploration strategy is used to define the region in which an optimal solution can be found. A numerical optimisation technique is then used to find the solution in this region. In particular, the proposed strategy uses a potential-fields technique to obtain a coarse movement direction for each robot. A nonlinear optimisation method is then used to calculate the veloc-ity and angle deviation from the coarse direction to achieve the maximum exploration for each move. Simulation results have shown that the proposed method provides an efficient explora-tion strategy.

16:50
FP1.4: Relative Visual Servoing
Shahram Jafari, Ray Jarvis, Thirukkumaran Sivahumaran
Monash University, Australia

In this paper, we present two methods of performing eye-to-hand visual servoing: relative visual servoing and interpolation. These methods need only a monocular eye-to-hand camera and primitive tactile sensors. The set-up is part of a humanoid robot under development, named COERSU [1]. Experimental results from COERSU are provided to validate these methods. An evolved visual perception system based on genetic algorithms was used to obtain the best possible combination of segmentation parameters. The experimental results show, relative visual servoing represents a significant improvement over the other methods in terms of reliability.

17:10
FP1.5: Static Analysis of Cable-Driven Manipulators with Non-negligible Cable Mass
Kris Kozak, Qian Zhou, Jinsong Wang
Tsinghua University, China

This paper addresses the static analysis of cable-driven manipulators with non-negligible cable mass. An approach to computing the static displacement of a homogeneous cable is presented. The resulting cable displacement expression is used to help solve the inverse kinematics of general cable-driven manipulators. In addition, the sag-induced stiffness of the cables is derived. Finally, a sample manipulator, with dimensions and system parameters similar to a large scale cable-driven manipulator currently under development, is analyzed. The results show that cable-sag can have a significant effect on the stiffness of such manipulators.

17:30
FP1.6: On the Comparison of Model-Based and Modeless Robotic Calibration Based on the Fuzzy Interpolation Technique
Ying Bai, *Hanqi Zhuang
Johnson C. Smith University, USA; *Florida Atlantic University, USA

Traditional robot calibrations implement model-based and modeless methods. The calibration of position error in model-based method implements four steps: kinematic model definition of the robot, measurement process of the robot's positions, Identification of the kinematic model of the robot and compensation of the position errors. This

method is both time consuming and complicated because of the identification and compensation processes. Most traditional modeless methods are relatively simple and practical, but the calibration accuracy is relatively low and most of them are only suitable for the robots calibration in 2D domain and in relative small workspaces. This paper provides a novel modeless fuzzy interpolation method to improve the compensation accuracy for the robots calibration in 3D workspace. A comparison between the model-based and modeless fuzzy interpolation calibration method is made. The simulated results show that the modeless fuzzy interpolation calibration method is compatible with the model- based calibration method, and even outperforms a model-based counterpart in terms of accuracy and complexity in small workspaces.

SESSION: FP2	**Temasek 2**
Segmentation and correspondence	

Chair: Phee Soo Jay, Louis
Co-Chair: Xin Wang

15:50
FP2.1: An Efficient Algorithm for Line Extraction from Laser Scans
Alen Alempijevic, Gamini Dissanayake, *Gu Fang
University of Technology Sydney, Australia; *1232

In this paper, an algorithm for extracting line segments from information gathered by a laser rangefinder is presented. The range scan is processed to compute a parameter that is invariant to the position and orientation of straight lines present. This parameter is then used to identify observations that potentially belong to straight lines and compute the slope of these lines. Log-Hough transform, that only explores a small region of the Hough space identified by the slopes computed, is then used to find the equations of the lines present. The proposed method thus combines robustness of the Hough transform technique with the inherent efficiency of line fitting strategies while carrying out all computation in the sensor coordinate frame yielding a fast and robust algorithm for line extraction from laser range scans. Two practical examples are presented to demonstrate the efficacy of the algorithm and compare its performance to the traditional techniques.

16:10
FP2.2: Tracking Objects and Faces using Color Histograms Enhanced with Specularity Detection
Jae Byung Park, Youngrock Yoon
Robot Vision Laboratory, Purdue University, USA

This paper presents a robust histogram based tracking algorithm that is capable of detecting specular highlights on objects or faces to be tracked. The materials with shiny and smooth surfaces such as car exterior, ceramics or glasses often exhibit specularities which are highly saturated regions in the image that are produced by mirror-like reflections. Whenever confronted with such specular highlights on the target objects, the results of segmentation and tracking become inaccurate and unreliable. Speaking of real-time color object tracking, there are two major issues that are associated with such specular highlights. First issue is how to detect specular highlights suddenly appearing in the image sequence. Second one is how the detected specular highlights can be correspondingly considered to improve the tracking performance. In this paper, we describe our specularity detection method that can be applied to every pair of consecutive frames in the tracking sequence. Experimental results of two tracking systems: 1) with specularity detection and 2) without handling specularities are compared to show the improvement. This method has been successfully tested on multiple tracking tasks with monochromatic objects.

16:30
FP2.3: A Study on Detecting Moving Objects via Projective Transformation
Midori Nagayoshi, Shigeru Uchikado
Tokyo Denki University, Japan

We analyze the proposed correspondence methods in detail, and new interpretations of them are given so that new method is proposed based on this result. Here the epipole and the epipolar line play an important role. Then a method in general camera configuration is proposed. This method is easily constructed by using singular value decomposition and projective transformation. Furthermore it shows that this method is effective under the environment of a moving camera. Based on the new method proposed for the correspondence problem, we propose a method to detect moving objects by using a camera on a mobile robot.

16:50
FP2.4: Texture Segmentation Algorithm Based on Wavelet Transform and Kd-tree Clustering
Guosheng Yang, Yanli Hou, Chunyan Huang
Henan University, China

A texture image segmentation algorithm based on wavelet transform and kd-tree clustering is studied in this paper. Firstly, texture features of an image are extracted using wavelet transform. Secondly, an improved algorithm based on quarter partition is given to smooth the texture feature image. Thirdly, the clustering algorithm using the kd- tree data structure is applied to the texture segmentation, and then a fast texture feature clustering effect is achieved. At last, simulations are performed on the presented algorithm, and the simulation result shows that the presented algorithm has lower segmentation error rate, high accuracy and good in-time performance.

17:10
FP2.5: X-Ray Image Segmentation Based on Genetic Algorithm and Maximum Fuzzy Entropy
Xin Wang, Brian Stephen Wong, *Chen Guan Tui
Nanyang Technological University, Singapore; *Republic of Singapore Air Force, Singapore

The x-ray radiographic testing method is often used for detecting defects as a non-destructive testing method (NDT). In many cases, NDT is used for aircraft components, welds, etc. Hence, the backgrounds are always more complex than a piece of steel. It is difficult to detect defects using conventional image processing methods. In this paper, we propose a genetic algorithm to find the optimal thresholds to segment X- ray images. In our algorithms, after obtaining the x-ray image, we firstly use adaptive histogram equalization technique and wavelet thresholding to improve the quality of the radiographic image. Then the image is divided into three parts, namely dark, gray and white part. The fuzzy region of their member functions can be determined by maximizing fuzzy entropy. The procedure to find the optimal combination of all the fuzzy parameters is implemented by genetic algorithm, which can overcome the computational complexity problem. The experiment results show that our proposed method gives good performance for X-ray image.

17:30
FP2.6: A Divide and Conquer Algorithm for Rectilinear Region Coverage
Amit Agarwal, Meng Hiot Lim, Lip Chien Woon
Nanyang Technological University, Singapore

We give an algorithm to generate a coverage motion plan for a single unmanned reconnaissance aerial vehicle (URAV) over a holed rectilinear polygonal region. The URAV is

equipped with a stabilized downward- looking sensor which has a square footprint of a fixed area. The algorithm is based on the principle of divide-and-conquer. In the first step, we generate the lexicographically maximum area rectangle partition of the polygon. We outline a sweep line based algorithm to compute this partition. Next, we find a coverage motion plan for movement of the sensor over each rectangle in the partition. Plans for adjacent rectangles are finally merged to generate a complete plan for the entire region. Our algorithm yields paths with minimal length and minimal turns.

SESSION: FP3	Temasek 3
Production scheduling	
Chair: S. G. Ponnambalam	
Co-Chair: Taweepol Suesut	

15:50
FP3.1: Bi-objective Schedule Control of Batch Processes in Semiconductor Manufacturing
ViswanathKumar Ganesan, *Amit Kumar Gupta, *Sivakumar Appa Iyer
SMA, NTU, Singapore; *MPE, NTU, Singapore

This work presents the concept of schedule control using two contradicting objectives in dynamic scheduling of backend batch processes in a semi-conductor industry. A convex combination approach is presented to achieve the desired level of control in dynamic scheduling considering the two contradicting objectives, viz., the mean cycle time and the maximum tardiness. At each decision instance during simulation, an appropriate job referred as pareto-job is selected using the convex combination approach and loaded on the machine for processing. We demonstrate using simulation experiments the concept of schedule control, and show how a batch processing machine can be controlled at specified operating conditions (scheduling objectives) dictated by the market requirements.

16:10
FP3.2: Composite Rules Selection Using Reinforcement Learning for Dynamic Job-Shop Scheduling
Yingzi Wei, *Mingyang Zhao
Shenyang Institute of Automation, Chinese Academy of Science, China; Shenyang Ligong University, China; *Shenyang Institute of Automation, Chinese Academy of Science, China

Dispatching rules are usually applied dynamically to schedule the job in the dynamic job-shop. Existing scheduling approach seldom address the machine selection in the scheduling process. Following the principles of traditional dispatching rules, composite rules, considering both the machine selection and job selection, were proposed in this paper. Reinforcement learning (RL) is an on-line actor critic method. The dynamic system is trained to enhance its learning and adaptive capability by a RL algorithm. We define the conception of pressure for describing the system feature and determining the state sequence of search space. Designing a reward function should be guided based on the scheduling goal. We present the conception of jobs' estimated mean lateness (EMLT) that is used to determine the amount of reward or penalty. The scheduling system is trained by Q-learning algorithm through the learning stage and then it successively schedules the operations. Competitive results with the RL-agent approach suggest that it can be used as real-time optimal scheduling technology.

16:30
FP3.3: Parameter Tuning of Production Scheduling Rules by an Ant System-Embedded Genetic Algorithm
Tsung-Che Chiang, Li-Chen Fu

National Taiwan University, Taiwan, R.O.C.

In this paper, a search algorithm is proposed for parameter tuning of production rules in job shop scheduling problems. This algorithm is developed based on the genetic algorithm, which is the core for exploration in the search space. Then an ant system is incorporated, which directs the genetic algorithm to search in the potential regions by marking potential genes for changing during reproduction. The improvement of search ability is verified by several experiments.

16:50
FP3.4: An Intelligent Integrated Scheduling Model for Flexible Manufacturing System
Saravana Sankar S, *Ponnambalam S G, Rajkumar R, Gurumarimuthu M
Arulmigu Kalasalingam College of Engineering, India; *Monash University, Malaysia
This paper deals with the simultaneous scheduling of incoming jobs, machines, and vehicle dispatching in Flexible Manufacturing System (FMS) having a single device Automated Guided Vehicle AGV. The objective is to find an optimal sequence of incoming parts, which will reduce the waiting times due to blocking and starving of resources, deadheading times, resulting in overall minimization of makespan. In this work a Genetic Algorithm based iterative procedure, which accommodates the combinatorial nature of the problem, is proposed to approximately solve the integrated scheduling problem. The procedure is evaluated through different benchmark problems and the outcome of the study is encouraging and paves ample scope for further research in this area.

17:10
FP3.5: Look Ahead Batching to Minimize Earliness/Tardiness Measures in Batch Processes
Amit Kumar Gupta, Sivakumar Appa Iyer, *ViswanathKumar Ganesan
MPE, NTU, Singapore; *SMA, NTU, Singapore

Scheduling problems involving earliness/tardiness (E/T) measures have received significant attention in recent years. This type of problem became important with the advent of the just-in-time (JIT) manufacturing philosophy, where early or tardy deliveries are highly discouraged. In this paper we examine the single batch processing machine-scheduling problem in dynamic environment for minimizing the E/T measures. We propose a look ahead batching (LAB) method where the scheduling decisions are made considering the arrival epochs and due dates of incoming lots, which are easily predictable in a computer integrated manufacturing environment, especially in semiconductor industry. The results of proposed method are compared with Dynamic Batching Heuristic (DBH) and Next Arrival Control Heuristic (NACH), which are look ahead strategies developed based on the arrival information alone. The E/T performance is measured by the minimization of the absolute sum of earliness and tardiness of the lots ($|E|+|T|$) and the minimization of their square sum (E^2+T^2). The steady state simulation results show that exploiting the knowledge of future arrivals and their due dates leads to a significant reduction in the E/T measures for tight and loose due date settings at two different various utilization levels.

17:30
FP3.6: Interpretation Petri Net model to IEC 1131-3:LD for Programmable Logic Controller
Taweepol Suesut, Prayut Inban, Phongchai Nilas, Prapas Rerngreun
King Mongkut's Institute of Technology Ladkrabang, Thailand

The Programmable logic Controllers (PLCs) are widely used in industrial. Thus PLCs usually used the IEC 1131-3 standard programming language. The ladder diagram is the most popular language that similar to the electrical schematic diagrams which does not require a lot of the steps and sequences of the operation. Therefore it is difficult to understand the program structure and developing the system. The Petri nets is one of graphical models that can be explained the system operating easily and clearly. This paper presents the transformation structures from Petri Nets to Ladder diagram and possible implementation to control the process through PLC's input and output. In this article can be applied to other applications on any PLCs as well.

2004 IEEE CIS

Wednesday, 1 Dec 2004, 10:00-12:00

SESSION: WA5	Penang 1
Adaptive Computing	

Chair: Chunshien Li
Co-Chair: Jing Zhou

10:00
WA5.1: Soft Computing Approach to Adaptive Noise Filtering
Chunshien Li, Kuo-Hsiang Cheng, *Chih-Ming Chen, Jin-Long Chen
Chang Gung University, Taiwan; *Kuang Wu Institute of Technology, Taiwan

A soft computing filtering approach is proposed for adaptive noise cancellation. The goal of noise cancellation is to extract the desired signal from its noise-corrupted version, using the proposed neuro-fuzzy system (NFS) as an adaptive filter. Traditional linear filtering may not be good enough to handle with the noise complexity. In the study, the NFS filter is trained in hybrid way using the well-known random optimization (RO) method and the least squares estimate (LSE) method for the noise canceling problem. The premises and the consequents of the NFS are updated for their parameters using the RO and the LSE, respectively. With the hybrid learning algorithm, the proposed approach has moderate computation and the training of the NFS filter is fast converged. An example of noise cancellation by the proposed adaptive NFS filter is illustrated and the result is discussed. The NFS filer has stable filtering performance for noise cancellation.

10:20
WA5.2: Self-Adaptive Memetic Algorithm: An Adaptive Conjugate Gradient Approach
Neda Shahidi, Hadi Esmaeilzadeh, Marziye Abdollahi, Eiman Ebrahimi, Caro Lucas
University on Tehran, Iran

Combining hill climbing methods that search for the optimum points in a bounded region of search space with genetic algorithm is effective in the cases that the search space or optimization problem is complicated. However, parameter setting of selected HC can influence the performance of the algorithm significantly. In this paper a run-time self-adaptation strategy is utilized to discover the most appropriate HC parameters for the problem at hand. The HC method is used in this work is conjugate gradient that is an efficient gradient based hill climber for a wide range of problems. Traditionally, key parameters of the conjugate gradient are tuned by some deterministic or pre-determined adaptive rules. But in our self-adaptation approach these parameters are encoded in genotypes and co-evolved alongside the solutions and adjusted based on regional or generational conditions of individuals in the evolution process. Another advantage of this individualistic approach is that it puts forth different hill climbing capabilities to each individual and this prevents undesirable convergence of solutions to a local optimum that is a side effect of ordinary memetic algorithm. This proposed method not only adds no extra computation load to the genetic algorithm but also eliminates computation burden of parameter adjustment of hill climbing operator. Results of applying this approach on several test functions are demonstrated to illustrate improvements achieved using our self adaptive memetic algorithm in comparison with ordinary memetic algorithm.

10:40
WA5.3: Adaptive Output Feedback Control of Linear Systems Preceded by Unknown Backlash-like Hysteresis
Zhou Jing
Nanyang Technological University, Singapore

In this paper, a new scheme is proposed to address an output feedback control problem: control of a class of uncertain linear systems proceeded by unknown backlash-like hysteresis nonlinearities, where the hysteresis is modelled by a differential equation. The controller designed by using backstepping technique consists of a new robust control law and a new estimator to estimate the unknown parameters. For the implementation of the controller, no knowledge is assumed on the bounds of unknown system parameters and the effect contributed by the hysteresis. It is shown that all the signals are bounded. A bound for the truncated L_2 norm of the tracking error is obtained as a function of design parameters. Simulation studies also verify the effectiveness of the proposed scheme.

11:00
WA5.4: Semantic Preloading in the Adaptive Web Query
Xiaogang Wang, *Zhengding Lu, *Zhigang Wang, **Yue LI
Huazhong University of Science and Technology, Wuhan University of Science and Engineering, China; *Huazhong University of Science and Technology, China; **Wuhan University of Science and Engineering, China

At present query based on Web is short of adaptability. This is caused by the absence of common sense knowledge relative to the conception queried, and information system often makes a basic mistake. In the paper, we introduce a formal model of ontology, modeling semantic relation between conceptions of ontology through a conception called associate-degree. This model facilitates the processing of common sense knowledge, which is the base of semantic extension and preload, builds context relation and association of the conception queried, and brings adaptability to information query based on Web.

11:20
WA5.5: Dynamic Reconfiguration Service for Component Based Software Architectures
Yacine Narsis, Yacine Amirat, Karim Djouani
University of Creteil, Paris 12, France

For several years the dynamic reconfiguration of software applications has been a very lively research area. We introduce in this article our work that deals with dynamic reconfiguration of component based applications. We use the architectural agent concept to carry out functions, to supervise, evaluate and achieve dynamic architecture modification. In our approach the reconfiguration is an optional service offered to the application by an agent based framework.

11:40
WA5.6: Chattering-Free Adaptive Fuzzy Sliding Mode Control
Nasser Sadati, Ali Talasaz
Sharif University of Technology, Iran
An adaptive fuzzy sliding mode control (AFSMC) for uncertain dynamic systems is presented in this paper. Chattering problem in classical sliding mode control (CSMC) is highly undesirable because it may excite unmodeled high frequency plant dynamics and leads to unforeseen instabilities. The proposed approach in this paper completely eliminates the chattering by using adaptive fuzzy system to calculate continuous control gain vector instead of discontinuous one in classical sliding

mode control. Mathematical proof for the stability and the convergence of the system is also presented to show its validity theoretically. The proposed approach and the classical sliding mode control are both applied to a flexible transmission system in order to illustrate how the new approach can eliminate the chattering in this control strategy.

SESSION: WA6	Penang 2
Computer Vision I	

Chair: Liyuan Li
Co-Chair: Boon Kiat Quek

10:00
WA6.1: Robot Detection with Multi-Target Tracking
kanji tanaka, eiji kondo
Kyushu University, Japan

In this paper, we propose a vision-based method for detecting and tracking a mobile robot in dynamic, complex and unstructured environments, such as an office. When there are many moving objects (e.g. robot and persons) in the environment, and they interact with each other, it is not easy to estimate the correct correspondence between detected moving objects and individual targets. We introduce GPF (Generic Particle Filter) to discard and multiply possible hypotheses about which moving object is the robot. Also, we utilize MCMC-PF (Markov Chain Monte Carlo -based Particle Filter) to track multiple targets efficiently and robustly by predicting interactions between targets. As a result, we have achieved robust detection and efficient tracking of targets.

10:20
WA6.2: Vision-based Self-localization in Non-stationary Environments by using Support Vector Machine
Mitsuru Hirayama, Kanji Tanaka, Nobuhiro Okada, Eiji Kondo
Kyushu University, Japan

Self-localization is one fundamental problem in robotics, and important for various tasks. Most previous methods for self-localization is based on comparison between an environment-map and observed features (or landmarks). These approaches often fail in a dynamic and large environment with noisy sensors. To solve this problem, in this paper, we propose a vision-based method for learning-based self-localization by using Support Vector Machine (SVM). We designed an effective filter to extract features robust against sensor uncertainty as well as object movement. Also, we propose to use a set of SVMs to minimize misrecognition rate. In experiments with a real robot and an omni- directional vision sensor, effectiveness of the proposed method will be demonstrated.

10:40
WA6.3: A Tracking Method of End-effectors in a Vision-based Marker-free Motion Capture System
Sung-Eun Kim, Chang-Joon Park, In-Ho Lee
ETRI, Korea

We describe a tracking method for analyzing 3D motions of human in a real-time vision-based marker-free motion capturing system. We capture human motions by using three synchronized color CCD cameras when an actor wearing normal clothes without any attached marker. We obtain the 2D positions of blobs such as the head, the hands, the feet and the root of an actor to use in a proposed tracking method. Then, this proposed tracking method reconstructs end-effectors having 3D coordinates from 2D blob data by using a grouping and an epi-polar constraint. For correct tracking of freely moving end-effectors in real-time, we apply the spatial and temporal analysis to each 3D

end- effector to distinguish right and left directions, restore a disappeared or an occluded end-effectors. Finally, we generate a 3D virtual human having 20 joints that moves like real human by using an Inverse Kinematics method in real-time.

11:00
WA6.4: Object-Oriented Scale-Adaptive Filtering for Human Detection from Stereo Images
Liyuan Li, *Shuzhu Sam Ge, *Terence Sim, *Ying Ting Koh, Xiaoyu Huang
Institute for Infocomm Research, Singapore; *National University of Singapore, Singapore

In this paper, an effective and efficient methodology to extract visual evidence of suitable scale for object detection, Object-Orient Scale- Adaptive Filtering (OOSAF), is proposed. With OOSAF, object extraction from stereo images is formulated as the design of scale-adaptive filters. Based on OOSAF, two methods for human detection from stereo images are developed. One is to detect human objects with close distances to the camera for intelligent human-machine interaction, and the other is to detect human heads in distant crowds for security surveillance. Experiments show that, with OOSAF, efficient solutions for human detection from stereo images could be achieved with high detection rates and low false alarm rates.

11:20
WA6.5: Feature Detection for Stere-Vision-Based Unmanned Navigation
Boon Kiat Quek, *Javier Ibañez-Guzmán, *Khiang Wee Lim
Singapore Institute of Manufacturing Technology / National University of Singapore, Singapore; *Singapore Institute of Manufacturing Technology, Singapore

A fuzzy logic-based approach for the generation of feature maps with a commercial off-the-shelf (COTS) stereo-vision system is presented in this paper. This approach is applied for the guidance of autonomous vehicles in urban and outdoor environments. Useful features comprising obstacles and free-space regions are detected from disparity images generated by the COTS stereo-vision algorithm. Image pixels, disparity information and camera parameters enable the inverse mapping of each pixel and their associated properties such as colour composition onto an occupancy grid map that is used for navigation purposes. A measure of certainty in the location of obstacles within the perceivable environment is introduced by comparing the displacement if every grid cell from a dynamically estimated ground plane. In addition, discontinuities in the disparity images are identified as possible boundaries of features within the perceivable environment and mapped onto the same occupancy grid. Furthermore, a new fuzzy colour segmentation algorithm that quantifies the free-space within the perceived environment is presented. The advantages of this approach are computational speed and ease of implementation as well as obstacle detection robustness based on multiple features. Promising experimental results obtained on both live and recorded images demonstrate the effectiveness of this approach.

11:40
WA6.6: Face Detection Using the Shape of Face with Both Color and Edge
Yusuke Nara, *Jianming Yang, Yoshikazu Suematsu
Nagoya University, Japan; *Meijo University, Japan

The algorithm for the detection of faces in color scenery is proposed in this paper. Usually several faces are located in various styles with different size in input image. In our method the face projection is modeled as an elliptic shape.

The elliptic size is adjusted to satisfy a certain condition that is derived from both features of the color and edges of the image. Then, to eliminate the non-face candidates, the elliptic candidates are checked whether the facial features such as eyes and mouth are involved in the area. It is concluded that several face candidates in a scene and the face candidates in the background of skin-like color are properly determined by our method.

SESSION: WA7	Malacca 2
Data Mining and Management I	

Chair: John Oommen
Co-Chair: Danny van Noort

10:00
WA7.1: MinClue: A MST-based Clustering Method with Auto-Threshold-Detection
Yu He, LiHui Chen
Nanyang Technological University, Singapore

Clustering is to group data points into homogenous clusters so that data points within the same cluster are more similar than data points belonging to different clusters. There are many effective clustering algorithms for discovering arbitrary shaped clusters, but one common problem of many algorithms is the dif- ficulty for users to decide appropriate parameters for these algorithms. To reduce the dependence of clustering performance on parameters, this paper proposes a threshold criterion for the single linkage cluster analysis and incorporates it into the Minimum Spanning Tree(MST) based clustering method. Since the threshold can be automatically decided according to the underlying data distributions, arbitrary shaped clusters can be discovered with little human intervention. The experimental results on spatial data are very encouraging.

10:20
WA7.2: A New Method for Learning Pseudo-Boolean functions with Applications in Terrorists Profiling
Jianhua Chen, Peter Chen, Guoli Ding, Robert Lax
Louisiana State University, USA

In this paper, we present a new framework for learning pseudo-Boolean functions from training data. The new learning framework is based on the observation that the training data can be seen as constraints on the possible candidate pseudo-Boolean functions and that, without any additional information, any of the pseudo-Boolean functions satisfying these constraints is equally likely. We define two types of learning from a training data set: One is to learn to predict the probability that the target function value $f^*(x\_0)$ falls within an interval $[a, b]$; and the other is to learn a specific pseudo-Boolean function f as an approximation of the target function f^*. Efficient algorithms for both learning tasks are presented. We relate our approach to the Bayesian classifier method. We argue that the new learning framework is suitable for applications in which the training data is rather limited and yet one would like to make useful and reliable predictions on the future data points. Applications in terrorist detection and classification clearly present such a situation where training data for terrorists are rather scarce.

10:40
WA7.3: Supervised Hidden Markov Model Learning Using the State Distribution Oracle
Luis Moscovich, Jianhua Chen
Louisiana State University, USA

Hidden Markov Models (HMMs) are probabilistic models with applications across a large number of fields, most prominently Speech Recognition and Computational Biology. In this paper, we propose a polynomial-time algorithm for learning the parameters of a first order HMM by using a state distribution probability (SD) oracle. The SD oracle provides the learning algorithm with the state distribution corresponding to a query string in the target model. The SD oracle is necessary for efficient learning in the sense that the consistency problem for HMMs, where a training set of state distribution vectors such as those supplied by the SD oracle is used but without the ability to query on specific strings, is NP-complete. The algorithm proposed here is an extension to an algorithm described by Tzeng for learning Probabilistic Automata (PA) using the SD oracle.

11:00
WA7.4: Generalized TSE: A New Generalized Estimator-based Learning Automaton
Mariana Agache, John Oommen
Carleton University, Ottawa, Canada

The fastest Learning Automata (LA) algorithms currently available fall in the family of Estimator Algorithms introduced by Thathachar and Sastry [1]. The pioneering work of these authors was the Pursuit Algorithm, which pursues only the current estimated optimal action. Later, the same authors introduced a more sophisticated estimator algorithm[12], known as the TSE algorithm. This paper introduces first a vectorial representation the TSE algorithm that shows more clearly the underlying concepts of the TSE algorithm. Furthermore, using this vectorial representation, we introduce a Generalized TSE estimator algorithm (GTSE). We argue that this learning scheme minimizes the probability of pursuing a wrong action and it is proven empirically to be the fastest converging estimator learning algorithm known to date. To attest this, we present a quantitative comparison of its performance against the TSE and other existing continuous estimator algorithms.

11:20
WA7.5: Visualization of High-dimensional Data Using an Association of Multidimensional Scaling to Clustering
Antoine Naud
University of Torun, Poland

A common task in data mining is the visualization of multivariate objects on scatterplots, allowing human observers to perceive subtle inter-relations in the dataset such as outliers, groupings or other regularities. Multidimensional scaling (MDS) is a well known Exploratory Data Analysis family of techniques that produce one display on which inter-object similarity relationships are preserved. The algorithm scales with the square of the number of visualized data, which limits its application to small datasets. In order to alleviate this limitation, we associate MDS with three different clustering models, namely Learning Vector Quantization, the k-means and the dendrograms. We propose to perform dimensionality reduction on a reduced set of cluster centers, to which the data are added using a "relative" MDS mapping. Our experiments show that this approach allows to obtain displays of large datasets with fairly good visualization properties, when compared with the display obtained by a direct mapping of the whole dataset.

11:40
WA7.6: Sputter Process Variables Prediciton via Data Mining
Ravi Vadlamani, Arul Shalom S. A., Manickavel Arumugam
ISS, National University of Singapore, Singapore

Media manufacturing process plays a vital role in the Hard Disk Drive (HDD) Industry. Sputtering is an important process within the media manufacturing process that

provides magnetic properties, which in turn affects the performance of the media in a HDD assembly. In this study, an attempt has been made to predict the critical magnetic characteristics and yield of the media, which in turn affects the overall product performance, by resorting to data mining technology. Feature selection was carried out using methods such as Principal Components Analysis (PCA), and weight information of Multi- Layer Feed-Forward Neural Networks (MLFF) and General Regression Neural Networks (GRNN) [1]. In addition, Classification And Regression Trees (CART) [2] was used to generate rules to understand the dataset, as Neural Networks are considered as black boxes without rule extraction mechanism. A new hybrid architecture was also developed combining the top inputs identified by MLFF, GRNN and CART. It is concluded that models constructed using feature selection carried out by MLFF or GRNN performed very well. These models are preferred since they use the minimum number of input variables. Hence they are practically and economically more viable than other models with similar performance. The predictions have been validated using the 10-fold Cross validation method, to ensure that the results are not due to any anomaly in the dataset.

SESSION: WA9	Level 2a Foyer
Posters	

WA9: Research on the Reconstruction Method of B-spline Surface Based on Radius Basis Function Neural Networks
Xumin Liu, Houkuan Huang, Weixiang Xu, *Jing Chen
Beijing Jiaotong University, China; *Capital Normal University, China

Surface reconstruction is the key technology in the geometry Reverse Engineering. In order to obtain the object's geometrical model, we have to construct surface by large numbers of measured data points. This paper introduces a new method for the reconstruction of free-form surface. Firstly, it pre-fits scattered and measured data points which come from free-form surface archetype by Radius Basis Function neural networks algorithm. Secondly, it maps the mathematical model of free- form surface by the linear combination of Radius Basis Function and the weights of the hidden layer. Finally it transforms the mathematical model to Bicubic B-spline surface. This paper also commentates the feasibility of the above idea that resolves the problems of surface fitting by Radius Basis Function Neural Networks.

WA9: A Semi-supervised Classification Method Based on Transduction of Labeled Data
Shiliang Sun, Changshui Zhang, *Naijiang Lu, *Fei Xiao
Tsinghua University, China; *Shanghai Cogent Biometrics Identification Technology Co. Ltd., China

The semi-supervised classification problem with partially labeled data is very important in the research area of pattern recognition and machine learning. In this paper, an approach based on transduction of labeled data is proposed to improve current classification methods. The general knowledge about the attribute of data distribution is used to carry out transduction. Employing this kind of knowledge, the commonly existent mode of the distribution corresponding to each labeled sample can be effectively found by mean shift, and the data at the mode can be regarded as having the same label with the original labeled sample with high confidence. Using the mode data instead of the original labeled data for classification can be capable of improving classification performance. Encouraging experimental results both on synthetic data and real-world handwritten characters validate the applicability and effectiveness of the approach.

WA9: The Application of Edge Feature in Automatic Sports Genre Classification
Yuming Yuan, Chunru Wan
Nanyang Technological University, Singapore

As a specific application of semantic video content analysis, automatic video classification has emerged as a very active area of research during the past few years. In terms of sports genre classification, commonly utilized features include color, motion, audio, and caption text. Although the edge feature is widely employed in other fields such as object detection, image enhancement and restoration, its potential value is underestimated, and it is seldom explored in automatic video content analysis. In this paper, we propose a sports video categorization method using edge feature. Our experiments show that our proposed method has achieved 97.1% accuracy on a set of 5 different popular sports video types. Moreover, we demonstrate the effect of video sequence length in accurate identification, and the advantages of edge feature over color information in sports genre classification.

WA9: To Apply Fuzzy Theory in the Control of Weld Line of Plastic Injection-Molding
Mei-Yung Chen, Yi-Cheng Chen Chen, *Shia-Chung Chen
China Institute of Technology, Taiwan; *Chung Yuan Christian University, Taiwan

This study concerns the application fuzzy theory on the control of weld line positions of injection-molded parts. The study utilizes the molding experiences of expert to construct a dialog way of IF~THEN~ to set the fuzzy production rules. Then the rules are applied to an example case to the control of weld line position by adjusting gate location and part thickness. The present algorithm not only succeeds in such application but also reduces the simulation time by try and error resulting in speeding up the mold design process.

WA9: Design of Single-row Layouts for Flexible Manufacturing Systems Using Genetic Algorithm and Simulated Annealing Algorithm
Ramkumar A S, *Ponnambalam S G
Amrita Institute of Technology, India; *Monash University, Malaysia

In this paper, layout design in Flexible Manufacturing Systems (FMSs) is addressed. Optimal design of the physical layout is one of the most important issues that must be solved in early stages of the FMS design. For FMSs, the layout design is even more crucial than in conventional manufacturing systems. Developing a machine layout is an important step in designing manufacturing facilities due to the impact of the material handling cost and time, on throughput, and on productivity of the facility. A layout type that has been extensively implemented in FMSs is the single row machine layout. In this paper simulated annealing algorithm and genetic algorithm are proposed and the performance of the two algorithms for solving the single row machine layout problem is evaluated.

WA9: ANN-GA Approach of Credit Scoring for Mobile Customers
Zhan Li, ji sheng Xu, *Min Xu
Wuhan University, China; *Huazhong University of Science and Technology, China

In this paper, an approach to evaluate the credit level of mobile customers has been proposed, in order that this would help solve the fraudulent problems that puzzled most of the mobile corps. The approach is based on the combination of the artificial neural network (ANN) and Genetic Algorithms (GA), which are two useful methods in

the field of artificial intelligence, so that it could overcome the drawbacks of both ANN, such as its deficiency in solving the multi-peak problems, and GA, such as the lack of precision compared with ANN. Besides, in the paper we also use the fuzzy sets theory to depict the real state of the customers. The feasibility of the approach has been demonstrated with the comparison between the state and the credit score of customers with actual data. The approach could be easily applied in the mobile corp. to solve the contradiction between the satisfying services and the efficient management.

WA9: A New Evaluation Model for Human-Computer Interaction
Xu Weixiang, Liu Xumin
Beijing Jiaotong University, China

In order to evaluate human-computer interaction systems, we improved the heuristic evaluation, and develop a new evaluating model, which is the meta-synthesis of Delphi approach, analytic Hierarchy process, and Fuzzy evaluation (DHF). The theory foundation of the evaluating model is meta-synthesis method from qualitative to quantitative. Using the methods, the accuracy of evaluation was estimated, and a practical example for accuracy of model was given. It is shown DHF can be used to evaluate human-computer interaction systems.

WA9: Expert System for Flame Analysis
Anjali Mahajan, *Ravikiran Mahajan
G H Raisoni College of Engineering, Nagpur, India; *Urja Consultancy Services, Nagpur, India

Combustion is the most important source of energy for power generation, heating, and transportation in the world. In this paper, we propose the use of Infrared thermography for flame analysis1.Various features available in the flame are process indicators & can provide great assistance in controlling the combustion system as well as the study of the combustion performance. Use of important parameters inherently available in the flame is the basic objective of proposed system. While building this system, there are two basic modules: Generating the standard database, Commissioning System for controlling of combustion system. An image obtained from IR camera is the query image. Our searching algorithm makes use of multi-resolution wavelet decompositions of the query and database images. The coefficients of these decompositions are distilled into small "signatures" for each image. We introduce an "image querying metric" that operates on these signatures. This metric essentially compares how many significant wavelet coefficients the query has in common with potential targets. After retrieval of the matching image from flame image databases, it will then provide input to the process control computer thus monitoring the combustion processes.

Wednesday, 1 Dec 2004, 13:00-15:20

SESSION: WM5	Penang 1
Agents	

Chair: Roger Jianxin Jiao
Co-Chair: Cheng Xiang

13:00
WM5.1: Multi-agent Emergent Self-organization Using an Apropriate Reward Function
Luis Miramontes Hercog
Monterrey Technological Institute, Sta Fe, Mexico

This paper shows the importance of the reward function and distribution in a game theoretical framework. the game at hand is the ``El Farol" Bar Problem well known for the need

of inductive reasoning to find the solution. The agents are evolutionary learners which perception is very simple. The first results show no adaptation using the traditional reward function of the Minority Game. Then, a new reward function which is layered and positive in all its domain is introduced. Using the new reward function, the multi-agent system adapts to the problem through emergent behavior, appearing an agent that is changing side all the time, called the vacillating agent. The agent balances the system allowing some agents to fix on both sides, the bar and at home, producing a Nash equilibrium, hence the optimal performance of the system.

13:20
WM5.2: Agent-based Collaborative Negotiation for Manufacturing Supply Chain Coordination
Jianxin (Roger) Jiao, Xiao You, Arun Kumar
Nanyang Technological University, Singapore

This paper applies the multi-agent system paradigm to collaborative negotiation in manufacturing supply chain coordination. Multi-agent computational environments are suitable for studying a broad class of coordination and negotiation issues involving multiple autonomous or semiautonomous problem solving agents. A case study of mobile phone global manufacturing supply chain coordination is reported.

13:40
WM5.3: Learning with Imperfections - A Multi-Agent Neural-Genetic Trading System with Differing Levels of Social Learning
Graham Kendall, Yan Su
University of Nottingham, UK

Some real life dynamic systems are so large and complex that the individuals inside the system can only partially understand their environment. In other words, the dynamic environment is imperfect to its participants. In this paper, by using the stock market as a test bed, we demonstrate an integrated individual learning and social learning model for optimisation problems in dynamic environments with imperfect information. By applying differing levels of social learning process in an evolutionary simulated stock market, we study the importance of social learning on the adaptability of artificial agents in imperfect environments. Comparisons between the integrated individual and social learning model and other evolutionary approaches for dynamic optimisation problems, particularly the memory-based approaches and multi-population approaches, are also drawn with the emphasis on optimisation problems with imperfect information.

14:00
WM5.4: A Proxy-Based Communication Scheme for Mobile Agents: Protocols and Performance
Xiao Yan Zhou, A. Neil Arnason, Sylvanus A. Ehikioya
University of Manitoba, Canada

Although the mobile agent paradigm provides great potential advantages over traditional approaches in distributed computing applications, there are still several issues to be addressed before the technology can be widely accepted. The performance of the communication protocol is one of the critical issues in mobile agent systems. A practical communication protocol for mobile agents must satisfy three basic requirements: location transparency, reliability and efficiency. Although many communication protocols have been proposed for mobile agent systems and most of them are location transparent, these protocols usually compromise some aspects of reliability and efficiency. In this research we develop a communication

scheme for efficient location tracking of agents and reliable message delivery in mobile agent systems by using a proxy-based scheme. The location update and message delivery protocols are developed and shown to be reliable even when agents migrate during message delivery. A simulation model is developed to estimate the performance relative to a (non-proxy-based) home-server protocol. Sensitivity analysis is used to reveal the important circumstances (domain/agent dimensions and exogenous demand/movement characteristics) for efficient communication performance.

14:20
WM5.5: Evolution of A Multi-Agent System with Distributed Multi-level Memory
Babak Tavassoli, Caro Lucas
University of Tehran, Iran

Conceptually, one of the important applications of evolutionary algorithms is in the field of multi-agent systems. But the agents cannot always act as the members of an evolutionary algorithm generation and elaborated solutions for mapping these different concepts are needed. In this paper a memory-like structure is proposed for the agents to increase the efficiency of an evolving multi-agent system. Then the idea is applied to a group of mobile robots for object displacement where simulation results show the efficiency of the proposed idea.

14:40
WM5.6: An Agent-based Approach to Adaptive Navigational Support within 3D-Environments
Bianca Schoen, Gregory O'Hare, *Brian Duffy, Alan Martin, John Bradley
University College Dublin, Ireland; *Media Lab Europe, Ireland

This paper investigates mechanisms and approaches to assisting user navigation and exploration within 3-dimensional worlds. Specifically it advocates the deployment of an agent-based approach to dynamic system assistance and intervention. A performance equation is presented in a basic and an extended version, which is used to activate system interventions and to evaluate user performances online and offline. The measure is derived via a light-weight computationally inexpensive masking approach. We describe some navigation experiments and the results of navigational intervention via the damping of the sensitivity of the navigational keys. Interestingly the navigational assistance does not yield improvements in the subjects' navigational abilities.

15:00
WM5.7: From Multilayer Perceptrons to Radial Basis Function Networks: A Comparative Study
Shenqiang Ding, Cheng Xiang
National University of Singapore, Singapore

A special additional input, which is the sum of the squares of the other inputs, is added to the standard multilayer perceptron, so that the multilayer perceptron works similarly as the radial basis function network with localized response. Specially, we will show a three-layered multilayer perceptron with exponential activation function and this kind of additional input is naturally a generalized radial basis function network, which can by trained with the well developed training strategies of multilayer perceptrons. A comparative study is also conducted between multilayer perceptrons, multilayer perceptrons with additional inputs and radial basis function networks trained by various methods.

SESSION: WM6   **Penang 2**
Computer Vision II
Chair: Ruihua Ma
Co-Chair: Takahiko Shimmura

13:00
WM6.1: Design of Vision System and Recognition Algorithm in Mirosot
Jun Zhou, Hong-shuang Zhang, Yong Chen, Chang-zhi Zhang
Hohai University, China

The components of Mirosot system are introduced in this paper and the realizing process of vision system and some affecting factors are especially analyzed, this paper also analyzes the factors should be cared about in the design of color mark and the algorithm design for recognizing color mark.

13:20
WM6.2: Automatic Multiview Coarse Registration of Range Images for 3D Modeling
Ajmal Mian, Mohammed Bennamoun, Robyn Owens
The University of Western Australia, Australia

Automatic registration of different overlapping range images (views) of an object is performed by matching their features. This process, known as correspondence identification, registers the views coarsely and is followed by fine registration. Existing correspondence techniques are limited to a pair of views at a time. In case there are more than two views of an object in random order, these techniques must perform an exhaustive search for correspondences between all possible view pairs. In this paper, we present an efficient automatic multiview surface matching algorithm for 3D modeling which simultaneously matches a single view with multiple views. Our approach represents local surface patches of each view with multiple tensors. Tensors are indexed by a 4D hash table. A voting approach is used with the help of the hash table to simultaneously identify potential corresponding tensors of different views. Correspondences are verified and used to construct a spanning tree graph with nodes representing the views and arcs representing the rigid transformation that aligns two views. This graph is used to register all the views. Our results show that our algorithm is efficient and robust to noise.

13:40
WM6.3: Design of a Haptic Display for Interacting and Sliding on Deformable Objects
Mehrdad H. Zadeh, Kash Khorasani
Concordia University, Montreal, Canada

This paper presents stable and robust point-based haptic rendering methods to interact with various types of deformable elastic object, from (soft) low-stiff to (rigid) high-stiff, using control algorithms. The proposed method offers a high-fidelity 3D force reflecting haptic model to guarantee a stable sliding and force (feedback) field over the surface of polygonal-based deformable bodies with different normal stiffness in each triangle mesh. Control algorithms are examined to maintain and to improve the stability margins and achievable performances for the haptic display with force continuity. Two classes of control strategies are investigated here. The first is a Lead-Lag (L-L) compensator designed based on classical control and the second scheme is a Linear-Quadratic-Gaussian (LQG) controller designed from modern control theory. Detailed comparison and evaluation of the proposed methods are presented to illustrate the performance of the haptic display when applied for deformable objects.

14:00
WM6.4: On Pixel Count Based Crowd Density Estimation For Visual Survaillance
Ruihua MA, Liyuan LI, Weimin HUANG, Qi TIAN
Institute for Infocomm Research, Singapore

Surveillance systems for public security are going beyond the conventional CCTV. A new generation of systems rely on image processing and computer vision techniques and deliver more ready-to-use information and provide assistance for early detection of unusual events. Crowd density is a useful source of information because unusual crowdedness is often related to unusual events. Previous works on crowd density estimation either ignore perspective distortion or perform the correction based on incorrect formulation. Also there is no investigation on whether the geometric correction derived for the ground plane can be applied to human objects standing upright to the plane. This paper derives the relation for geometric correction for the ground plane and proves formally that it can be directly applied to all the foreground pixels. We also propose a very efficient implementation because it is important for a real-time application. Finally a time- adaptive criterion for unusual crowdedness detection is described.

14:20
WM6.5: A Real Time Method to Object Detection and Tracking Applied to Robot-Soccer
Frank Helbert Borsato, Franklin Cesar Flores
State University of Maringa, Brazil

This paper proposes a computer vision system to a robot-soccer team, which specifications follow the stated by MiroSot (Micro-Robot Soccer Tournament) league, organized by FIRA (Federation of International Robot-Soccer Association). This system consists in a calibration module followed by a robust real time computer vision module applied to detect and track the objects in the playfield. The very fast processing time and the robustness under smooth light variations are the major contributions of this paper.

14:40
WM6.6: Estimating Human-flow Speed for Video Surveillance by Probabilistic Stands
Takahiko SHIMMURA, Hiroyuki ARAI, *Ushio INOUE
NTT DATA CORPORATION, Japan; *TOKYO DENKI UNIVERSITY, Japan

There are strong demands to extend existing surveillance systems with monocular cameras to create systems that can automatically detect unusual situations and issue alarms to the administrator. Most public surveillance functions pay attention to human traffic: the speed and direction of human flow. This is because these clues help to identify exceptional situations. In this paper, we propose a method for estimating people-flow speed in video sequences by allocating stands on CG (computer generated) scenes. To effectively handle crowded indoor scenes captured through a common monocular camera, we calculate an actual motion vector with optical flows and a background scene model. Because the location of objects cannot be specified by cross shots, it is not possible to relate a motion vector in a video sequence to that in the real world. To overcome this problem, we infer the motion vector in the real world by scaling the vector in the video sequence. For this purpose, we employ the "scaling factor" which is derived from a probability distribution of camera-distances of CG objects in CG images. We examine the effectiveness of our method using video sequences captured by two train station surveillance cameras.

15:00
WM6.7: Automatic Loop-shaping Method in NLQFT and its Application in Aircraft Control
LU En hai, ZHAO Chang an, *HUANG Xiaoyu
Harbin Institude of Technology, China; *Institute for Infocomm Research, A*STAR, Singapore

This paper proposes an improved automatic loop-shaping method in nonlinear quantitative feedback theory (NLQFT). Dynamic inversion (DI) is used to partially linearize the dynamics, and modify the plant templates. Based on Genetic Algorithms (GA), the lead compensation parameter is optimized. The optimized parameter is converted to pole-zero assignment to generate the robust optimal, less order controller in CAD IDE (The Interactive Design Environment). In the light of angle of attack (AOA) control of F-16 aircraft with complicated and nonlinear features, the control laws demonstrate perfect performance by accurately following large AOA commands at flight speeds raging from 53 to 150m/s. Robustness is verified by including 20% variations in pitching moment derivatives. The simulation results show that, compared to a fixed-gain, linear design, the proposed method eliminated actuator oscillations effectively, except that the max overshoot is increased.

SESSION: WM7	Malacca 2
Automation and Robotics in Biomolecular Computing (Invited Session)	

Chair: Masami Hagiya
Co-Chair: Osamu Ono
Organizer: John A. Rose
Organizer: Masami Hagiya, Osamu Ono

13:00
WM7.1: Invited speaker: Prof. Akira Suyama

13:20
WM7.2: Adaptive DNA Computing Algorithm by Using PCR and Restriction Enzyme
Shinpei Watanabe, Yusei Tsuboi, Zuwairie Ibrahim, Tsuneto Yamamoto, Osamu Ono
Meiji University, Japan

In this paper, we introduce a new adaptive DNA computing algorithm by using Polymerase Chain Reaction (PCR). The adaptive algorithm is designed based on Adleman-Lipton [3] paradigm of DNA computing. However, unlike the Adleman-Lipton architecture, a cutting operation has been introduced to the algorithm and the mechanism in which the molecules used by computation were feedback to the next cycle was devised. Moreover, amplification by PCR is performed in the molecule used by feedback and a concentration difference arises in the base sequence can be used again. By doing this, the molecules, which serve as a solution candidate, can be narrowed down and the optimal solution can be detected easily. From the application point of view, a simulation has been carried out on the shortest path problem and the validity of the proposed adaptive algorithm is stated from the results of the simulation. Finally, we go on to propose applying adaptive algorithm to the chemistry experiment, which used the actual DNA molecules for solving a universal problem.

13:40
WM7.3: Code Generation for a DNA Computer by Integer Linear Programming
Seika Abe, Masami Hagiya, *Takao Nakajima
University of Tokyo, Japan; *NovusGene Inc., Japan

In this paper, we describe code generation using integer linear programming for a robot called ANP-96, which automatically performs DNA computing experiments. The robot consists of 8 tables for placing plates; a device called IMU to do various operations on a plate, etc., and can

execute many experimental operations in parallel according to a given program. Since operations for DNA computing are executed under various constraints and may take a long time, executing many operations automatically and efficiently is essential. On the other hand, the current programming environment of ANP-96 is troublesome since it requires programmers to specify low level details which are not essential to experiments. In particular, programmers have to appropriately allocate a finite number of tables, and also efficiently schedule operations that take a long time. To automate such programming activities, we first designed a framework for specifying the problems of table allocation and operation scheduling, at an abstract level independent from ANP-96, and then implemented a code generator based on the framework. In the code generator, we employed the integer linear programming method developed in the field of compilers, which gives the optimal solution for the problems mentioned above.

14:00
WM7.4: Automation of Microfluidics for Molecular Computers
Danny van Noort
Seoul National University, Korea

Boolean problems can be solved by using DNA in microfluidic systems. It will be shown that computational problems can be solved with a programmable microfluidic system. Furthermore, microfluidics lend themselves to easy integration in automated set-ups. This paper will show that the optimal configuration of computing in microfluidics is a system containing components analogue with electronic elementary building blocks components, such as switches, logic gates and memory, making it programmable for any type of Boolean problem.

14:20
WM7.5: DNA Coding in Evolutionary Computation
Chieh Suang Khor, Peng Xiao, Prahlad Vadakkepat, Tong Heng Lee
National University of Singapore, Singapore

The parallelism in DNA Computing provides great potential to solve complex problems. DNA Coding methods are useful to promote the genetic algorithms' (GAs) performance on some problems. This work compares two coding methods for the genetic algorithm. The effect of the developed coding methods on the algorithms is analyzed by application to classification problem.

14:40
WM7.6: Preliminary Experiments on Hairpin Structure Dissociation for Constructing Robust DNA Machines
Keiichiro Takahashi, Masami Hagiya
The University of Tokyo, Japan

Our group has constructed several hairpin-based DNA machines that have multiple transition states. In these studies, we have conducted technical design of a single sequence or multiple sequences forming an artificial DNA nanomachine, based on prediction of free energy of secondary structures in silico. In this study, rather than relying on the free energy prediction in silico, we verified some fundamental behaviors of hairpin-based machines in vitro. In particular, we conducted some fundamental experiments about how a hairpin structure is opened when its opener sequence is added with or without the existence of a blocking sequence which prevents the opener from annealing with the hairpin structure. This paper reports on the new experimental results, and also discusses some new ideas based on the new results.

15:00
WM7.7: Adaptive Particle Swarm Optimization Based on Quantum Oscillator Model
Bin Feng, Wenbo Xu
Southern Yangtze University, China

In this paper, after establishing a quantum oscillator model for PSO, according the general convergence condition, we propose an approach of parameter control and an adaptive QPSO. The numerical experiment result shows its much advantage.

SESSION: WM9	Level 2a Foyer
Posters	

WM9: Automated Neural-ware System for Stock Market Prediction
Arosha Senanayake
Monash University Malaysia, Malaysia

This article uses neural networks in forecasting stock market prices. With their ability to discover patterns in nonlinear and chaotic systems, neural networks offer the ability to predict market directions more accurately than current techniques such as technical analysis, fundamental analysis, and regression compared with neural network performance. Proposed intelligent stock market prediction system is based on the Quantitative and Qualitative factors. Three feedforward neural models can be used to analyze these factors. Input data to the neural network proposed are quantitative factors. Input data to the neural network proposed for qualitative factors can be factors related to the political effect considered. Third neural network consists of decision integration in which input data will be the outputs of above- mentioned neural networks. This facilitates to make right decision whether stock market is influenced by quantitative or qualitative factors.

WM9: The Spatial-Domain Encryption of Digital Images Based on High-Dimension Chaotic System
Wang Ying, *Zheng Deling, *Ju Lei, *Wei Yaoguang
Heilongjiang Institute Of Science and Technology, China; University Of Science and Technology Beijing, China; *University Of Science and Technology Beijing, China

In this paper, the Lorenz chaotic system is applied to the digital image encryption based on the thought of higher secrecy of high- dimension chaotic system. Firstly, the pretreatment to the real value chaotic sequences produced by the system is carried out. Secondly, the index matrix of pixel permutation is structured by this real value chaotic sequence. Finally, the spatial-domain encryption of digital image is realized in 8×8 block. The analysis and simulation indicates, after the pretreatment, the real value chaotic sequence has the better pseudo-random characteristic. Additionally, with the bigger secret-key space of the high-dimension chaotic system, the algorithm has the quite strong function of resisting decryption and resisting attack. Three- dimension outputs of the system can realize the parallel encryption of three or more images, so increase the encryption efficiency of the algorithm.

WM9: Intelligent Negotiation based on individual mental Factor
Hong Zhang, Yuhui Qiu
Southwest China Normal University, China

This paper provides an intelligent multiagent approach to incorporate human temperament into the negotiation process of e-commerce bargaining. In this paper, we apply the idea of personality to BDI models and present a negotiation model based on temperament, therefore attempt to give out negotiation architecture based on various

concession rates. Also we illustrate the strategy for negotiation. Through the experiments this paper analyses and proves that temperament exerts great influence on concession rates in negotiation, and therefore affects the choices of negotiation strategy.

WM9: INS/GPS/Pseudolite Integrated Navigation for Land Vehicle in Urban Canyon Environments
Wei Wang, Zongyu Liu, Rongrong Xie
Northwestern Polytechnical University, China

The vehicle navigation and location system plays an essential role in all aspects of ITS. GPS/INS integrated navigation system has been widely used in land vehicle navigation. However, the performance of INS/GPS integrated system will severely degrade in urban canyon environments, where the GPS signals are often blocked by high-rise buildings, dense foliage and tunnels. To solve the problem, a pseudolite-augmented scheme is proposed, and a modified measurement model is presented, which uses the double difference of measured pseudo-ranges and INS estimated ranges. By employing this scheme, only two GPS signals are required to position a fix if using one pseudolite, which can be satisfied in many urban canyon environments. Simulation results indicate that this approach can solve the urban canyon problem successfully.

WM9: The Analysis of the Dynamic Equilibrium in Nonlinear Control System
Li Wang, Qinglin Wang
Beijing Institute of Technology, China

This paper discusses not a point of equilibrium to free system, but a certain family of equilibrium of nonlinear dynamical system with inputs. This equilibrium depends on the input, so it is called the dynamic equilibrium. The expression of the dynamic equilibrium is given under some certain condition. The stability property of the dynamic equilibrium depends also on the input, and it is discussed in systems with slowly varying input by two methods. We suggest some applications of this theory in the design of the nonlinear control system, address the direct method of feedback linearization based on the dynamic equilibrium state theory and the backstepping technique based on the dynamic equilibrium state theory.

WM9: Negotiation in a Multi-Dimensional CBR System
Esyin Chew, Syed Mustapha S.M.F.D
University of Malaya, Malaysia

Negotiation is a process of human communication, involving two parties, where each with his preconceived belief and objectives, trying to reach a mutually satisfactory result after exchanging and reconciling over matters. Negotiation can be computationally modeled using CBR techniques. The negotiators represent their negotiated terms as cases, either as a flat case or multi-dimensional case. We built the negotiation engine which performs negotiation on multi-dimensional case. This engine is built on Re-maker, a system which searches suitable partner by negotiating the differences in values specified by both negotiators. Episode strategy is the negotiation technique we adopt in our negotiation engine. The generic multi-dimensional CBR computation model for iterative matching in with negotiation is produced.

WM9: Topology Analysis for Safety Conscious Production Systems
Hossam A.Gabbar, *Kazuhiko Suzuki
Tokyo Institute of Technology, Japan; *Okayama University, Japan

The analysis and design of process topology is an important factor to ensure safety during the design and operation of chemical production plants as well as to support other lifecycle activities. This paper presents topology analysis mechanism, which is integrated within computer-aided engineering environment and used to support the design and operation of chemical production plants with considerations of process safety assessment. The proposed topology analysis is based on robust modeling methodology, which enabled the structuring of the accumulated design knowledge where fault propagation models are defined and mapped to process topology. A case study chemical production plant is used to illustrate the proposed solution.

Wednesday, 1 Dec 2004, 15:50-17:50

SESSION: WP5	Penang 1
Computational Intelligence	

Chair: Ryotaro Kamimura
Co-Chair: Keeley Crockett

15:50
WP5.1: Modular Structure Generation by Greedy Network-Growing Algorithm
Ryotaro Kamimura, *Haruhiko Takeuchi
Tokai University, Japan; *National Institute of Advanced Industrial Science and Engineering, Japan

In this paper, we propose a new method to generate modular structures. In the method, the number of elements, that is, the number of competitive units is gradually increased. To control a process of module generation, we introduce two kinds of information, that is, unit and modular information. Unit information represents information content obtained by individual elements in all modules. On the other hand, modular information is information content obtained by each module. We try to increase both types of information simultaneously. We applied our method to two classification problems: random data classification and web data classification. In both cases, we observed that modular structures were automatically generated.

16:10
WP5.2: Accelerated greedy network-growing algorithm by Gaussian Activation Functions
Ryotaro Kamimura, *Haruhiko Takeuchi
Tokai University, Japan; *National Institute of Advanced Industrial Science and Technology, Japan

In this paper, we propose a new computational method for a network- growing method called {\em greedy network-growing}\cite{Kamimura2002- greedy}. We have so far introduced a network-growing algorithm called {\em greedy network-growing} based upon information theoretic competitive learning. For competitive unit outputs, we have used the inverse of the squares of Euclidean distance between input patterns and connections. The algorithm has extracted very faithful representations of input patterns. However, one problem is that learning is very slow, and sometimes ambiguous final representations are obtained. To remedy these shortcomings, we introduce a new activation function, that is, Gaussian activation functions for competitive units. By changing a parameter for the Gaussian activation functions, we can build a network that does not focus on faithful representations of input patterns, but try to extract the main characteristics of input patterns. Because this method are not concerned with detailed parts of input patterns, learning is significantly accelerated and salient features should be extracted. We applied the method to a road classification problem. Experimental results confirmed that learning was significantly accelerated and salient features could be extracted.

16:30
WP5.3: A Consistency-based Approach to Efficient Test Case Generation from Timed Automata Specifications
Dario Kresic
University of Erlangen-Nuremberg, Germany

In this paper we describe the PROPeRTy project (Propagation Rules for Real-Time Systems) ongoing at the University of Erlangen-Nuremberg, a framework for testing real-time systems using logic programming approach combined with consistency techniques. A real-time system specification relies on the timed automata model and is automatically executed allowing the user to study the behaviour of the system by specifying constraints under which the execution should be performed. Such constraints, taken into account during a symbolic execution, are resolved by constraint propagator under consistency preserving. The symbolic execution generates a path (or multiple paths) consistent with the user formula and helps to decide if the formula is satisfied by the specification. In this paper we report about our project on using constraint propagation in the testing such real-time systems.

16:50
WP5.4: Power System Load Frequency Control Using RBF Neural Networks Based on μ-Synthesis Theory
Hossien Shayeghi, *Heidarali Shayanfar
Azad University, Ardebil, Iran; *Iran University of Science and Technology,Tehran, Iran

This paper describes a nonlinear Radial Basis Function Neural Networks (RBFNN) controller based on μ synthesis technique to load frequency Control (LFC) of the power systems. Power systems such as other industrial plants have some uncertainties and deviations due to multivariable operating conditions and load variations that for controller design had to take the uncertainties into account. For this reason, in design of the proposed load frequency controller the idea of μ synthesis theory is being used. The motivation of using the μ-based robust controller for training of the RBFNN controller is to take the large parametric uncertainties and modeling error into account. The proposed controller is effective and can guarantee the stability of overall system in the presence of plant parameter changes and system nonlinearities. The simulation results on a two-area power system show that the proposed RBFNN controller gives good dynamic responses and is superior to the conventional PI and μ-based robust controllers.

17:10
WP5.5: Lower Bounds of Stochastic Complexities in Variational Bayes Learning of Gaussian Mixture Models
Kazuho Watanabe, *Sumio Watanabe
Tokyo Institute of Technology, Japan; *P&I Lab., Tokyo Institute of Technology, Japan

The Bayesian learning is widely used and proved to be effective in many data modelling problems. However, computations involved in it requires huge costs and generally cannot be performed exactly. The Variational Bayes approach, proposed as an approximation of the Baysian learning, has provided computational tractability and good generalization performance in many applications. In spite of these advantages, the properties and capabilities of the Variational Bayes learning itself have not been clarified yet. It is still unknown how good approximation the Variational Bayes approach can achieve. In this paper, we discuss the Variational Bayes learning of gaussian mixture models and derive the lower bounds of the stochastic complexities. Stochastic complexity not only becomes important in addressing the model selection problem but also enables us to discuss the accuracy of the Variational Bayes approach as an approximation of the true Bayesian learning.

17:30
WP5.6: A Framework for Optimising Fuzzy Inference in Classifier Systems
Keeley Crockett, Zuhair Bandar
Manchester Metropolitain University, United Kingdom

In generating a suitable fuzzy classifier system, significant effort is placed on the determination and the fine tuning of the fuzzy sets. In such systems, little thought is given to the selection of the most suitable inference strategy. Often a traditional inference strategy is applied which allows no control over how strong or weak the inference is applied. A number of theoretical fuzzy inference operators have been proposed but not investigated in real world applications. This paper proposes a novel Genetic Algorithm Framework for optimizing the strengths and weaknesses of fuzzy inference operators concurrently with a set of membership functions for a given fuzzy classifier system. The paper investigates several theoretical proven fuzzy inference techniques and applies them within the proposed framework. The results from three real world data sets establish that the choice of inference parameters has a significant effect on the accuracy and robustness of fuzzy classifiers.

17:50
WP5.7: A Global Search Strategy of Quantum-Behaved Particle Swarm Optimization
Jun Sun, Wenbo Xu, Bin Feng, Jing Liu, Daiyan Xu
Southern Yangtze University, China

In this paper, based on the Quantum-behaved Particle Swarm Optimization (QPSO) algorithm in [3], we formulate the philosophy of QPSO and introduce a so-called "Mainstream Thought" of the population to evaluate the search scope of a particle and thus propose a novel parameter control method of QPSO. After that, we test the revised Q PSO algorithm on several benchmark functions and the experiment results show its superiority.

SESSION: WP6	Penang 2
Pattern Recognition	

Chair: Mohd Yusoff Mashor
Co-Chair: Masood Mehmood Khan

15:50
WP6.1: The Interactive Learning System
Dipak Sundaram, Pavitra Eshwar
St. Joseph's College of Engineering (University of Madras), India

The use of technology can be a key element in strengthening the art of independent learning. This paper discusses the issues in creating an interactive educational environment, most suited to children. Here we aim to introduce the features of the Interactive Learning System (ILS); a software which is an integration of teaching, training, testing, learning, analyzing, and mastering; with a high level of interactivity. We have in the course defined a simulation of a human teacher to be the interface for the learning process, which is the primary focus of this paper. This simulated agent also learns from its users and shares the information gained via the Internet paving way for a rapidly growing KnowledgeBASE. By making use of both Desktop and Distributed Computing, ILS can emerge as a global system.

16:10
WP6.2: Intelligent Classification System for Cancer Data Based on Artificial Neural Network
Nor Ashidi Mat Isa, Noorhabsah Haji A Hamid, Harsa Amylia Mat Sakim, Mohd Yusoff Mashor
University Sains Malaysia, Malaysia

This paper describes an intelligent classification system for cancer data. The system employs a hybrid radial basis function (HRBF) network in order to classify cancer data into several classes. The HRBF network is trained using the moving k-means clustering algorithm to position the network's centre and the Given least square (GLS) algorithm to estimate the network's weights. Two cancer data, i.e. cervical cancer and breast cancer, are used as case studies. For cervical cancer, the system classifies the data into three classes, i.e. normal, low grade squamous intraepithelial lesion (LSIL) and high grade squamous intraepithelial lesion (HSIL). The system produces 98.00% accuracy. While for breast cancer, the system classifies the data into benign and malignant data. The system produces 98.57% accuracy. The result illustrates the promising capabilities of the system for assisting cervical and breast cancer detection

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16:30
WP6.3: Automated classification and recognition of facial expressions using infrared thermal imaging
Masood Khan, *Robert Ward, *Michael Ingleby
American University of Sharjah, UAE; *The University of Huddersfield, UK

Facial expressions classification (FEC) software has usually been based upon the analysis of visible-spectrum images. Little work has been done on the use of Infrared Thermal Imaging (IRTI) in this area. We report ongoing work on the use of IRTI for FEC. We have identified thermally significant points on human faces, termed Facial Thermal Feature Points (FTFPs) and have discovered that variances in Thermal Intensity Values (TIVs) recorded at these FTFPs can help classify common intentional facial expressions. Using multivariate tests and linear discriminant analysis, we examined whether it is possible to distinguish between faces on the basis of TIVs for FEC. Results show that TIVs provide a viable set of thermal data that can be used to classify intentional facial expressions of happiness, sadness and disgust. IRTI may provide an alternative, or be complementary, to visible-spectrum based FEC techniques. IRTI also promises non-intrusive facial feature extraction and FEC in low illumination and image quality conditions.

16:50
WP6.4: Stability of the Classifier Based on Modification on Schweizer & Sklars Equations
Pasi Luukka, Jouni Sampo
Lappeenranta University of Technology, Finland

In this article we have applied Schweizer & Sklars implications with extension to generalized mean to classification task. We will show that classification results are not so sensitive to p values with Schweizer & Sklars measures which indicates generalized form of equations. Investigation for correct mean values is carried out. In this article we have also tested stability of the classifier. Two different tests for stability was made: in one test stability was checked respect to weight parameters and other test was carried out for idealvectors.

17:10
WP6.5: On Anti-Monotone Frequency Measures for Extracting Sequential Patterns from a Single Very-Long Data Sequence
Koji Iwanuma, Yo Takano, Hidetomo Nabeshima
Yamanashi University, Japan

In this paper, we propose a novel frequency measure, called the total frequency, for counting multiple occurrences of a sequential pattern in a very-long single data sequence. The total frequency satisfies the anti-monotonicity property, and makes it possible to count up pattern occurrences without duplication. Moreover the total frequency has a good property for implementation based on the dynamic programming strategy. We also show a preliminary result of our experiment for evaluating the total frequency.

17:30
WP6.6: An Implementation of Knowledge Based Pattern Recognition for Finicial Prediction
Chiung-Hon Leon Lee, *WenSung Chen, Alan Liu
National Chung Cheng University, Taiwan; *National Cheng Kung University, Taiwan

Japanese candlestick charting and analysis is one of the most widely used technical analysis techniques and definitely viable and effective for stock and commodity market timing and analysis. The candlestick theory is an empirical model of investment decision. The candle patterns reflect the psychology of market, and the investor can make his investment decision by the identified candle patterns. A knowledge based pattern recognition method for candlestick pattern is proposed in this paper. The investor can define the imprecise and vague candle pattern by this method. The investing expertise can be store in the knowledge base and the modeled candle pattern can be identified automatically from the large amount of the trading data by the software tool. A prototype system has been established for automating the process of candle pattern recognition.

17:50
WP6.7: Intelligent Temperature Control of Ignition Furnace in Sintering Machine
Zhang changfan, *he jing, **Long Yonghong, Cai Yejing
Zhuzhou Institute of Technology, China; *National University of Defense Technology, China; **Central South University, China

Based on the thorough analysis of the technique flow of ignition furnace in sintering machine, put forward a model following control method through the fusion of multiple subject theory. It can control the sintering endpoint with sliding mode method based on fuzzy neural network. What's more, we control the temperature of ignition furnace; gas flow and air flow with the field bus devices. Through the practical application, this project can satisfy the design demand and improve the quality and quantity of products.

SESSION: WP7   **Malacca 2**
Advances In Intelligent Data Processing
(Invited Session)

Chair: Douglas Chai
Co-Chair: Yew Soon Ong
Organizer: Yew Soon Ong
Organizer: Kok Wai Wong

15:50
WP7.1: Experimental Condition Selection In Whole-Genome Functional Classification
Zexuan Zhu, Yew Soon Ong, Kok Wai Wong, Kiam Tian Seom
Nanyang Technological University, Singapore

Microarray technologies enable the quantitative simultaneously monitoring of expression levels for thousands of genes under various experimental conditions. This is new technology has provided a new way of learning gene functional classes on a genome-wide. Previously, lots of unsupervised clustering methods and supervised classification have shown power in assigning functional annotations based on gene co-expression. However, due to the noisy and highly dimensional nature of microarray data and the inherent heterogeneity of gene functional classes,

the whole-genome learning of gene functional classes from microarray data has remained a great challenge for scientists. Currently, most of the methods do not discriminate the different attribution of experimental conditions in the learning process, which impaired the ability of learning functional classes and prevented these methods from discovering the links between the experimental conditions and gene functional classes. In this study, we perform a selection of experiment conditions during the systematically learning of ~100 functional classes categorized in MIPS's comprehensive yeast genome database. In particular, a hybridization of genetic algorithm and k- nearest neighbors classifier has been adopted here. Through a comparison of the results with other previous methods our studies indicate promising improvements in learning performance. Further, by identifying the critical experimental conditions, significant links between the experiments and the functional classes were uncovered.

16:10
WP7.2: Image Clustering and Retrieval Combining fixed/adaptive-binned Histograms and various Distance Functions
Mladen Jovic, *Thomas Seidl, Zoran Stejic, **Ira Assent
Tokyo Institute of Technology, Japan; *RWTH Aachen University, Gemany; **RWTH Aachen University, Germany

In the context of content-based image retrieval, we compare two types of histograms, fixed and adaptive, both frequently used for modeling the image features. We demonstrate that a choice of a histogram type, combined with the choice of a distance function, can have a huge impact onto the clustering structure of the dataset. Such a hierarchical clustering structure visualization of database objects helps often the user to find similar objects and discover unknown patterns. In our experiments we use real data sets with large number of semantic categories, and evaluate both the reachability plots and the clustering accuracy, to show the effects of appropriate choice of fixed and/or adaptive binning in combination with various distance functions. Results show that significant clusters, along with their representatives, can be automatically extracted, which is a basis for visual data mining but even more important for non-visual data mining.

16:30
WP7.3: Facial image processing: an overview
Douglas Chai, *Kok Wai Wong
Edith Cowan University, Australia; *Nanyang Technological University, Singapore

Facial image processing is an area of research that holds an important key to future advances in intelligent human-to-computer and human-to- human systems. This paper presents an overview of this research. It also addresses some of the latest research directions and applications, as well as several important issues raised from recent studies.

16:50
WP7.4: Fuzzy modelling using a simplified rule base
Sebastian W. Khor, *M. Shamim Khan, *Che Fung Chun
Murdoch University, Australia; *Murdoch University, Perth, Australia

Transparency and complexity are two major concerns of fuzzy rule-based systems. To improve accuracy and precision of the outputs, we need to increase the partitioning of the input space. However, this increases the number of rules exponentially, thereby increasing the complexity of the system and decreasing its transparency. The main factor behind these two issues is the conjunctive canonical form of

the fuzzy rules. We present a novel method for replacing these rules with their singleton forms, and using aggregation operators to provide the mechanism for combining the crisp outputs.

17:10
WP7.5: A Movie Recommender System Based on Inductive Learning
PENG LI, *SEIJI YAMADA
CISS, IGSSE, Tokyo Institute of Technology, Japan; *National Institute of Informatics, Japan

Recommender Systems apply intelligent access technologies to large information systems. These systems, especially collaborative filtering based ones, are achieving widespread success on the Web. In recent years, the amount of available information and the number of visitors to Web sites are increasing enormously. New recommender system technologies are needed that can quickly produce high quality recommendations, even for very large-scale information resources. In this paper we apply inductive learning algorithm to the recommendation process. Instead of computing user-user or item-item similarities, we construct a decision tree to represent user preference. Recommendations are performed by decision tree classification. To inspect the effectiveness of this technology, we set up a movie recommender system based on inductive learning and make online experiments for evaluation. Our results suggest that inductive-learning-based technology is promising for the solution of the very large-scale problems and high-quality recommendations can be expected.

17:30
WP7.6: Consideration of Relevance Feedback on Keyword Space for Interactive Information Retrieval
Yasufumi Takama
Tokyo Metropolitan Institute of Technology, Japan

The relevance feedback based on a keyword map is proposed so that a Web interface can be more interactive. There exists vast amount of information in the Web, from which users usually gather information without definite information needs. The relevance feedback techniques have been studied in the field of document retrieval, aiming to generate appropriate queries for users' information needs. However, conventional relevance feedback techniques are performed on document space, while the resultant queries should be represented in keyword space. In this paper, it is proposed to perform relevance feedback on keyword space. The relevance feedback is supposed to work with interactive keyword map system, which visualizes the relationship between keywords extracted from retrieved results. As the first step for realizing relevance feedback based on interactive keyword map, this paper also proposes the algorithm for extracting the pair of keywords that reflects a user's interest from the keyword map. Experimental results are given for showing how the algorithm works on the keyword map that is modified by the user, and for discussing the difference between the RF based on keyword map and conventional RF methods.

Thursday, 2 Dec 2004, 10:00-12:00

SESSION: TA4	Temasek 4
Image Processing I	

Chair: Sei-Wang Chen
Co-Chair: Wei Shao

10:00
TA4.1: A Wavelet and Canny based Image Comparison
Woon Chung Chan, Minh Viet Le, Phu Dung Le
Monash University, Australia

A robust and reliable image comparison method enables many computer vision applications such as wireless surveillance systems, fingerprint and face recognition. In this paper, we propose an image comparison method that can indicate reliably the similarity and difference between two images. It is constructed by combining an image quality measure and a simple Canny based image comparison metric. Our experiment results show that it is tolerant to random noise, structured noise and invariant to the affine transformation.

10:20
TA4.2: The Whole Greater Than the Sum of Its Parts: Maximizing the Strengths of Heuristic Set Covering Algorithms
Nigel Gwee, *Peter Chen
Southern University, Baton Rouge, Louisiana, USA; *Louisiana State University, Baton Rouge, Louisiana, USA

We describe a general procedure that maximizes the strengths of selected heuristic optimization algorithms to produce solutions that are often better than what each algorithm could produce individually. We illustrate our procedure on the generalized set covering problem. By combining several heuristic algorithms, we obtain optimal solutions in many instances. The algorithms used in this way are shown to be effective also in solving the classical set covering problem.

10:40
TA4.3: Feature Extraction In Medical MRI Image
Somkait Udomhunsakul, Pichet Wongsita
King Mongkut's Institute of Technology Ladkrabang, Thailand

A feature extraction approach in medical magnetic resonance imaging (MRI) is proposed. In this approach, first the combination of spatial filters using the 5x5 wiener filter followed by a 3x3 Gaussian filter is used to remove the noisy pixels while preserving the important information. Next, the edge detection algorithm based on multiple-scales edge detection of Gabor filters is applied. Moreover, Wavelet transform based image fusion is used to combine the detail coefficients. Finally, the nonmaxima suppression technique is adopted to get the final result. The experiments show that the proposed algorithm can be detected well-localized, and thin edges. Therefore, the algorithm leads to a useful method for feature extraction in MRI images and can be used for diagnostic purposes.

11:00
TA4.4: Deformable Registration Between MRI/MRSI and Ultrasound Images for Targeted Robotic Prostate Biopsy
Wei Shao, Keck Voon Ling, *Choon Hua Thng, **Ruoyun Wu, Wan Sing Ng
Nanyang Technological University, Singapore; *National Cancer Centre, Singapore; **Tan Tock Seng Hospital, Singapore

Development of a prostate biopsy robotics can alleviate urologists' labor and ensure high accuracy. However, intervention from urologists is still needed to define the target cores of biopsy. It is being recognized that Magnetic Resonance Imaging (MRI) and Magnetic Resonance Spectroscopy Imaging (MRSI) are potential to provide cancer distribution pre-operatively. So guiding the biopsy needle towards those suspected cancer sites could improve its detection rate and reduce the possibility of false negative results. In this paper, a deformable registration method is presented for the purpose of merging MRI/MRSI and transrectal ultrasound (TRUS) images. Considering the ultrasound (US) image quality and the cross-modal deformation, a framework including a global rigid alignment and a non-rigid transformation is established to match the two prostate surfaces and thereafter their volumes. For validation purpose, a deformable prostate phantom that simulates the human condition was set up. Fifteen fiducial markers were implanted inside the phantom prostate to act as the "ground truth". The phantom study shows that our method can achieve an accuracy around 1.28 ± 0.50mm, under voxel dimension of 0.5mm$'0.5$mm$'0.5$mm. This result was promising for blind knowledge about the interior prostate was utilized in the algorithm. Experimental result on patient data was also demonstrated.

11:20
TA4.5: Chaos Based UWB Imaging Radar for Homeland Security
Vijayaraghavan Venkatasubramanian, *Peiguo Liu, Henry Leung
Department of ECE, University of Calgary, Canada; *School of Electrical Engineering, National university of defense technology, China

In this paper, we present a novel chaos based ultra-wideband (UWB) imaging radar for surveillance applications in a closed environment. The proposed chaos based UWB imaging radar has good range resolution and excellent range-sidelobe suppression characteristics that enhance its imaging performance. The imaging performance of the proposed radar is better than that of the conventional time modulated UWB (TM-UWB) radars in reducing false alarms and in imaging targets closely lying behind the wall. Numerical electromagnetic (EM) simulations using finite difference time domain (FDTD) method illustrate the definite advantages of the proposed radar under different scenarios.

11:40
TA4.6: A Non-Parametric Blur Measure Based on Edge Analysis for Image Processing Applications
Yun-Chung Chung, Jung-Ming Wang, Robert R. Bailey, Sei-Wang Chen, *Shyang-Lih Chang
National Taiwan Normal University, Taiwan; *St. John's & St. Mary's Institute of Technology, Taiwan

A non-parametric image blur measure is presented. The measure is based on edge analysis and is suitable for various image processing applications. The proposed measure for any edge point is obtained by combining the standard deviation of the edge gradient magnitude profile and the value of the edge gradient magnitude using a weighted average. The standard deviation describes the width of the edge, and its edge gradient magnitude is also included to make the blur measure more reliable. Moreover, the value of the weight is related to image contrast and can be calculated directly from the image. Experiments on natural scenes indicate that the proposed technique can effectively describe the blurriness of images in image processing applications.

SESSION: TA5	Penang 1
Data Mining and Management II	

Chair: Siu Cheung Hui

10:00
TA5.1: Visual Interactive 3-Dimensional Clustering with Implicit Functions
Olga Sourina, Dongquan Liu

Nanyang Technological University, Singapore

Visualization techniques could enhance the current knowledge and data discovery methods by increasing the user involvement in the interactive process. In this paper, we propose a novel interactive clustering method based on geometric model with implicit functions and visualization techniques integrated in the GUI. First, visual clustering with blobby model allows the user to see the result of clustering on the screen and set the appropriate parameters interactively. After that, the user can get data of cluster in two ways. First method implies using solid-based subdivision algorithm. In the second method, the user needs to wrap the cluster he/she is interested in with geometric primitive solids that currently are cubes and/or spheres/ellipsoids. Geometric operations of union, intersection or subtraction can be performed over the geometric primitive solids to get the final wrapping shape. The user visually clusters the data and wraps the clusters with geometric shapes or even query clusters through graphics interface accessing dynamically 3- dimensional projections of multidimensional points from database or files.

10:20
TA5.2: Free-Parameters Clustering of Spatial Data with Nonuniform Density
Dongquan Liu, Olga Sourina
Nanyang Technological Univ, Singapore

Clustering is a challenging task due to the rapid increase of data variety and the lack of prior knowledge about data. On the other hand very few clustering methods can successfully and automatically deal with the irregular data sets where density varies not only across clusters but also inside clusters, and clusters can also be linked by multiple bridges. Thus, it is important to design a clustering method that can handle such irregular data sets and generate all values of parameters automatically. In this paper, we proposed a new Automatic Non-uniform Density Clustering algorithm (ANDC) based on triangulation method. This approach allows us to cluster irregular data sets efficiently finding uniform and non-uniform density clusters as well. The method does not require any input from the user. The results of tests and comparisons with other algorithms shown in this paper confirm the efficiency of our method.

10:40
TA5.3: An Intelligent Recommender System using Sequential Web Access Patterns
Baoyao Zhou, Siu Cheung Hui, Kuiyu Chang
Nanyang Technological University, Singapore

To provide intelligent personalized online services such as web recommendations, it is usually necessary to model users' web access behavior. To achieve this, one of the promising approaches is web usage mining, which mines web logs for user models and recommendations. Different from most web recommender systems that are mainly based on clustering and association rule mining, this paper proposes an intelligent web recommender system known as SWARS (Sequential Web Accessbased Recommender System) that uses sequential access pattern mining. In the proposed system, CS-mine, an efficient sequential pattern mining algorithm is used to identify frequent sequential web access patterns. The access patterns are then stored in a compact tree structure, called Pattern-tree, which is then used for matching and generating web links for recommendations. In this paper, the proposed SWARS system is described, and its performance is evaluated based on precision, satisfaction and applicability.

11:00
TA5.4: Web Mining for Cyber Monitoring and Filtering
Tien Dung Do, Kuiyu Chang, Siu Cheung Hui

Nanyang Technological University, Singapore

Like any self-regulating environment, the Internet is fertile ground for all kinds of potential abuse ranging from get-rich-quick scams, touting of illegal or adult-oriented material, promotion of extremist/anarchist views, to online pimping, etc. Consequently, the ability to discreetly intercept and analyze Internet access has tremendous potential in shielding users, especially our youngsters, from inappropriate content. This paper proposes one such system, the Web Access Monitoring and Filtering (WAMF) system. The WAMF system comprises two main decoupled components, one for online monitoring and filtering, and the other for offline Web classification and data analysis. The former tracks, tallies, and selectively blocks user Web access in real-time, whereas the latter employs Web mining techniques to classify Web pages into pre- defined user categories and analyze user Web access data for user behavior patterns. In this paper, we will discuss the WAMF system, and in particular, Web mining techniques for adaptive Web page categorization.

11:20
TA5.5: Extension of Fuzzy c-means Algorithm
Chengjia Li, *Victor M. Becerra, *Jiamei Deng
Hangzhou Dianzi University, China; *University of Reading, UK

Clustering is a procedure through which objects are distinguished or classified in accordance with their similarity. The Fuzzy c-Means method (FCM) is one of the most popular clustering methods based on minimization of a criterion function. However, the FCM method is sensitive to the presence of noise and outliers in data. This paper introduces a new clustering algorithm by extending the criterion function. As a special case, this algorithm includes the well-known Fuzzy c-Means method. Performance of the new clustering algorithm is experimentally compared with the FCM method using synthetic data with different clusters and outliers.

11:40
TA5.6: Int-EM-CEM algorithm for imprecise data. Comparison with the CEM algorithm using Monte Carlo Simulations
Hani HAMDAN, *Gérard GOVAERT
CETIM & HEUDIASYC (UTC), France; *HEUDIASYC (UTC)

This paper addresses the problem of fitting mixture model based- clustering to imprecise data using the CEM algorithm. Imprecise data are modelled by multivariate uncertainty zones, which constitute a generalization of multivariate interval-valued data. To estimate simultaneously the mixture model parameters and the partition from uncertainty zone data, we propose an adapted version of the CEM algorithm. Results on simulated data compare the proposed algorithm with the classical one (applied to the raw data then to the uncertain data).

SESSION: TA6	Penang 2
Fuzzy Control	

Chair: Jun Yoneyama
Co-Chair: Dongrui Wu

10:00
TA6.1: A Simplified Architecture for Type-2 FLSs and Its Application to Nonlinear Control
Dongrui Wu, Woei Wan Tan
National University of Singapore, Singapore

A type-2 fuzzy logic system (FLS) is one that has at least one type-2 membership function (MF) in its rule base. Consequently, the output of the inference engine is a type-2 fuzzy set and must be type-reduced before the defuzzifier is able to convert the output set into a crisp value. Type-2 FLS may not be suitable for certain real-time applications

because type-reduction is very computationally intensive, especially when there are many MFs and the rule base is large. In this paper a simplified architecture for type-2 FLSs is proposed, where only one fuzzy set for each input domain is type-2 and all others are type-1. This architecture relieves the computational burden of the type-2 fuzzy system, while preserving its advantages over traditional type-1 FLSs. Two FLSs that have the proposed architecture are used to control a nonlinear SISO plant. Experimental results show that they cope well with the complexity of the plant, and can handle the modelling uncertainties better than their type-1 counterpart.

10:20
TA6.2: Generalized Stability Conditions for Takagi-Sugeno Fuzzy Time-Delay
Jun Yoneyama
Aoyama Gakuin University, Japan

In this paper, we consider generalized delay-dependent stability conditions of Takagi-Sugeno fuzzy time-delay systems. In the literature, both delay-independent stability conditions and delay-dependent stability conditions for fuzzy time-delay systems have already been obtained. However, those conditions are rather conservative and do not guarantee wide stability regions. This is true in case of designing stabilizing controllers for fuzzy time-delay systems and it thus leads to a conservative fuzzy controller design as well. We first make a generalized transformation of fuzzy time-delay system to obtain generalized delay-dependent stability conditions. In such a generalized transformation, we have some arbitrary matrices that generalize a system representation. In fact, these matrices generalize not only the system representation but also delay-dependent stability conditions. Delay-dependent conditions we obtain here depend on the upper bound of time-delay and are given in Linear Matrix Inequalities(LMI's). Then, we compare our generalized delay-dependent stability condition with other stability conditions in the literature, and show that our condition is a generalized one. Next, we consider the stabilization problem. Based on our generalized delay-dependent stability conditions, we obtain delay- dependent sufficient conditions for the closed-loop system to be stable. Finally, we give a simple example that illustrates our result.

10:40
TA6.3: Robust Fuzzy Multimodel Control using Variable structure System
Nasser Sadati, Ali Talasaz
Sharif university of technology, Iran

The robust fuzzy multimodel control as a potential tool to control the complex systems is presented in this paper. The main idea in multimodel controllers is to identify the best model of system at any instant and apply the appropriate control input to it. Classical multimodel controller works based on switching and tuning, while fuzzy logic is used in construction of fuzzy multimodel controller. The basic control signal for each model is calculated using the sliding mode control and the final control input is inferred as the weighted average of the local control inputs. A new algorithm is proposed in order to use the fuzzy multimodel control for time variant linear systems. To show the validity of the proposed approach, simulations are done for a flexible transmission system which is a good example for complex time variant linear system.

11:00
TA6.4: Fuzzy Intelligent Control of Automotive Vibration via Magneto-rheological Damper
Rui Li, *Weimin Chen, *Miao Yu, **Kaidi Liu
Chongqing University of Post and Telecom, China ; *Chongqing University, China ; **University of Technology, Sydney, Australia

Based on analyses of characteristics of Magneto-rheological (MR) damper, a hierarchical fuzzy intelligent controller is proposed for vibration control of an automotive vehicle with MR dampers. This controller consists of control level and coordination level. In the control level, a semi-active fuzzy logic controller is designed for each MR suspension system based on a hybrid control strategy of skyhook control and groundhook control. In the coordination level, a coordination controller is designed to coordinate the four independent semi-active fuzzy logic controllers by adjusting their output parameters according to the system feedback. To validate the results of hierarchical fuzzy intelligent control, a MR semi-active suspension control and test system is set up and is implemented on a mini bus, which is equipped with four controllable MR dampers. Test results indicate that the hierarchical fuzzy intelligent controller can effectively reduce the vertical vibration and improve the ride comfort and handle stability of automobile.

11:20
TA6.5: Apply Fuzzy PID Rule to PDA Based Control of Position Control of Slider Crank Mechanisms
Chung-Dar Lee, *Chih-Cheng Kao, Chin-Wen Chuang
I-Shou University, Taiwan; *Kao-Yuan Institute of Technology, Taiwan

This paper proposes a fuzzy PID control scheme to control the position of a slider crank coupled with a PM synchronous motor. By the Hamilton principle and Lagrange multiplier method, the mathematical formula is derived. On the basis of relationship of input and output, a fuzzy inference rule is made up. The nominal parameters of PID are first decided on no-load condition. The varying ranges of parameters of PID are chosen under full-load condition. The fuzzy rule is used to intelligently tune the optimal parameters among these ranges under operating condition. To demonstrate the potential of the proposed rule, a prototype board is developed in this paper. A PC based operating platform is used to have human interface characteristic and fast process capability. Finally, the numerical simulation and experimental results will show the robustness of the fuzzy PID control for position control of slider crank mechanisms.

11:40
TA6.6: An LMI-Based stable T-S fuzzy model with parametric uncertainties using Multiple Lyapunov Function approach
Chien-Hung Liu, *Jiing-Dong Hwang, **Zhi-Ren Tsai, Shih-Hsiung Twu
Chung-Yuan Christian University, Taiwan, R.O.C.; *Jin-Wen Institute of Technology, Taiwan, R.O.C.; **Chang Gung University, Taiwan, R. O. C

This paper addresses stability analysis and stabilization for Takagi- Sugeno (T-S) fuzzy systems with parametric uncertainties via a so- called fuzzy Lyapunov function, which is a multiple Lyapunov function. The fuzzy Lyapunov function is defined by fuzzily blending quadratic Lyapunov functions. First, the Takagi-Sugeno (T-S) fuzzy model with parametric uncertainties is used as the model for the uncertain nonlinear system. Based on the fuzzy Lyapunov function approach and a parallel distributed compensation (PDC) scheme, we give stabilization conditions for closed-loop fuzzy systems with parametric uncertainties. Second, all the conditions are formulated in the format of linear matrix inequalities (LMIs) and contain upper bounds of the time derivative of premise membership functions as LMI variables. Finally, the T-S fuzzy model of the Chaotic Lorenz system, which has complex nonlinearity, is developed as a test bed. A numerical example of the Chaotic Lorenz system is given to illustrate the utility of the fuzzy Lyapunov function approach.

SESSION: TA7   **Malacca 2**
Genetic Algorithms - Theory
Chair: Yiyang Zhang
Co-Chair: Shamim Khan

10:00

TA7.1: Voronoi Model-Building Genetic Algorithm
Hisashi Shimosaka, *Tomoyuki Hiroyasu, *Mitsunori Miki
Graduate School of Engineering, Doshisha University, Japan; *Department of Engineering, Doshisha University, Japan

This paper proposes the Voronoi Model-Building Genetic Algorithm (VMBGA), which is one of real-coded GAs. In the VMBGA, a voronoi model is constructed using with voronoi diagrams. Because of this mechanism, the distribution of offspring can adapt to the landscape of the objective function by changing the voronoi model. Through the some standard test functions, the effectiveness of the VMBGA is examined. It is clarified that the VMBGA has higher searching ability than the UNDX-m, which is one of the typical real-coded GAs. Additionally, the distribution of the offspring is also discussed.

10:20

TA7.2: Tabu Local Search Mechanism for Mega Process Genetic Algorithm
Yoshiko Hanada, Tomoyuki Hiroyasu, Mitsunori Miki
Doshisha University, Japan

In this study a new Genetic Algorithm (GA) using Tabu Local Search mechanism for large-scale computer systems is proposed. We call the GA that uses huge computing resources a Mega Process GA. The GA described in this paper is considered a Mega Process GA which has the effective mechanism to solve the problems quickly and to use massive processors, namely Mega Processors, comprised in large-scale computing systems such as super PC clusters and Grid computation environments. Our proposed method has a GA-specific database that possesses information of space that has been already searched. At the same time, the proposed GA performs a local search for the space that is not searched. Such mechanisms enable us to comprehend the quantitative rate of a searched region during the search. Using this information, the searched space can be expanded linearly as the number of computing resources increase and the exhaustive search is guaranteed under infinite computations. Using and describing different experiments, the features of the introduced GA are discussed and examined. At first, this method was applied on one max problem and 3-deceptive problem; the former is one of primitive functions and the latter is one of trap functions. Through this experiment, it is shown that the method ensures an effective exhaustive search. This method was then applied to the test functions of continuous optimization problems under restricted computing costs. Using such an experiment, it is clear that this method has the same performance as a conventional GA.

10:40

TA7.3: Chaotic Parallel Genetic Algorithm with Feedback Mechanism and its Application in complex Constrained Problem
Youfa Sun, Feiqi Deng
South China Universtiy of Technology, China

Lots of improvements have been made to genetic algorithm, but they did not nearly solve the dilemmas—slow convergence and crowding problem due to the conventional genetic algorithms' oversimplified mechanisms: pseudo-diversity of population and randomized evolutionary operation. Basing on a new scheme—random evolution plus feedback, which is reported to well represent the nature of biological evolution process, we propose Chaotic Parallel Genetic Algorithm with Feedback Mechanism. In this new algorithm, chaotic mapping is embedded for maintaining a

good diversity of population; and Baldwin effect based posterior reinforcement learning, which can successfully deal with the feedback information from evolutionary system, is included to speed up the evolution along the right direction. The performance of this new algorithm was demonstrated on two well-known benchmark constrained problems. Results show that this new genetic algorithm is feasible and quite effective.

11:00

TA7.4: A Novel GA-Based Algorithm Approach to Fast Biosequence Alignment
Ying-Tung Hsiao, Cheng-Long Chuang, Cheng-Chih Chien
Tamkang University, Taiwan

This paper presents a novel approach algorithm for bimolecular sequences alignment. Sequences comparison is the most important primitive operation in computational biology. There are many computational requirements for a alignment algorithm such as computer memory space requirement and computational complexity (computation time). To overcome the computational complexity of sequence alignment, the presented method first randomly divides the entire bimolecular sequences into several small sequences, and search for a partial near optima solution. After all of the partial near optima searching operations are completed, the algorithm starts to search for better global optima by scan the new bimolecular sequences that are combined from the optimized small sequences. It allows pairwise alignment in each small sequence and does not apply dynamic programming at any optimization operation. The proposed algorithm also provides highly alignment efficient and very fast performance. Moreover, the proposed algorithm has been implemented in an x86 program, and used to verify the validity of the proposed algorithm and experiment on real DNA and protein datasets.

11:20

TA7.5: A Quick Convergent Genetic Algorithm for Pattern Alignment
Yo-Ping Huang, Yueh-Tsun Chang
Tatung University, Taiwan

In this paper we present a modified genetic algorithm to overcome the slow convergent problem existed in traditional genetic algorithms. We introduce a new elite competition schema, which dominates the mutation and crossover operations, to expedite the evolution. On the benefits of the rapid convergence, our proposed algorithm is very suited to solve the optimization problems in many application domains. Moreover, to verify the effectiveness of the proposed model, we use the algorithm to solve the problems of polynomial fitting and gene sequence alignment. The experimental results demonstrate that our proposed algorithm is more efficient than traditional algorithms.

11:40

TA7.6: A Heuristic Genetic Algorithm for Product Portfolio Planning
Jianxin Jiao, Yiyang Zhang
Nanyang Technological University, Singapore

For any manufacturing company, product portfolio planning constitutes one of the most important decisions regarding how to offer the "right" products to the target market. Essentially, such decisions exhibit a typical combinatorial optimization problem, which deems to be very complex and hard to solve using conventional optimization techniques. Enumeration is inhibitive if the problem size is extremely large. Genetic Algorithms (GAs) have been proven to excel in solving combinatorial optimization problems. This paper develops a heuristic GA to tackle the product portfolio planning problem.

TA9: XFC – XML based on Fuzzy Clustering- Method for Personalized User Profile based on Category in Recommendation System
Jin-Hong Kim, Eun-Seok Lee
University of SungKyunKwan, Korea

In data mining, to access a large amount of data sets for the purpose of predictive data does not guarantee a good method. Even, the size of Real data is unlimited in Mobile commerce. Hereupon, in addition to searching expected Products for Users, it becomes necessary to develop a recommendation service based on XML Technology. In this paper, we design the optimized XML Recommended products data. Efficient XML data preprocessing is required in include of formatting, structural, attribute of representation with dependent on User Profile Information. Our goal is to find a relationship among user interested products and E- Commerce from M-Commerce to XDB. First, analyzing user profiles information. In the result creating clusters with user profile analyzed such as with set of sex, age, job. Second, it is clustering XML data, which are associative objects, classified from user profile in shopping mall. Third, after composing categories and Products in which associative Products exist from the first clustering, it represent categories and Products in shopping mall and optimized clustering XML data which are personalized products. The proposed personalizing user profile clustering method is designed and simulated to demonstrate the efficiency of the system.

TA9: Sensor Fusion System for Improving the Recognition of 3D object
Ji Kyoung Kim, Jae Woo Wee, Chong Ho Lee
University of InHa, South Korea

Human being recognizes the physical world by integrating a great variety of sensory inputs, the information acquired by their own action, and their knowledge of the world using hierarchically parallel-distributed mechanism. In this paper, authors propose the sensor fusion system that can recognize multiple 3D objects from 2D projection images and tactile information. The proposed system focuses on improving object recognition rate. Unlike the conventional object recognition system that uses image sensor alone, the proposed method uses tactual sensors in addition to visual sensor. Tactual signals are obtained from the reaction force by the pressure sensors at the fingertips when unknown objects are grasped by four-fingered robot hand. The experiment evaluates the recognition rate and the number of learning iterations of various objects. The experimental results show that the proposed system can improve recognition rate and reduce learning time. These results verify the effectiveness of the proposed sensor fusion system as 3D object recognition scheme.

TA9: A Context-Aware System in Ubiquitous Environment: a Research Guide
Jihyung Park, Seungsoo Lee, Sungju Kim, Seokho Lee, Kiwon Yeom
CAD/CAM Research Center in Korea Institute of Science and Technology, Korea

The ubiquitous environment is to support people in their everyday life in an inconspicuous and unobtrusive way. This requires that information of the person and her preferences, liking, and habits are available in the ubiquitous system. In this paper, we propose the context aware system that can provide the tailored information service for user in ubiquitous computing environment. The system architecture is composed of 4 domain models that can perform some pre-defined tasks independently. And we suggest the hybrid algorithm combined with fuzzy and Bayesian network to reason what information is suitable for

user environment. Finally, the system is applied to RGA(Research Guide Assistant) and the efficiency and usefulness is described.

TA9: Fuzzy Logic Based Control Of Rotor Motion In Active Magnetic Bearings
Maki Habib
Monash University Malaysia, Malaysia

Active magnetic bearings (AMB) are increasingly being used as an alternative to rolling element and fluid-film bearings in rotating machinery application. Stable operation of AMB can only be achieved via feedback control of which the most widely used controllers are of the linear PID type. Under extreme conditions, however, the dynamic response of the rotor in AMB becomes highly nonlinear. As a result, the linear controllers are no longer capable of suppressing or controlling the bifurcations of the rotor response. In order to suppress the non- linearity in AMB, a nonlinear control strategy is required. One of such strategies is the use of fuzzy logic based control approach. This paper aims to investigate and analyze the dynamical response of rotors in active magnetic bearings in AMB and presents the development and implementation of a fuzzy logic control strategy for suppressing the non- synchronous response in AMB. This control strategy is expected to stabilize the rotor-bearing system or to delay its onset of instability. Through modeling and simulation of the non-linear rotor response, it is found that for certain operating parameters, the rotor in AMB exhibits non-synchronous response (quasi-periodic or chaotic). However, the use of fuzzy logic control has been able to eliminate the undesirable non-synchronous response and improve the rotor stability performance.

TA9: Neural Network Models for Analysis and Prediction of Raveling
Maryam Miradi
Delft University of Technology, Netherlands

The most unacceptable damage on porous asphalt is raveling. Therefore it is important to predict when porous asphalt will achieve a critical level of raveling. In this paper Artificial Neural Network (ANN) was employed to predict raveling having input parameters related to time- series data of raveling, climate, construction and traffic factors obtained from SHRP-NL database. For raveling low, Moderate and High correlation factors were $R2=0.986$, $R2=0.926$ and $R2=0.976$. Another ANN model provided sensitivity analysis indicating relative contribution percentage of input parameters. Finally another model analyzed the relationship between materials and raveling. ANN proved to be powerful technique to predict and analyze raveling.

TA9: A Primal Neural Network for Solving Nonlinear Equations and Inequalities
Yunong Zhang, *Shuzhi Sam Ge
University of Strathclyde, U.K.; *National University of Singapore, Singapore

In this paper, the concept and utility of primal neural networks are introduced for the context of dynamical constraints or inequalities. Based on the neural-network design experience on solving linear equations/inequalities, we generalize a primal neural network to handling the nonlinear situation. Numerical examples (including the robotic applications) are given to demonstrate the effectiveness of the primal network.

TA9: Engineering Intuition for Designing Multi-Robot Search and Rescue Solutions
Yuh Miin Chan, Serene Wong, *Mao Ching Foo, *Rodney Teo
Nanyang Technological University, Singapore; *DSO

National Laboratories, Singapore

There has been a lot of interest over the last decade in the use of multiple robots in applications such as search and rescue missions. The use of multiple robots could increase mission effectiveness and robustness. The design of algorithms for robot cooperation to achieve collective mission goals is still on-going research. Various possibilities depending also on the resources available, namely the communication range and bandwidth, computational power and memory, have been previously proposed. As in most system engineering problems, the design of multiple robot solutions will be driven partly by intuition. This paper is an initial attempt to provide a multiple robot applications designer some engineering intuition for the solution development. For a specific multiple robot search and rescue application, three solutions over a spectrum of possibilities are compared. The three solutions range from very limited to more capable communications and processing. The light weight approaches are based on Swarm Intelligence which mimics insect behaviour and the heavy weight approach is based on Multi-Agent Systems which mimic human behaviour. For each solution, the performance is derived through numerous simulations. The various performances are then compared. Attempts are also made to identify key characteristics of each solution and to relate them across solutions and to the simulation results.

TA9: Development and Preliminary Study of the NTU Lower Extremity Exoskeleton
Xiaopeng Liu, Kin Huat Low
Nanyang Technolocial University, Singapore

Exoskeletons for human performance augmentation are controlled and wearable devices that can increase the speed, strength, and endurance of the operator. To help those who need to travel long distances by feet with heavy loads such as infantry soldiers, we are developing a lower extremity exoskeleton for human performance enhancement at the Nanyang Technological University (NTU). Together with the exoskeleton linkages, an exoskeleton foot is designed to measure the human and the exoskeleton's ZMP. By using the measured human ZMP and the human leg position signals, the exoskeleton's ZMP can be modified by trunk compensation. Simulation results are demonstrated and the prototype being developed is introduced.

TA9: Building Intelligent Systems: Learning from the cortico-hippocampal network
Gee Wah Ng, Chung Huat Tan, *Namit Chaturvedi
DSO National Laboratories, Singapore; *National University of Singapore, Singapore

This paper describes the way human brain structures its memory. Human memory could be broadly classified into sensory buffer memory, short-term memory, and long term memory. The work involves an investigation on current human memory function and its association to information processing. Also investigated, is a model of the functioning of a part of the brain, called the cortico–hippocampal region that explains how the brain can learn to predict stimuli based on context cues. The work explores the cortico-hippocampal model and the possibility of an extension of this model. Its possible applications in the field of intelligent computer systems are also being considered in this paper.

TA9: An Application of SVM, RBF and MLP with ARD on Bushings
Sizwe Dhlamini, *Tshilidzi Marwala
Distribution Technology Department, Eskom, South Africa ; *University of Witwatersrand, South Africa

This paper examines classification models using three classes of artificial neural networks (ANN). The first ANN uses Support Vector Machine activation functions. The second uses Multi-layer Perceptron (MLP) activation functions with automatic relevance detection (ARD). And the third uses Radial Basis activation functions (RBF). In this work the decision can be taken to remove or leave a bushing in service based on analysis of bushing parameters using RBF, SVM or MLP. The work finds that the RBF converges to a solution faster than both SVM and MLP. The MLP is the best tool of the three for analyzing large amounts of non- parametric non-linear data. MLP is the most accurate of the three networks. ARD reveals that methane was the most common cause for intervention needed during the two years evaluation period.

TA9: A Nozzle Selection Heuristic to Optimise the Hybrid Pick and Place Machine
Masri Ayob, *Graham Kendall
University of Nottingham, UK; *University of Nottingham, UK

In this paper we present a constructive heuristic to optimise the component pick and place operations of a hybrid pick and place machine, which is a new type of surface mount device placement machine. Since a nozzle change operation is very expensive (it significantly adds to the overall assembly time), the heuristic gives highest priority to minimising the number of nozzle changes. The ordered nozzle selection heuristic begins by choosing the best nozzle pair that is most effective for picking and placing components onto the printed circuit board (PCB). Next, we schedule all pairs of PCB points, that are expecting components from the chosen nozzle pair. Then, the nozzle pairs are re-ranked based on the availability of component feeders and the PCB points that need to be scheduled. Again, the best nozzle pair is chosen and the previous steps are repeated. When none of the selected nozzle pairs can pick and place two components in a sub tour, we schedule the one component sub tour. Finally, when all the available PCB points, have been scheduled, we then reoptimise the schedule by minimising the nozzles changes. Computational results are presented.

Thursday, 2 Dec 2004, 13:00-15:20

SESSION: TM5	Penang 1
Evolutionary Computation	

Chair: Min Huang
Co-Chair: Lihui Chen

13:00
TM5.1: Economic Dispatch by Ant Colony Search Algorithm
Thanathip Sum-im
Srinakharinwirot University, Thailand

In this paper, ant colony search algorithm (ACSA) is proposed to solve the economic dispatch (ED) with transmission losses problem. ACSA is a new cooperative agents approach, which is inspired by the observation of the behaviors of real ant colonies on the topic of ant trail formation and foraging methods. In the ACSA, a set of cooperating agents called "ants" cooperates to find a good solution for economic dispatch problem. The merits of ACSA are parallel search and optimization capabilities. The feasibility of the proposed method is tested on the IEEE 30 bus system and compared to Lambda iteration method and genetic algorithm.

13:20
TM5.2: Research on Ant Colony Algorithm based Risk Programming for Virtual Enterprise
Min Huang, Xuejing Wu, Xingwei Wang
Northeastern University, China

Based on the ant colony optimization idea, this paper presents a new algorithm for the risk programming problem in virtual enterprise. Using this method, the entire risk level of the virtual enterprise is minimized by combination optimization of risk solutions with the constraint of risk investment. Results of numerical tests show the effectiveness of the algorithm and it is the scientific management method for virtual enterprise risk programming.

13:40
TM5.3: Design of Orthogonal Near-Symmetric Scaling Filters by Using Differential Evolution
Jouni Sampo
Lappeenranta University of Technology, Finland

The use of differential evolution in the design of a near-symmetric orthogonal scaling filter is studied. Parametrization is used for maintaining the orthogonality while the symmetry and moment conditions are optimized. Several near-symmetric scaling filters have been found and the results are compared with filters found by Gröbner basis method. Especially a very near-symmetric and smooth 8-tap orthogonal filter is constructed.

14:00
TM5.4: A New Evolutionary Computing Model based on Cellular Learning Automata
Reza Rastegar, *Mohammad Reza Meybodi
Amirkabir University, Iran; *Amirkabir University, Iran

In this paper, a new evolutionary computing model, called CLA-EC, is proposed. This new model is a combination of a model called cellular learning automata (CLA) and the evolutionary model. In this new model, each genome is assigned to a cell of cellular learning automata to each of which a set of learning automata is assigned. The set of actions selected by the set of automata associated to a cell determines the genome's string for that cell. Based on a local rule, a reinforcement signal vector is generated and given to the set learning automata residing in the cell. Based on the received signal, each learning automaton updates its internal structure according to a learning algorithm. The process of action selection and updating the internal structure is repeated until a predetermined criterion is met. This model can be used to solve optimization problems. To show the effectiveness of the proposed model it has been used to solve several optimization problems such as real valued function optimization and clustering problems. Computer simulations have shown the effectiveness of this model.

14:20
TM5.5: Improving EHW Performance Introducing a New Decomposition Strategy
Emanuele Stomeo, Tatiana Kalganova
Brunel Uninversity, United Kingdom

This paper describes a new type of decomposition strategy for Evolvable Hardware, which tackles the problem of scalability. Several logic circuits from the MCNC benchmark have been evolved and compared with other Evolvable Hardware techniques. The results demonstrate that the proposed method improves the evolution of logic circuits in terms of time and fitness function in comparison with BIE and standard EHW.

14:40
TM5.6: Recursive Percentage Based Hybrid Pattern (RPHP) Training for Curve Fitting
Sheng Uei Guan, Kiruthika Ramanathan
National University of Singapore, Singapore

In this paper, we present the RPHP training algorithm, which finds several good local optimal points (pseudo

global optima) automatically using an efficient combination of global and local search algorithms. This overcomes the problem of supervised learning algorithms being trapped in a local optima. Further, to solve a test pattern, we use a modified version of the Kth nearest neighbor (KNN) algorithm as a second level pattern distributor. We tested our approach on three curve fitting problems, whose coefficients were estimated both using genetic algorithms and the RPHP algorithm. The problems were chosen such that they had a small probability of finding a global optimal solution. It was found that the RPHP algorithms performed faster and improved generalization accuracy by as much as 25%.

15:00
TM5.7: High dimensional gene expression data dimension reduction
Chao Shi, LiHui Chen
Nanyang Technological University, Singapore

Gene expression data analysis is a new approach in cancer diagnosis. Feature selection is an important preprocessing step in gene expression data clustering. In this paper, we demonstrate the effectiveness of feature grouping approach in feature dimension reduction. In our proposed framework, large number of features are grouped to form several feature subsets. By criteria of clustering accuracy, one feature subset is chosen as the candidate subset for further processing by PCA or entropy ranking, and the final feature subset are formed by selecting the features from top ranked ones. Advantage of the framework is that it considers both subset and individual feature's discrimination power, also it requires little information about the class label. A prototype of the proposed framework has been implemented and tested on the leukemia data set. The results have given positive support to the framework.

SESSION: TM6	Penang 2
Intelligent Systems	

Chair: Vijayaraghavan Venkatasubramanian
13:00
TM6.1: Proposal for an Intelligent Lighting System, and Verification of Control Method Effectiveness
Mitunori Miki, Tomoyuki Hiroyasu, Kazuhiro Imazato
Doshisha University, Japan

In recent years, various types of equipment have become more intelligent. In this research, we propose an intelligent lighting system for providing the necessary illuminance to a desired location; actually construct a fundamental experiment system based on that concept; and verify the effectiveness of the newly developed control method. Verification tests were conducted using an optimization algorithm specialized for lighting control, and the results showed that the various illuminance sensors converged to the preset target illuminance. We also confirmed that the system can respond adaptively to the movement of illuminance sensors and contingencies like lighting malfunctions.

13:20
TM6.2: Integrating Translation Technologies Towards a Powerful Translation Web Service
VASSILIOS ANTONOPOULOS, IASON DEMIROS, GEORGE CARAYANNIS, STELIOS PIPERIDIS
National Technical University of Athens, Greece

Rapid changes in the global marketplace have given rise to new demands and have provided new opportunities for the translation industry. The need for multilinguality in the presentation and business logic layers of most modern systems, applications and services is a great challenge that the translation industry now faces. But even after many years of intense research and many commercial attempts of related products, translation systems of today still fail to

completely meet the above needs. Within this framework, an architecture of a modern automatic translation system exploiting current infrastructure and covering today and future needs is proposed in this paper.

13:40
TM6.3: Evolutionary Reactive Behavior for Mobil Robots Navigation
José A. Fernández León, Marcelo A. Tosini, Gerardo G. Acosta
Universidad Nacional del Centro de la Provincia de Buenos Aires, Argentina

Mobile robot's navigation and obstacle avoidance in an unknown environment is analyzed in this paper. From the guidance of position sensors, artificial neural network (ANN) based controllers settle the desired trajectory between current and a target point. Evolutionary algorithms were used to choose the best controller. This approach, known as Evolutionary Robotics (ER), commonly resorts to very simple ANN architectures. Although they include temporal processing, most of them do not consider the learned experience in the controller's evolution. Thus, the ER research presented in this article, focuses on the specification and testing of the ANN based controllers implemented when genetic mutations are performed from one generation to another. Discrete-Time Recurrent Neural Networks based controllers were tested, with two variants: plastic neural networks (PNN) and standard feed-forward (FFNN) networks. Also the way in which evolution was performed was analyzed. As a result, controlled mutation do not exhibit major advantages against the non controlled one, showing that diversity is more powerful than controlled adaptation.

14:00
TM6.4: The Integrated Software Product Line Model
Makoto Yoshida, *Noriyuki Iwane, *Yukihiro Matsubara
Okayam University of Science, Japan; *Hiroshima City University, Japan

In the industry, how to acquire customer's needs and how to reflect them quickly into the software products are important issues. Recently, several architecture analysis and design methodologies have been developed and evaluated, and the software product line is receiving increasing attention for cost reduction in the software development. Combining the architectural requirements with the software product line systems is at the very center of what the software industry has to do in today's fast-changing environment. We developed the toolkit which automatically generates software programs from specifications. The toolkit was extended to the software product line system, and connected to the questionnaire system. This paper describes an integrated software product line model. A KITS (Knowledge based Integrated quesTionnaire-Software product line) model which integrates software product line systems with questionnaire systems through a knowledge base system is proposed. It will produce the efficient customized software systems while offering a substantial savings in time and cost.

14:20
TM6.5: KSL Protocol: Design and Implementation
Boon Tiong Sunny Toh, Supakorn Kungpisdan, Phu Dung Le
Monash University, Australia

Recently several payment protocols have been proposed and have claimed to operate well in wireless environments. However, most of them are merely theoretical approaches and have not been really implemented. In this paper, we present detailed implementation of KSL protocol, a newly proposed mobile credit-card payment protocol. An environment with a client using a PDA performing

transactions over a wireless LAN was set up and used for testing the implementation. We discuss several important issues regarding the implementation including the suitability of deploying various kinds of cryptographic algorithms to the protocol. Ease of use of the implementation has also been accounted for and factored in. The results show that the KSL protocol offers satisfactory transaction performance and secure transaction.

14:40
TM6.6: Performance Control Mechanism for Customer Network Management
HYUN CHUL KANG, Shin-Kyung LEE, Gil-Haeng LEE
Electronics and Telecommunications Research Institute, Korea

The customer network management (CNM) provides the end customer with a window to view their entire enterprise network. We have proposed a server-based performance Control Mechanism using CORBA and the Web technologies. This paper proposes Customer Network Management System (CNMS) architecture, and performance management on ATM Services.

15:00
TM6.7: An EM Based Method for Semi Blind Identification of Linear Systems Driven by Chaotic Signals
Vijayaraghavan Venkatasubramanian, Henry Leung
Department of ECE, University of Calgary, Canada

In this paper, we propose an expectation maximization (EM) based approach for semi blind identification of linear moving average (MA) systems. The system is driven by chaotic signals and a robust EM based estimator is formulated to estimate the system parameters and the driving chaotic signal. It is shown through numerical simulations that the proposed EM semi blind estimation technique outperforms other conventional techniques such as minimum non linear prediction error (MNPE) method and that based on extended Kalman filter (EKF). Also the proposed estimator is applied in the equalization of chaos based communication to illustrate the performance improvement.

SESSION: TM7	Malacca 2
Neural Networks - Theory	

Chair: Mohd Yusoff Mashor
Co-Chair: G A Vuayalakshmipai

13:00
TM7.1: A Biologically Inspired Methodology for Neural Networks Design
Lidio de Campos, *Mauro Roisenberg, *Jorge Barreto
Federal University of Para, Brazil; *Federal University of Santa Catarina, Brazil

The aim of this paper is to introduce a biologically plausible methodology that can automatically generate Artificial Neural Networks (ANNs) with an optimum number of neurons and connections, good generalization capacity, smaller error and larger tolerance to noises. In order to do this, three biological metaphors were used: Genetic Algorithms (GA), Lindenmayer Systems (L-Systems) and ANNs. At the end of the paper some experiments are presented in order to investigate the possibilities of the method, especially in problems where a recurrent neural network should be evolved. The proposed problems are the parity generator and the recognizers for some regular languages proposed by Tomita. Some of the advantages of the proposed methodology is that it increases the level of implicit parallelism of genetic algorithm and seems to be capable to generate an economical satisfactory neural architectures that solve specifics tasks, reducing the project costs and increasing the performance of the obtained neural network.

13:20
TM7.2: Semantic Evolution in Agent Talk
Shigeki Sugiyama
University of Gifu, Japan

There are some computational mechanical interpreters and artificial intelligences that are able to treat semantics. The computational mechanical interpreters are generally just one by one a sentence translation oriented processor that can only treat one sentence processing, and no relationship with another sentences can be created with in a semantic meaning (IS-A link, referred to [1]). And Artificial Intelligences (AI) are possible to solve some kinds of problems within a very restricted atmosphere intelligently but they need a lot of pre- processes before inputting information for the AI systems, referred to [2]. This occurs out of two reasons; 1 Lack of understanding in a structural matter about an intelligence description of knowledge, 2 Lack of understanding in a functional matter about an intelligence of knowledge behaviour. So here studies about a structural matter of knowledge description and a functional matter of knowledge behaviour by introducing a brand new idea of Semantics Evolution in Knowledge Base, which makes possible Agent to talk each other on any matter focused.

13:40
TM7.3: Modelling of Neurone Networks in Java and VHDL
Johan Iskandar, John D. Zakis
Monash University, Australia

This paper describes a model of neurones and networks of neurones based on their biological characteristics. Neurones communicate with each other at contact points called synapses that receive signals from axons of other neurones. Such a signal can be either excitatory or inhibitory. A neurone generally receives several input signals and produces an output signal depending on the weighted sum of the input signals. When the post-synaptic potential sum reaches the threshold for excitation, an action potential is generated and propagated along the axon. Previous work has postulated that artificial neurones that are more biological in their function can form more robust and noise-tolerant neurone networks compared with conventional artificial neural networks (ANN). We are therefore examining a proof-of-concept by modelling a simple neurone network that uses a waveform resembling a biological action potential. Our neurone network implementation is different from an ANN, in that each neurone is modelled on biological function and communicates via action potential pulses rather than static voltage summing networks. Note that we refer to neurone as having a biological style of behaviour as described in this paper and that we use the word neuron to designate the common neurons used in a typical ANN.

14:00
TM7.4: Global Exponential Stability of Cellular Neural Networks with Time-Varying Delays
Yiping Luo, *Feiqi Deng, *Rui Yao
South China University of Technology, China; *South China University of Technology, China

The existence of equilibrium point and global exponential stability (GES) for cellular neural networks with time-varying delay are explored in this paper by applying the extended Halanay's delay differential inequality, the theory of homotopy invariance, Dini's derivative, and several functional analysis techniques. Some simple and new sufficient conditions are obtained to ensure existence, uniqueness of the equilibrium point and its GES of the neural networks. The results are less conservative than those established in the previous literature. In addition, this condition requires neither the active functions to be differentiable, bounded, and monotone non-decreasing nor the time- varying delays to be differentiable.

14:20
TM7.5: Performance Comparison between HMLP, MLP and RBF Networks with Application to On-line System Identification
Mohd Yusoff Mashor
University Sains Malaysia, Malaysia

This paper compares the performance of Hybrid Multilayered Perceptron (HMLP), Multilayered Perceptron (MLP) and Radial Basis Function (RBF) Networks. These networks were tested to perform on-line system identification of nonlinear systems. Two sets of data were used for this comparison, one simulated data set and one real data set. The results for both data sets indicated that HMLP network gave significant improvement over standard MLP network. The additional linear input connections of HMLP network do not significantly increase the complexity of MLP network since the connections are linear. In fact by using the linear input connections, the number of hidden nodes required by the standard MLP network model can be reduced that will also reduce computational load. It was also found that HMLP network gave better performance and more efficient than RBF network. HMLP network has less adjustable parameters but could offer better performance than RBF network.

14:40
TM7.6: Complex Valued Neural Associative Memory on Complex Hypercube
Rama Murthy G., *Praveen D.
International Institute of Information Technology, Hyderabad, India; *Gayatri Vidya Parishad College of Engineering, Visakhapatnam, India

A model of a complex multi-valued neural associative memory is presented. This memory uses a newer form of a complex signum function that allows the state space to be a complex hypercube. Using a quadratic energy function, a new convergence theorem is proved. Thus the convergence properties and the network stability for asynchronous dynamics can be observed. The convergence properties of such a network prove that the network serves to be a generalization of the Real-valued Neural network. The analogies to the behavior of the latter render the network to be applied to a variety of applications like Gray-scale image processing and Pattern recognition.

15:00
TM7.7: A Fast Converging Evolutionary Neural Network for the Prediction of Uplift Capacity of Suction Caissons
G A Vijayalakshmi Pai
PSG College of Technology, India

Evolutionary Neural Networks (ENN) with Genetic Algorithm (GA) based weight determination have lead to better performance aspects such as fast convergence or reduced learning error of the network, or better solutions when compared to their specific counterparts. In this investigation, we propose a scheme of GA based weight determination employing a genetic inheritance operator termed Short term Reproduction Expectancy (STRE) which when embedded in the scheme results in a better performing ENN. The ENN employing the STRE scheme of inheritance (NEU_GEN (STRE)) has been implemented and its performance compared with the same employing a generational GA for its weight determination (NEU_GEN). The performance analysis has been demonstrated on the problem of prediction of uplift capacity of Suction Caissons in the field of Geotechnical engineering.

SESSION: TM9	Level 2a Foyer
Posters	

TM9: A Single Lag Smoothing Technique for Track maintenance in clutter
Rajib Chakravorty, Subhash Challa

University of Technology, Sydney

We introduce a multi-target smoothing algorithm based on the Integrated Probabilistic Data Association (IPDA) filter. IPDA jointly estimates both the target state and its existence. An expression for a single lag smoothing of track existence is derived in this paper. This algorithm can be viewed as a extension to PDA smoothing where, combined with the PDA smoothing, a recursive formulation for one lag smoothing of track existence is incorporated. Simulation results show that the new algorithm can track multiple targets in a cluttered environment providing a better estimate for both the track states and existence. The result could be of great significance for situation awareness.

TM9: Hybrid Rule-Extraction from Support Vector Machines
Joachim Diederich, *Nahla Barakat
University of Queensland, Australia; *Sohar University, Oman

Rule-extraction from artificial neural networks (ANNs) as well as support vector machines (SVMs) provide explanations for the decisions made by these systems. This explanation capability is very important in applications such as medical diagnosis. Over the last decade, a multitude of algorithms for rule-extraction from ANNs have been developed. However, rule-extraction from SVMs is not widely available yet. In this paper, a hybrid approach for rule-extraction from SVMs is outlined. This approach has two basic components: (1) data reduction using a logistic regression model and (2) learning based rule-extraction. The quality of the extracted rules is then evaluated in terms of fidelity, accuracy, consistency and comprehensibility. The rules are also verified against the available knowledge from the domain problem (diabetes) to assure correctness and validity.

TM9: Turntable-Based 3D Object Reconstruction
Vincent FREMONT, *Ryad CHELLALI
Vision and Robotic Laboratory, France; *IRCCYN, France

In this paper, we present a system that can acquire graphical models from real objects. Given an image sequence of a complex shape object placed on a turntable, the presented algorithm generates automatically the 3D model. In contrast to previous approaches, the technique described here is only based on conics properties and uses the spatiotemporal aspect of the sequence of images. From the projective properties of the conics and using a the camera calibration parameters the euclidean 3D coordinates of a point are obtained from the geometric locus of the image points trajectories. An algorithm has been implemented to compute the 3D reconstruction automatically. Examples on both synthetic and real image sequences are presented.

TM9: Service Integration in Distributed Control Systems: An Approach Based on Fusion of Mereologies
Richard Dapoigny, Nacima Mellal, Eric benoit, Laurent Foulloy
University of Savoie, France

The objective of the present paper is to provide a methodology where the functional characteristics of a distributed engineering system can be obtained by merging domain-dependent knowledge at run-time. We focus on distributed control systems where computing nodes are related to the physical environment in which they operate via sensors/actuators. The knowledge representation is formally expressed with a mereological approach where a structural mereology describes the physical environment and a functional mereology identifies available engineering goals for each computing node. During the design step, a mechanism based on Formal Concept Analysis (FCA) allows to generate the resulting goal mereology. The concept of goal is refined with sub- concepts in the multilevel structure. Because computing nodes depend on each other for goals to be achieved, an agent-based method is proposed to establish dynamically the dependencies among distributed nodes. This method is centered on a fusion mechanism involving the functional mereologies of appropriate nodes. We use an example from an open-channel hydraulic system controlling the water level to motivate and illustrate the model. Although it is limited to the engineering systems, this approach can be reused in related domains where the goal representation can be expressed as a triple including an action, a role and a physical entity.

TM9: A New Fuzzy Competitive Algorithm for Removing Impulsive Noises in Digital Images
Mehrtash Harandi, Caro Lucas
Control and Intelligent Processing Center of Excellence, Iran

Images are often contaminated by impulse noise. The major drawback of median filtering and its variants that are widely used for removing impulsive noise is the blurring effect for large window sizes and low noise suppression for small window sizes. In this paper, a fuzzy- competitive algorithm for removing impulse noise in images is proposed. The proposed algorithm utilized fuzzy inference systems for impulse detection. The detected impulses are then removed using long range correlation information in a competitive scheme. The experimental results show that the performance of our method in removing impulsive noises is better than that of most other state of the art methods.

TM9: An AR Model Based on a Fuzzy Approach for Traffic Modeling
Yukinori Suzuki, Issei Ohyama, Sato Saga, Junji Maeda
Muroran Institute of Technology, Japan

Broadband integrated digital networks (B-ISDN) using an asynchronous transfer mode (ATM) is the new generation of ISDNs for telecommunication networks. An ATM is designed to support various classes of multimedia traffic flow (voice, data, and video) with different bit rate and quality of service (QoS) requirements. However, in actual networks, congestion and deadlock may occur due to some problem. An AMT provides various traffic controls to reduce congestion and to keep high quality networking such as connection admission control (CAC), usage parameter control (UPC), priority control (PC). These controls are essentially reactive- type control. For proactive control, future cell rate flowing into the ATM has to be predicted on the basis of the past and current traffic, and control signal then generated using the predicted cell rate. We propose a traffic model by an autoregressive (AR) model based on fuzzy approach in this paper. Computational experiments were carried out to show usefulness of the proposed model. As a result of experiments, the proposed model shows better performance than that by previous models.

TM9: Learning and Recognizing Behavioral Patterns Using Position and Posture of Human
Shigeki Aoki, *Masaki Onishi, **Atsuhiro Kojima, **Kunio Fukunaga
Kumamoto National College of Technology, Japan; *RIKEN, Japan; **Osaka Prefecture University, Japan

In general, it is possible to find certain behavioral patterns in human daily activity. Such patterns are called as daily behavioral patterns. The purpose of this research is to learn and recognize behavioral patterns. In the previous methods, it is difficult to recognize in detail how a person acts in a room because the methods recognize only a sequence of existing position of human by using the information of infrared sensors or of switching on/off of electrical appliances. On the other hand, many have proposed the

methods recognizing human motions from sequential images, in most of which motion models must be prepared in advance. In this paper, we propose a method for learning and recognizing motions of human without any motion models. In addition, we also propose perceptive methods of recognizing behavioral patterns by taking not only the sequence of position but also the sequence of motion into consideration. Experiments show that our approach is able to learn and recognize human behavior and confirm effectiveness of our method.

TM9: Clinical Diagnosis Support System based on Symptoms and Remarks by Neural Networks
Tsutomu Matsumoto, Yasuyuki Shimada, *Shigeyasu Kawaji
Kumamoto Natiobal College of Technology, Japan; *Kumamoto University, Japan

The importance of developing a support system for medical decision-making in the clinical field has been pointed out in order to improve accuracy and objectivity of the judgment of clinician, and to detect early the disease. Various attempts on clinical diagnosis support have been done in the literature, e.g., rule-based production system, analysis of ECG or the image, focusing on only specific diseases, so those can not utilized for the general internal medicine diagnosis support. In this paper, it is noticed that signs, symptoms, remarks, clinical laboratory data such as blood and biochemical check up data are essential information which show functional depression and failure of the ecosystem, and a practical software system providing the physicians with clues to clinical diagnosis. First, after analysis of the medical task and structuralization of information from the patient, the medical modelling method is provided, and it is indicated that diagnosis can be considered the identification of patient who corresponds to the controlled object. Secondly, by the concept of patient model and disease model, the system identification algorithm is proposed, and actual system constructed for the medical diagnosis is described using Neural Networks. The diagnaccuracy of this system using symptoms and remarks data from medical journal case reports is also described.

TM9: Adding QoS to Web Service Transaction Management
Jie Li, Weiqing Tang, Xinggang Wang
Institute of Computing Technology, CAS, China

In e-business, we often need to integrate services across distributed, heterogeneous, dynamic virtual organizations. This integration can be technically challenging because of the need to achieve various Qualities of Service (QoS). Achieving a general QoS support for Web service transaction will play an important role for the success of this emerging technology. Unfortunately, current Web service transaction environments do not offer comprehensive QoS support. To enhance with QoS management, we propose a QoS model that allows for the description of Web service transaction components. Then we present a QoS-based commit protocol to enable the QoS integration in Web service transactions.

Thursday, 2 Dec 2004, 15:50-17:50

SESSION: TP4	Temasek 4
Particle Swarm Optimization	

Chair: Renato Krohling
Co-Chair: Lei Wang
15:50
TP4.1: Using Vector Operations to Identify Niches for Particle Swarm Optimization
Isabella Schoeman, Andries Engelbrecht
University of Pretoria, South Africa

In some problems described by objective functions, it is important to find all optimal solutions in the problem space. The particle swarm optimizer has originally been designed to locate a single optimum and avoid premature convergence on suboptimal solutions. To locate all optimal solutions, niches have to be identified containing good candidate solutions. In this paper a technique is introduced using vector operations to demarcate the boundaries of those niches and maintain subswarms in order to find optimal solutions.

16:10
TP4.2: A Hybrid Particle Swarm Algorithm with Embedded Chaotic Search
HONG-JI MENG, PENG ZHENG, RONG-YANG WU, XIAO-JING HAO, ZHI XIE
Northeastern University, China

A new hybrid evolutionary-based method combining the particle swarm algorithm and the chaotic search is proposed for optimizing. To achieve high performance in optimizing, the chaotic search mechanism is embedded in the standard particle swarm algorithm adaptively to avoid the stagnancy of population and increase the speed of convergence. This hybrid method makes use of the ergodicity of chaotic search to improve the capability of precise search and keep the balance between the global search and the local search. It has been compared with other methods such as standard particle swarm algorithm, standard genetic algorithm and improved particle swarm algorithm. In comparison, the proposed method shows its superiority in convergence property and robustness. It is validated by the simulation results.

16:30
TP4.3: Gaussian Swarm: A Novel Particle Swarm Optimization Algorithm
Renato Krohling
University of Dortmund, Germany

In this paper, a novel particle swarm optimization algorithm based on the Gaussian probability distribution is proposed. The standard Particle Swarm optimization (PSO) algorithm has some parameters that need to be specified before using the algorithm, e.g., the accelerating constants c_1 and c_2, the inertia weight w, the maximum velocity V_{max}, and the number of particles of the swarm. The purpose of this work is the development of an algorithm based on the Gaussian distribution, which improves the convergence ability of PSO without the necessity of tuning these parameters. The only parameter to be specified by the user is the number of particles. The Gaussian PSO algorithm was tested on a suite of well-known benchmark functions and the results were compared with the results of the standard PSO algorithm. The simulation results shows that the Gaussian Swarm outperforms the standard one.

16:50
TP4.4: Grouped-and-delayed Broadcasting Mechanism for Optimum Information in PSO
Lei Wang, Qi Kang, Qidi Wu
Tongji University, China

In this paper, the grouped-and-delayed mechanism for optimum information broadcasting is introduced into optimization process of particle swarm optimization algorithm to make sufficient search in optimization space and to meet the requirement of general convergence. The algorithm is improved based on the modified particle algorithm published in paper [15], and used to optimize the multi-dimensional and multi-modal function. Simulation results show that, for same iterations and computation times, the average optimization results derived in this paper is better than the fuzzy adaptive particle swarm optimization algorithm in paper [17].

SESSION: TP5   **Penang 1**
Advances In Intelligent Data Processing
(Invited Session)

Chair: Takashi Onoda
Co-Chair: Yew Soon Ong
Organizer: Yew Soon Ong
Organizer: Kok Wai Wong

16:10
TP5.2: Rarity-based Similarity Relations in a Generalized Fuzzy Information System
Rolly Intan
Petra Christian University, Indonesia

A generalized fuzzy information system contains data about objects of interest characterized by some attributes. Every data in a domain attribute may be precise as well as imprecise data (fuzzy data). A more generalized representation of fuzzy information system may be regarded as a mapping to a possibility of fuzzy data in the corresponding domain attribute. In other words, a possibility of fuzzy data might be regarded as a level 2 fuzzy set. Similarity relation between two fuzzy data satisfies the properties of weak similarity relations in which similarity between two fuzzy data may not necessarily be symmetric or transitive. In the fuzzy information system, two objects are intuitively looked more similar if their similar values of attributes are rarer. Hence, this paper proposes a concept of calculating similarity between two objects by considering rare values of attributes in a generalized fuzzy information system.

16:30
TP5.3: A Parallel Architecture for Feature Extraction in Content-Based Image Retrieval System
Kien-Ping Chung, Jia Bin Li, Chun Che Fung, *Kok Wai Wong
Murdoch University, Australia; *Nanyang Technology University, Singapore

Although it is possible to retrieve images from database using a unique identification defined by a human operator as an index to images, it is more convenient and natural to search images based on their contents. The principle of Content-Based Image Retrieval (CBIR) system is to retrieve images based on the content of the images. One of the important components in CBIR system is to extract the visual features of the images for performing more abstract analysis. However, some of these features are computationally expensive. To solve this issue, a flexible parallel architecture has been proposed to improve the extraction time for the system. This architecture will also provide the software system with the flexibility of adding and removing any visual features from the system. Thus, a system becomes more intelligent and so it is able to adapt changes caused by the replacement of more appropriate visual features for representing the images.

16:50
TP5.4: Remote Power System Harmonics Measurement and Monitor via the Internet
Hsiung-Cheng Lin
Chien Kuo Technology University, Taiwan

Traditional methods to measure power system harmonics employ either the power harmonic analyser or the software package such as Matlab. They, however, usually have limited capability in the Internet connection and/or graphical interface. In this paper, a PC-based virtual instrument (VI) that can carry out a remote measurement and monitor using LabVIEW and the microprocessor (Intel 8051) for power system harmonics is proposed. The history of Total Harmonic Distortion (THD) in the waveform signal can be also recorded and tracked in the database.

17:10
TP5.5: Solving MAX-SAT Problems Using a Memetic Evolutionary Meta-heuristic
Dalila BOUGHACI, *Habiba DRIAS, **Belaid BENHAMOU
University of Sciences and technology, Algiers, Algeria; *Institute of Computer Science –INI-, Algeria, Algeria; **LSIS - UMR CNRS 6168, MARSEILLE CEDEX 20

Genetic algorithms are a population –based meta-heuristic. They have been successfully applied to many optimization problems. However, premature convergence is an inherent characteristic of such classical genetic algorithms that makes them incapable of searching numerous solutions of the problem domain. A memetic algorithm is an extension of the traditional genetic algorithm. It uses a hill climbing search technique to reduce the likelihood of the premature convergence. In this paper, a memetic approach is studied for the NP-Hard satisfiability problems, in particular for its optimization version namely MAX-SAT. Our evolutionary approach applies a search technique to further improve the fitness of individuals in the genetic population. Basically, the approach combines local search heuristics with crossover operators. The method is tested and various experimental results show that memetic algorithm performs better than the classical genetic algorithms for most benchmark problems.

SESSION: TP6   **Penang 2**
Fuzzy Systems

Chair: Katsuhiro Honda
Co-Chair: Kemal Kilic

15:50
TP6.1: Fuzzy c-Means Clustering of Mixed Databases Including Numerical and Nominal Variables
Katsuhiro Honda, Hidetomo Ichihashi
Osaka Prefecture University, Japan

Fuzzy c-Means (FCM) clustering is an unsupervised classification method for revealing intrinsic structure of multivariate data sets. It is, however, applicable to databases including only numerical variables. For analyzing the intrinsic feature of categorical data sets, many approaches to the quantification of nominal variables have been proposed. Most of them are performed with the goal being to construct combined category quantifications and object scores plots. In this paper, we propose a new approach to the clustering of mixed databases including not only numerical variables but also categorical variables. The clustering technique uses an FCM-type simple iterative algorithm that includes a quantification step. In the quantification step, the category scores are derived so that they suit FCM clustering considering cluster centers and memberships. Numerical experiments demonstrate the characteristic features of the proposed method.

16:10
TP6.2: Different Approaches of Fuzzy Structure Identification in Mining Medical Diagnosis Rules
Kemal Kilic, *Ozge Uncu, **Burhan Turksen
Sabanci University, Turkey; *Middle East Technical University, Turkey; **University of Toronto, Canada

Fuzzy system modeling approximates highly nonlinear systems by means of fuzzy if-then rules. There are various fuzzy if-then rule structures based on their consequents. In the literature, different approaches are proposed for mining fuzzy if-then rules from historical data. These approaches usually utilize fuzzy clustering in structure identification phase. In this research, we are going to analyze three possible approaches from the literature and try to compare their performances in a medical diagnosis classification problem, namely Aachen Aphasia Test. Given the fact that the comparison is conducted on a single data set; the conclusions are by no means inclusive. However, we

believe that the results might provide some valuable insights about the algorithms that are considered.

16:30
TP6.3: On the Use of Generalized Mean with T-norms and T-conorms
Kalle Saastamoinen
Lappeenranta University of Technology, Finland

In this article we will present two new generalized classes of t-norm- and t-conorm-based generalized means with weights. We are going to test the usability of these measures which we get by combining the classes of t-norms and t-conorms with the generalized mean operator. Since we are using the generalized mean we have an additional parameter that controls the power, which the argument values are raised. The Dombi and Yager type classes of fuzzy conjunctions and disjunctions are used as examples.

16:50
TP6.4: Semantic Study of the Use of Parameterized S Implications and Equivalences in Comparison
Kalle Saastamoinen
Lappeenranta University of Technology, Finland

In this article, we will create some new classes of parameterized equivalences that we get from the different meanings of the fuzzy conjunction operators. We will concentrate on studying the class called S implications and equivalences, which rise from this class. We will present measures on the basis of the use of implications and equivalences with generalized mean operators. Test results concerning corresponding implications versus equivalences are established using an instance-based classification method. It is shown that the measures established by parameterization presented in this article will give very good results and that the equivalences are more suitable for classification than corresponding implications.

17:10
TP6.5: A Fuzzy FCA Approach for Citation-based Document Retrieval
Thanh Tho Quan, Siu Cheung Hui, *Tru Hoang Cao
Nanyang Technological University, Singapore; *Hochiminh City University of Technology, Vietnam

In this paper, we propose a fuzzy FCA (Formal Concept Analysis) based approach to conceptual clustering for citation-based document retrieval. In the proposed approach, fuzzy logic is first incorporated into FCA to form a fuzzy concept lattice that can handle vague and uncertain information. A fuzzy conceptual clustering technique is then performed to cluster the fuzzy concept lattice into conceptual clusters and construct a concept hierarchy. Fuzzy query can then be formulated for document retrieval. The proposed fuzzy FCA-based approach has been applied to a citation database for fuzzy document retrieval. The performance of the citation-based document retrieval system is evaluated and presented in the paper.

SESSION: TP7	Malacca 2
Genetic Algorithms - Application	

Chair: Prathyush Menon

15:50
TP7.1: On the Optimum Design of Fuzzy Logic Controller for Trajectory Tracking Using Evolutionary Algorithms
Hossein Nejat Pishkenari, Seyed Hanif Mahboobi, Ali Meghdari
Sharif University of Technology, Iran

Differential Evolution (DE) and Genetic Algorithms (GA) are population based search algorithms that come under the category of evolutionary optimization techniques. In the present study, these evolutionary methods have been

utilized to conduct the optimum design of the fuzzy controller for mobile robot trajectory tracking. Comparison between their performances has also been conducted. In this paper we will present a fuzzy controller to the problem of mobile robot path tracking for the CEDRA rescue robot with a complicated kinematical model. After designing the fuzzy tracking controller, the membership functions will be optimized by evolutionary algorithms in order to obtain more acceptable results.

16:10
TP7.2: Determining Multicast Routes with QoS and Traffic Engineering Requirements Based on Genetic Algorithm
Gina Oliveira, *Paulo Araujo
Universidade Federal de Uberlandia, Brazil; *Universidade Presbiteriana Mackenzie, Brazil

Quality of Service (QoS) intends to guarantee that the end-to-end communication is obtained with the appropriate service level for each application. Traffic Engineering (TE) supplies forms of obtaining QoS in computer networks. TE proposals try to optimize the use of network resources and the performance of QoS traffic. Genetic Algorithms (GA) for QoS route computation was already proposed. The GA model discussed here incorporates innovations based on TE requirements: a "hops count" metric and a mechanism to avoid duplicated candidate routes. Our GA was applied to multicast routes and converged to better solutions than the ones previously published.

16:30
TP7.3: Optimum Design of Cogeneration System using Genetic Algorithm
Satoshi Hirai, Tomoyuki Hiroyasu, Mitunori Miki, Hisashi Simosaka, *Youichi Tanaka
Doshisha University, Japan; *Toho Gas Co. Ltd., Japan

This paper introduces the optimum design of Cogeneration System (CGS) using the Genetic Algorithm (GA). CGS is the energy reusing system, which generates more than two energies from one energy source. To design CGS, the types of machines and load scheduling should be determined. However, the optimum design of CGS is too complicated even for the Expert. One of the solutions for this problem is using GA. GA is the optimization model imitating evolution of life. If the coding of the problems is proper, GA can be applicable to many problems. However, proper coding for the problems is difficult, especially for CGS, because it has three different design variables, which consist of integer values and real values. To discuss the effective coding, this paper considers four models. First is simplest coding model. Second is two-step optimization model with integer coding. Third is two-step optimization model with the integer coding and the penalty method. Last is three-step optimization model with the integer. As a result of the experiments, three-step optimization model could achieve the higher energy efficiency design of CGS than the expert.

16:50
TP7.4: Improved Clearance of Flight Control Laws Using Hybrid Optimisation
Prathyush Menon, Jongrae Kim, Declan Bates, Ian Postlethwaite
University of Leicester, UK

A hybrid optimisation approach to the clearance of flight control laws for highly augmented aircraft is described. The approach is applied to the problem of evaluating a nonlinear clearance criterion for a detailed simulation model of a high performance aircraft with a delta canard configuration and a full authority flight control law. The proposed combination of local and global optimisation methods is shown to offer significantly reduced computation times when compared with using global optimisation methods alone. The accuracy (i.e. closeness to the global solution or true worst-case

behavior) of the clearance results derived using the hybrid scheme is also shown to be better than that achieved using either local or global methods on their own.

17:10
TP7.5: Real-Time Genetic Lips Region Detection and Tracking in Natural Video Scenes
Takuya Akashi, Minoru Fukumi, Norio Akamatsu
The University of Tokushima, Japan

In this paper, real-time detection and tracking of lips region of a talking person in natural scenes is addressed. In particular, we try to acquire numerical parameters to represent the lips information. Because, this information is very important for many applications, such as audio-visual speech recognition, robot perception, and interface of mobile devices. The difficulty lies in deformations and geometric change of lips, by speech and free camera work. Our proposed system is based on template matching with genetic algorithms (GAs). In our previous system, there is a trade-off between accuracy and a processing time. However, we can overcome this by two new methods: (a) a flexible control of a search domain, (b) inheritance of genetic information between video frames. We demonstrated the effectiveness of our proposed system by using some 5 seconds video sequences. The average results are that the accuracy is 94.44% and the processing time is 4.50 seconds.

Friday, 3 Dec 2004, 10:00-12:00

SESSION: FA4	Temasek 4
Multiobjective Optimization	

Chair: Choong Oh
Co-Chair: Ponnambalam Sivalinga Govindarajan

10:00
FA4.1: Incremental Evolution of Autonomous Controllers for Unmanned Aerial Vehicles using Multi-objective Genetic Programming
Gregory Barlow, *Choong Oh, Edward Grant
North Carolina State University, USA; *U.S. Naval Research Laboratory, USA

Autonomous navigation controllers were developed for fixed wing unmanned aerial vehicle (UAV) applications using incremental evolution with multi-objective genetic programming (GP). We designed four fitness functions derived from flight simulations and used multi-objective GP to evolve controllers able to locate a radar source, navigate the UAV to the source efficiently using on-board sensor measurements, and circle closely around the emitter. We selected realistic flight parameters and sensor inputs to aid in the transference of evolved controllers to physical UAVs. We used both direct and environmental incremental evolution to evolve controllers for four types of radars: 1) continuously emitting, stationary radars, 2) continuously emitting, mobile radars, 3) intermittently emitting, stationary radars, and 4) intermittently emitting, mobile radars. The use of incremental evolution drastically increased evolution's chances of evolving a successful controller compared to direct evolution. This technique can also be used to develop a single controller capable of handling all four radar types. In the next stage of research, the best evolved controllers will be tested by using them to fly real UAVs.

10:20
FA4.2: Multi-objective Satisfactory Optimization Method
Ping Wang, *Hong-Zhong Huang, *Xu Zhang
Chongqing Univ. of Posts & Telecommun., China ; *Dalian Univ. of Technol., China

The multi-objective satisfactory optimization method is developed in this paper. The proposed method is based on neural networks and genetic algorithm, and it is able to overcome the shortcoming of the single- objective optimization on the working unit of the loader. An example of the working unit optimization of the ZL50 loader is given to illustrate the effectiveness of the proposed multi-objective satisfactory optimization method.

10:40
FA4.3: A Pareto-based Multiobjective Genetic Algorithm for Scheduling of FMS
Subramaniam Saravana Sankar, *SG Ponnamabalam, Velusamy Rathinavel, Marimuthu Gurumarimuthu
Arulmigu Kalasalingam College of Engineering, India; *Monash University, Malaysia

Many real-world engineering and scientific problems involve simultaneous optimization of multiple objectives that often are competing. In this work, we have addressed issues relating to scheduling with multiple (and competing) objectives of Flexible Manufacturing System (FMS) and have developed a mechanism by employing a Pareto based GA to generate nearer optimal schedules. In the proposed method we have applied Pareto ranking to identify the elite solutions and their fitness values are derated using fitness sharing method. The procedure is evaluated with sample problem environment found in literature and results are compared with other available heuristics found in literature. The proposed Niched Pareto Genetic Algorithm (NPGA) exhibits superiority over the other heuristics and scheduling rules.

11:00
FA4.4: Optimisation of a hard disk drive servo system using multiobjective genetic algorithm
Kay Soon Low, Tze Shyan Wong
Nanyang Technological University, Singapore

For a hard disk drive servo system, there are multiple control objectives to be met simultaneously. While some of the objectives are constraint objectives, some of them are simply optimization objectives. In this paper, we describe a new approach for tuning the controller parameters such that the resultant servo system can perform and meet all the requirements. Unlike the Pareto ranking multiobjective genetic algorithm, our approach is able to place higher priority for the constraint objectives than the optimization objectives. Some experimental results are presented.

11:20
FA4.5: Pareto Archived Simulated Annealing for Permutation Flow Shop Scheduling with Multiple Objectives
Suresh. R.K, *Mohanasundaram K.M
AmritaVishwa Vidyapeetham, Coimbatore, India; *PSG College of Technology, Anna University, India

In this paper, a metaheuristic procedure based on simulated annealing (SA) is proposed to find Pareto-optimal or non-dominated solution set for the permutation flow shop scheduling problems (FSPs) with the consideration of regular performance measures of minimizing the makespan and the total flow time of jobs. A new perturbation mechanism called "segment-random insertion (SRI)" scheme is used to generate the neighbourhood of a given sequence. The performance of the proposed algorithm is evaluated by solving benchmark FSP instances provided by [1]. The results obtained are evaluated in terms of the number of non- dominated schedules generated by the algorithm and the proximity of the obtained non-dominated front to the Pareto front. The results and simple quality measures suggested in this paper can be used to evaluate the quality of the non-dominated fronts obtained by different algorithms.

11:40
FA4.6: Multi-objective Genetic Algorithms for Scheduling Material Handling Equipment at Automated Air Cargo Terminals
H.Y.K Lau, *YING ZHAO
University of Hong Kong, China; *University of Hong Kong, China

In order to improve the productivities of a typical cargo handling system, it is important to reduce the waiting time of stacker cranes (SCs) and the total traveling time of automated guided vehicles (AGVs) through efficient scheduling of SCs and AGVs, which are cooperating tightly to perform cargo handling operations in an optimal way. In this paper, we develop and investigate the application of the multi- objective genetic algorithm (MOGA) to solve such scheduling problem with the objectives of minimizing the AGV total traveling time and the total delay time of the SC. The results of the experiments demonstrated that MOGA produces better solutions than the single objective genetic algorithms

SESSION: FA5	Penang 1
Intelligent Transportation Systems	

Chair: Siril Yella
Co-Chair: Hasan Fleyeh

10:00
FA5.1: Speed Limit Traffic Sign Detection & Recognition
Yasser Baleghi Damavandi, Karim Mohammadi
Iran University of Science & Technology (IUST), Iran

Since carelessness about the maximum speed allowed in

roads has caused many fatal accidents, an intelligent system to detect and inform it automatically, seems to be very useful. In this paper a system is developed to detect and recognize the speed limit traffic signs, which takes digital images from driving scenes and then the pictures are being filtered and searched to find the circular speed limit sign. The new method proposed, that is named "Hierarchical Hough Transform" can optimize the solution of accuracy/complexity problem. The powerful tool of neural network is then applied to recognize the pattern (number) which has been well seperated by the previous method. Some results from natural scenes are shown during the process presentation.

10:20
FA5.2: Expert System to Calculate the Coefficient of Friction- An Approach to Enhance Traffic Safety
Siril Yella, Kalid Askar, Mark Dougherty
Dalarna University, Sweden

Friction plays a key role in causing slipperiness as a low coefficient of friction on the road may result in slippery and hazardous conditions. Analyzing the strong relation between friction and accident risk on winter roads is a difficult task. Many weather forecasting organizations use a variety of standard and bespoke methods to predict the coefficient of friction on roads. This article proposes an approach to predict the extent of slipperiness by building and testing an expert system. It estimates the coefficient of friction on winter roads in the province of Dalarna, Sweden using the prevailing weather conditions as a basis. Weather data from the Road Weather Information System, Sweden (RWIS) was used. The focus of the project was to use the expert system as a part of a major project in VITSA, within the domain of Intelligent Transport Systems.

10:40
FA5.3: Color Detection and Segmentation for Road and Traffic Signs
Hasan Fleyeh
Dalarna University, Sweden

This paper aims to present three new methods for color detection and segmentation of road signs. The images are taken by a digital camera mounted in a car. The RGB images are converted into IHLS color space, and new methods are applied to extract the colors of the road signs under consideration. The methods are tested on hundreds of outdoor images in different light conditions, and they show high robustness. This project is part of the research taking place in Dalarna University / Sweden in the field of the ITS.

11:00
FA5.4: Real-Time Road Following in Natural Terrain
Pooja Chaturvedi, Andrew Malcolm, *Javier Ibanez-Guzman
Singapore Institute of Manufacturing Technology, Singapore; *ingapore Institute of Manufacturing Technology, Singapore

In the context of autonomous vehicle navigation, the use of colour content in images of off-road terrain within a tropical environment as a means of segmenting the scene is investigated. The operating environment is composed of dirt roads and tracks lined with vegetation with an irregular boundary between the two. Scene images are intelligently separated into driveable and non-driveable regions. HSI colour representation provides robustness to spectral colour variations and invariance to sudden changes in ambient light conditions. The approach to feature identification, classification and thresholding based on training set statistics is discussed. Finally results from the real world deployment on an autonomous vehicle are included.

11:20
FA5.5: Visual 3D Target Tracking for Autonomous Vehicles
Zhen Jia, Arjuna Balasuriya, *Subhash Challa
School of EEE, Nanyang Technological University, Singapore; *Faculty of Engineering, The University of Technology, Sydney, Australia

In this paper, an algorithm is proposed to identify and track moving objects for the autonomous vehicles target following application. It is a difficult problem because both the targets and the cameras are moving. Here optical flow fields, color features, stereo pair disparity are used as visual features while vehicles' motion sensors are used to determine the camera motion. Then this paper proposes a data fusion algorithm which integrates information obtained from different visual cues and the camera motion sensor data. The fusion algorithm determines the speed and relative position of the interested target in the 3D world coordinate for the vehicle to track. This paper presents a detailed description of the thee-dimensional (3D) target tracking algorithm using an Extended Kalman Filter. Experimental results are presented to demonstrate the performance of the proposed scheme using different image sequences.

11:40
FA5.6: Sentient Autonomous Vehicle using Advanced Neural net Technology
Srinivasan T, J. B. Siddharth Jonathan, Arvind Chandrasekhar
Sri Venkateswara College of Engineering, Sriperumbudur, India

Over the past decade, the field of automated intelligent transport systems has been the focus of rigorous research. This paper proposes Sentient Autonomous Vehicle using Advanced Neural net Technology (SAVANT), an automated transport system with significant advantages over previous attempts in this field. The system uses a multi-layer feed- forward neural network with back propagation learning. In addition, the design of SAVANT involves the convergence of a plethora of technologies like a Global Positioning System (GPS), a Geographic Information System (GIS), and laser ranging. SAVANT can guide a mobile agent through a hostile and unfamiliar domain after being trained by a human user with domain expertise. One of the many areas in which SAVANT scores against the competition is that the system is completely domain independent and incurs substantially less processor overhead. SAVANT thus provides more functionality even though it requires considerably less input as compared to other attempts in this field. This reduction in the size of the input vector translates into more efficient and faster processing. Another of SAVANT's hallmark features is its ability to negotiate turns and implement lane-changing maneuvers with a view to overtaking obstacles. It does this by employing a novel technique, Selective Net Masking. A simulation of SAVANT's neural network was performed on a variety of network topologies, and the best network selected.

SESSION: FA6   **Penang 2**
Neuro-Fuzzy Systems
Chair: Yi-Jen Mon
Co-Chair: Jiun Keat Ong

10:00
FA6.1: Intelligent Vehicle Airbag Controller Design
Yi-Jen Mon, *Kuan_Tso Luo
Chung-Kuo Institute of Technology, Taiwan, R.O.C.; *Chung-Shan Institute of Science and Techonology, Taiwan, R.O.C.

An intelligent vehicle airbag controller design methodology is proposed in this paper. Firstly, the vehicle impact severity

is analyzed to get four characteristic factors utilized as fuzzy inputs. From these four char-acteristics factors, the 'two stages fuzzy algorithm' is de- veloped and used as the airbag deployment algorithm to identify the vehicle impact severity. Finally, the Fuzzy-Gaussian Neural Network (FGNN) is used to train the suitable fuzzy membership functions and fuzzy rules based on this proposed 'two stages fuzzy algorithm'. Simulation results for different vehicle crash data demon-strate the validity and effectiveness of the proposed design methodology.

10:20
FA6.2: Perception Management for the Guidance of Unmanned Vehicles
Jiun Keat ONG, Javier Ibanez-Guzman
Singapore Institute of Manufacturing Technology (SIMTech), Singapore

A review of multi-sensor management for sensor fusion as applied to the guidance of unmanned vehicles is presented. The need for something more than sensor management is presented introducing the concept of Perception Management. The concept is information-oriented and looks into the supervision and control of multi-sensors with the purpose of enhancing the perception process. This paper proposes two perception management methods: (i) means to measure performance through the use of information theory based techniques and, (ii) a query oriented supervision system that reconfigures sensors as a function of the system operation mode and the performance being attained by all the combined sensors. In addition the concept of a design framework of perception management is outlined.

10:40
FA6.3: Hybrid Intelligent Models for Visual Servoing
Shahram Jafari, Ray Jarvis, Thirukkumaran Sivahumaran
Monash University, Australia

In this paper, we present two methods of performing eye-to-hand visual servoing using vision and tactile information: direct fuzzy servoing and fuzzy correction. The fuzzy methods are tuned by an Adaptive Neuro-Fuzzy Inference System (ANFIS). The set-up is part of a humanoid robot, named COERSU [1]. Experimental results from COERSU are provided to validate these methods. An evolved visual perception system based on genetic algorithms was used to obtain the best possible combination of object segmentation and classification parameters. Some simple methods for scene classification and pose detection were also implemented for intelligent grasping. This paper integrates different concepts to perform hand-eye coordination to produce a working system. The experimental results show that these methods represent a significant improvement in terms of speed and reliability.

11:00
FA6.4: Can End Inspection Using Neuro-Fuzzy Modeling
Perfecto Mariño, Vicente Pastoriza, Miguel Santamaría, Emilio Martínez
University of Vigo, Spain

The authors have been involved in developing an automated inspection system, based on machine vision, to improve the coating quality control in can ends of metal containers for fish food. In this work we present a fuzzy model building to make the acceptance/rejection decision for each can end from the information obtained by the vision system. In addition it is inter-esting to note that such model could be interpreted and supplemented by process operators. In order to achieve such aims, we use a fuzzy model due to its ability to favour the inter-pretability for many applications. Firstly, the easy open can end manufacturing process, and the current, conventional method for quality control of easy open can end repair coating, are de-scribed. Then, we show the machine vision system operations. After that, the fuzzy

modeling, results obtained and their discus-sion are presented. Finally, concluding remarks are stated.

11:20
FA6.5: Detection of volatile organic compounds using Quartz Crystal Microbalance sensor array and artificial neural network
Emilia Noorsal, Othman Sidek, Junita Mohamad-Saleh, *Mohd Nor Ahmad
University Sains Malaysia, Malaysia; *Northern Malaysia University College of Engineering, Malaysia

This paper presents the design and development of an odour sensing system based on a Quartz Crystal Microbalance (QCM) odour-sensor array and an artificial neural network (ANN) for the identification of some of the volatile organic compounds (VOCs) such as Acetone, Benzene, Chloroform, Ethanol and Methanol. The QCM sensors were developed using PVC-blended lipids as sensing materials. A home-built data acquisition and embedded pattern recognition system were developed using the Xilinx IC and AT89C52 Microcontroller. In addition, user interface software was developed to control the vapours flow system, data acquisition, process the acquired data and display the detected vapours using optimised neural network. The performance of this odour sensing system for VOCs emission detection was tested under laboratory conditions to determine its ability to detect single odour compound emission. Simulation and experimental results using an optimised neural network system confirmed that the proposed odour recognition system was effective in identifying the tested VOCs.

11:40
FA6.6: Adaptive Neuro-Fuzzy Identification Method of Hammerstein Model
Li Jia, Min-Sen Chiu, Shuzhi Sam Ge, Zhuping Wang
National University of Singapore, Singapore

In this paper, adaptive neuro-fuzzy identification is investigated for the Hammerstein model, which consists of the cascade structure of a static nonlinearity followed by a linear dynamic part. Utilizing the approximation ability of neuro-fuzzy for the nonlinear static function, there is no need for prior knowledge and restriction on static nonlinear function. Furthermore, an adaptive algorithm designed by Lyapunov stability theory is proposed to obtain the neuro-fuzzy Hammerstein model. Example is used to illustrate the performance and applicability of the proposed neuro-fuzzy Hammerstein model.

SESSION: FA7	Malacca 2
Soft Computing	

Chair: G A Vuayalakshmi Pai
Co-Chair: Haruhiko Takeuchi

10:00
FA7.1: Improvement on Classification Performance Based on Multiple Reduct Ensemble
Qinghua Hu, Daren Yu, Zongxia Xie
Harbin Institute of Technology, China

Rough set approaches are widely applied to feature selection and data mining. The minimal reduct of an information system is preferred in traditional rough set approaches according to minimal description length principle. In this paper, we present some experiments and find a minimal reduct is a weaker solution for the given classification task in most cases. A multiple classifier system based on rough set reduction is proposed, which improves the performance by combining multiple rough set based reducts. Experiments based on CART and SVM show the proposed method is efficient and effective.

10:20
FA7.2: Faster Optimization of SVR Hyperparameters based on Minimizing Cross-Validation Error

Kenji Kobayashi, Ryohei Nakano
Nagoya Institute of Technology, Japan

The performance of Support Vector (SV) regression deeply depends on its hyperparameters such as the thickness of an insensitive zone, a penalty factor, kernel function parameters and so on. A method called MCV-SVR was recently proposed, which optimizes SVR hyperparameters so that a cross-validation error is minimized. This paper proposes a faster version of the MCV-SVR. The MCV-SVR method iterates two basic steps until convergence; step 1 optimizes parameters under given hyperparameters, while step 2 improves hyperparameters under given parameters. The present paper accelerates step 2 by effectively reducing the number of samples for evaluation. Our experiments using two data sets show that the cpu time for step 2 was reduced by more than one degree of magnitude and the total cpu time was reduced by half or more, while the generalization performance remained comparable.

10:40
FA7.3: Web Page Checker Using Psychological Word Database

Haruhiko Takeuchi, Muneo Kitajima, *Haruhiko Urokohara
Natl Inst of Adv Ind Sci & Technol (AIST), Japan; *Novas Inc., Japan

This paper presents a new approach for checking Web pages. The Web page checker examines the words in Web documents, and identifies the Web pages that are difficult to read for specific persons. The essence of our approach is that we use a psychological word database, derived by psychological experiments, for calculating the indices of Web pages. We demonstrate that the database is effectively used for estimating the characteristics of Web pages.

11:00
FA7.4: Performance Analysis of a Statistical and an Evolutionary Neural Network Based Classifier for the Prediction of Industrial Bankruptcy

G. A. Rekha Pai, *G. A Vijayalakshmi Pai, **Annapoorani R
Nirmala College for Women, India; *PSG College of Technology, India; **Sri Avinashilingam Deemed University, India

Corporate failure has been causing not only considerable concern to the banks, government and financial institutions, but also financial embarrassment to the industrial units by seriously threatening their very viability. Therefore developing a model to predict potential industrial sickness as an early warning screen is the need of the hour. Various prediction models using financial ratios as predictor variables and employing Statistical techniques or Neural Networks as classifiers have been proposed. However, these models consider the selection of only a few financial ratios according to a choice based criteria. In this aspect, an earlier investigation by the authors on the application of Principal Component Analysis (PCA) which allows any number of financial ratios as input thereby dispensing with the need to choose selective financial ratios, has turned out to be beneficial. Its ultimate function is to reduce the dimensionality of data sets and represent the same by a set of principal components, which intrinsically represent the information content of all the financial ratios put together. In this study we analyze the performance of two prediction models making use of the principal components of financial ratios as their input but with Multiple Discriminant Analysis and an Evolutionary Neural Network as their Classifiers. The performance has been analyzed over financial data of 72 Indian Manufacturing companies for the financial years 1998- 2001, with 21 financial ratios as predictors.

11:20
FA7.5: Rough Sets Method for SVM Data Preprocessing

Ye Li, Yunze Cai, Yuangui Li, Xiaoming Xu
Shanghai Jiaotong University, China

To improve the generalization performance and structure of SVM classifiers (SVCs), we introduce rough sets theory to the data preprocessing of SVCs. Three measures are taken: removing duplicate samples from the dataset, finding a reduct and then multiplying every attribute with its corresponding significance factor which equals to the dependency of decision attribute with respect to the attribute. Experiment results on a UCI benchmark dataset and a practical steam turbine failure diagnosis problem show that the presented approach is feasible.

11:40
FA7.6: Neuro-Genetic Energy Management For Hybrid Fuel Cell Power Train

Mohsen Mohammadian, Mohammad Bathaee, *S. M. Mehdi Ansarey M.
K.N.Toosi University of Technology, Iran; *Iran Khodro Co., Iran

This paper deals a new strategy developed for optimizing the energy flow by using evolutionary algorithms implemented on a hybrid fuel cell vehicle (HFCV) to reach the best performance, fuel economy, emission and acceptable operation of this hybrid structure. This paper investigates the applicability of the Evolutionary based algorithms for hybrid system optimization problems. Artificial neural networks (ANN) are a computational paradigm modeled on the human brain that has become popular in recent years, especially in engineering problems. Genetic algorithms (GA) are a class of search algorithms modeled on the process of natural evolution. In this paper the modeling phase is done using ANN. The sub models of system including battery and fuel cell has been replaced fully or partially with proper ANN. The GA is used for optimization phase and also for ANN weight and threshold selection. With respect to dynamic behavior of this optimization problem, the system is simulated to demonstrate the validity and the convenience of evolutionary approach. Hence an object oriented programming (OOP) tool is developed for simulation of this hybrid structure. It prepares a good environment for supervisory control of stack as a major part of HFCV. The simulation results confirm the feasibility and encourage more research towards an actual application.

SESSION: FA9	Level 2a Foyer
Posters	

FA9: A Chaos-GFRF Based Fault Diagnosis Method

Hongguang Ma, Chongzhao Han, Xiangyu Kong, *Guohua Wang, *Jianfeng Xu
Xi'an Jiaotong University, China; *Research Institute of Hi-Tech., China

This paper presents a fault-diagnosis method based on the approaches of phase space reconstruction and Generalized Frequency Response Functions (GFRF) for the complex electronic system. The system parameter-evolving induced nonstationary is treated as the studying object. The phase space reconstruction and Gamma-test algorithm are employed to convert the system observing data into the pseudo-input/output pairs, and then three orders of GFRF kernels are computed by means of the General Formula of GFRF. The system fault data are generated by using the surrogate algorithm. The system fault detection and identification are realized by tracking and estimating the distortion of intermodulation. The experimental results depict that this fault diagnosis method can correctly detect the fault phenomena of electronic system.

FA9: Application of Fuzzy Rules Adjustable Algorithm to Vehicle Active Suspension Sys
Jianmin Sun
Tianjin University, China

In this paper, the riding comfort and handling safety of vehicle are regarded as control aims. An adjustable fuzzy control algorithm which fuzzy control rule table can be obtained with the numerical calculation is advanced. Because the algorithm can adjust the rectification factor of fuzzy controller, it not only can reflect the advantage of fuzzy logic in nonlinearity system but also can improve the disadvantage of common fuzzy control method strongly depending on the experience. For two degree-of-freedom (DOF) vehicle model, the simulation of vehicle performance in road signal is studied; its results show the adjustable fuzzy algorithm can effectively control the vibration of vehicle system.

FA9: Adaptive Fuzzy Control of Ship Autopilots with Uncertain Nonlinear Systems
Yansheng Yang, *Changjiu Zhou
Dalian Maritime University, China; *Singapore Polytechnic, Singapore

This paper presents a novel adaptive fuzzy control for ship autopilots with uncertain system and gain nonlinear functions, which are all the unstructured (or non-repeatable) state-dependent unknown nonlinear functions. The Takagi-Sugeno type fuzzy logic systems are used to approximate uncertain functions and the algorithm is proposed by use of the idea of changing supply functions. The closed-loop system is proven to be semi-global asymptotical stability. In addition, the possible controller singularity problem in some of the existing adaptive control schemes met with feedback linearization techniques can be removed and the adaptive mechanism with only one learning parameterization can be achieved. The proposed methodology, which is applied to design ship autopilot to maintain the ship on a pre-determined heading, is verified using the simulation mode of Dalian Maritime University's ocean-going training ship, Yulong. Simulation results show the effectiveness of the control scheme.

FA9: A Predictive Modeling for Blast Furnace by Integrating Neural Network with Partial Least Squares Regression
Xiaojing HAO, Gang Du, Peng Zheng, Zhi Xie, Fengman Shen
Northeastern University, China

The prediction of the important running variables of blast furnace (BF) has been a major study subject as one of the most important means for the monitoring BF state in ferrous metallurgy industry. In this paper, a prediction model for BF by integrating a neural network (NN) with partial least square regression (PLS) is presented. The selection of influencing operational parameters of BF on parameter to be predicted is explored according to the minimization of residuals based on the theory of path analysis. The selected influencing parameter data series are processed as the inputs of the prediction model. In order to validate this prediction model, silicon content in hot metal of BF is taken as the parameter to be predicted. The model is trained and evaluated with industrial data, and the results show that it works well. Further modification of this prediction model is also analyzed to improve its application in the industry.

FA9: Choquet Fuzzy Integral-based Identification
Smriti Srivastava, Madhusudan Singh, *Madasu Hanmandlu
NSIT, New Delhi, India; *IIT, New Delhi, India

A Choquet fuzzy Integral based approach to identification of non-linear systems is investigated. The Choquet Integral replaces the maximum (minimum) operator in the information aggregation with a fuzzy integral based neuron.

The identification of Choquet integral based fuzzy model is developed with strength of the rules as the input functions and unknown fuzzy densities, subject to q-measure, as the coefficients. This is a significant contribution as it leads to a class of non-additive fuzzy systems. In addition to it, the use of q-measure provides a more flexible and powerful way of incorporating various fuzzy measures into the Integral. Simulation results show the effectiveness of the identification method.

FA9: Approximations of Large Rule Takagi-Sugeno Fuzzy Controller by Four Rule Takagi-Sugeno Fuzzy Controller
Rakesh Arya, *R. Mitra, Vijay Kumar
Indian Institute of Technology, Roorkee, India ; *Indian Institute of Technology, Roorkee, India

This paper deals with approximations of large rule Takagi-Sugeno (TKS) fuzzy controller by four rule TKS fuzzy controller (simpler) via comparison of rule base of two controllers. The inequalities between two controllers are compensated by proposed compensating factors. The proposed methodology enormously reduces the computational time and computational memory. The proposed methodology is utilized to control a second order plant. It has been found that the proposed approximations and conventional methods give approximately same results.

FA9: Extraction of System Dynamics of a Nonlinear System using Neural Networks
J.R.P. Gupta, Madhusudan Singh, Smriti Srivastava, Madasu Hanmandlu
NSIT, New Delhi, India

The present paper discusses an important issue of control engineering i.e. the extraction of system dynamics of a nonlinear system. For this a novel method based on neural network model has been developed which makes the task of calculating the system parameters simple in comparison to the methods reported so far for the extraction of system dynamics of a nonlinear system. Further the parameter obtained by this method has been used for getting the system theoretic properties in terms of stability, controllability and observability and has been compared with that obtained using other methods.

FA9: A Type-2 Fuzzy Neural Model based Control of a Nonlinear System
Madhusudan Singh, Smriti Srivastava, J.R.P. Gupta, Madasu Hanmandlu
NSIT, New Delhi, India

We propose a novel method for controlling a nonlinear system using the Neuro-Fuzzy model based on the type-2 fuzzy sets. The type-2 fuzzy logic controller (FLC) based Neuro-Fuzzy model handle the rule uncertainties. Lot of work has been done in the field of control using the type-1 FLC and NN or their combination where different models could minimize the error with greater efficiency [1][2][3][4][5]. But in the practical case they are unable to handle uncertainties in the rules, which leads to inaccuracy in the actual output. This can be very efficiently handled by the type-2 FLC [6][7][8]. As in the control purpose the handling of uncertainties is a necessary and an important issue. This issue is more important as it has to handle the uncertainties of a plant (as the control action taken by the controller effect the plant), so we need a powerful tool, which fulfill our need. The type-2 based controller is a necessary and sufficient answer of the above problem. The implementation of type-2 FLC involves the operation of fuzzification, inference and output processing. Fuzzification and inference process include; finding the number of rules, i.e., rule base formulation and learning the parameters of the membership function. We focus on the output processing, i.e., defuzzification, which is done by the neural network. Here we will show how type-2 FLC can handle

uncertainties in the rules with a good approximation, which can't be handled by the type-1 FLC.

Friday, 3 Dec 2004, 13:00-15:20

SESSION: FM4   **Temasek 4**
Neural Networks - Application
Chair: Guido Herrmann
Co-Chair: Hsiung Cheng Lin

13:00
FM4.1: Neural Network-Based Improvement in Class Separation of Physiological Signals
Enrique Leon, Graham Clarke, Francisco Sepulveda, Victor Callaghan
University of Essex, United Kingdom

Computer scientists have been slow to become aware of the importance of emotion on human decisions and actions. Recently, however, a considerable amount of research has focused on the utilisation of affective information with the intention of improving both human-machine interaction and artificial human-like inference models. It has been argued that valuable information could be obtained by analysing the way affective states and environment interact and affect human behaviour. A method to improve pattern recognition among four bodily parameters employed for emotion recognition is presented. The utilisation of Autoassociative Neural Networks has proved to be a valuable mechanism to increase inter-cluster separation related to emotional polarity (positive or negative). It is suggested that the proposed methodology could improve performance in pattern recognition tasks involving physiological signals. Also, by way of grounding the immediate aims of our research, and providing an insight into the direction of our work, we provide a brief overview of an intelligent-dormitory test bed in which affective computing methods will be applied and compared to non- affective agents.

13:20
FM4.2: An Evaluation of The Level of Daily Activities: LDA Using Neural Networks for Medical Treatment
Masanobu Nagata, *Shinichi Nojiri, **Shunichi Sakata
Kumamoto National College of Technology, Japan; *Geriatric Health Services Facility of Seigaen, Japan; **Kumamoto Technology and Industry Foundation, Japan

In the field of rehabilitation or care, it is extremely important that medical staff clearly understand the the level of daily activities (LDA) of each subject, especially the five appearances of lying , sitting, standing, walking and wheelchair-driving in order to decide the method of medical treatment, the rehabilitation program or care plan and moreover judge whether care in necessary or not. Thus grasping precisely how long they lie, how long they sit, how long they walk and so on can become a principal index to understand the actual symptoms of a subject. One of the purposes of medical treatment nowadays is the improvement of the QOL of subjects and not just the treatment of symptoms. From this point of view, grasping LDA of subjects is important to diagnose symptoms accurately. In this paper, a new evaluating method of LDA is proposed using neural networks. In the new evaluating method, a neural network acquires specific rules for a specific subject by learning with the measurement signals of the subject using accelerometers, and LDA of the subject is judged with the neural network which have obtained the specific rules. The effectiveness of the proposed evaluating method of LDA is shown by judging it with the actual measurement signals of a healthy subject.

13:40
FM4.3: Robust Neural Network Controller Design for a Biaxial Servo System
Zhi-Shian Yu, Tien-Chi Chen

National Cheng Kung University, Taiwan, R.O.C.

A robust control method for synchronizing a biaxial servo system motion is proposed in this paper. A new neural network based cross-coupled control and neural network techniques are used together to cancel out the skew error. In the proposed control scheme, the conventional fixed gain PID cross-coupled controller (PIDCCC) is replaced with the neural network cross-coupled controller (NNCCC) to maintain biaxial servo system synchronization motion. In addition, neural network PID position velocity and velocity controllers provide the necessary control actions to maintain synchronization while following a variable command trajectory. This scheme provides strong robustness with respect to uncertain dynamics and nonlinearities. The simulation results reveal that the proposed control structure adapts to a wide range of operating conditions and provides promising results under parameter variations and load changes.

14:00
FM4.4: Single Exponential Smoothing Method and Neural Network in One Method for Time Series Prediction
Dimce Risteski, Andrea Kulakov, Danco Davcev
Faculty of Electrical Engineering- Skopje, Macedonia

The purpose of this paper is to present a new method that combines statistical techniques and neural networks in one method for the better time series prediction. In this paper we presented single exponential smoothing method (statistical technique) merged with feed forward back propagation neural network in one method named as Smart Single Exponential Smoothing Method (SSESM). The basic idea of the new method is to learn from the mistakes. More specifically, our neural network learns from the mistakes made by the statistical techniques. The mistakes are made by the smoothing parameter, which is constant. In our method, the smoothing parameter is a variable. It is changed according to the prediction of the neural network. Experimental results show that the prediction with a variable smoothing parameter is better than with a constant smoothing parameter.

14:20
FM4.5: Hands-Free Control of Power Wheelchairs using Bayesian Neural Network Classification
Son Nguyen, Hung Nguyen, Philip Taylor
University of Sydney, Australia

This paper describes the formulation and implementation of Bayesian neural networks for head-movement classification in a hands-free wheelchair navigation system. Bayesian neural network training adjusts the weight decay parameters automatically to their near-optimal values that give the best generalisation. Moreover, no separate validation set is used so all available data can be used for training. Experimental results are presented showing that Bayesian neural network can classify the head movement accurately.

14:40
FM4.6: Performance Oriented Anti-windup for a Class of Neural Network Controlled Systems
Guido Herrmann, Matthew C. Turner, Ian Postlethwaite
University of Leicester, UK

This paper presents a conditioning scheme for a linear control system which is enhanced by a neural network (NN) controller and subjected to a control signal amplitude limit. The neural network controller improves the performance of the linear control system by directly estimating an actuator-matched, un-modelled, non-linear disturbance, in closed-loop, and compensating for it. As disturbances are generally known to be bounded, the nominal NN-control element is modified to retain the known bound of the disturbance as its maximum amplitude. The linear control element is

conditioned by an anti-windup (AW) compensator which ensures performance close to the nominal controller and swift recovery from saturation.

15:00
FM4.7: Dynamic Power System Harmonic Detection using Neural Network
Hsiung-Cheng Lin Lin
Chien Kuo Technology University, Taiwan

Conventional approaches for harmonics measurement usually employ either FFT or DFT. They, however, are susceptible to the presence of noise in the distorted power line. This paper proposes an alternative neural network based algorithm to detect the location of dynamic power harmonics in noisy environments. Sensitivity considerations are also conducted to determine the key parameters that affect the model performance efficiency in the lowest errors of testing patterns.

SESSION: FM5	Penang 1
Manufacturing Systems	

Chair: Ramasamy Kannaiyan Suresh
Co-Chair: Ping Jiang

13:00
FM5.1: Evolutionary algorithm and threshold accepting algorithm for lot-streaming and sequencing problems in two-machine flowshop
Marimuthu S, *Ponnambalam S G, **Suresh R K
KLN College of Engineering, India; *Monash University, Malaysia; **Amrita Institute of Technology, India

The objective of this paper is to propose and evaluate heuristic search algorithms for two machine flow shop problem with multiple jobs requiring lot streaming that minimizes makespan and total flow time of jobs. A job here implies many identical items. Lot streaming creates sub lots to move the completed portion of a production sub lots to down stream machine. The two heuristic search algorithms evaluated in this paper are Hybrid evolutionary algorithm (HEA) and Threshold accepting algorithm (TAA). A wide variety of data sets are randomly generated for comparative evaluation. The Hybrid evolutionary algorithm found to perform well for lot streaming in the two machine flow shop scheduling.

13:20
FM5.2: Task Scheduling Based on Probabilistic Constraint Propagation for Distributed Workflow Enactment
Sebastian Kanzow, Yacine Amirat
University Paris 12, France

Several architectures for decentralized workflow enactment have been proposed to improve workflow execution through cooperation of geographically distributed agents. To our knowledge, none of them solves the problem of dynamic task scheduling in trans-organizational relations, which are characterized by a limited observability of the global workflow execution state, due to confidentiality reasons. We present a new distributed dynamic scheduling approach for workflow execution in an inter-enterprise context, based on the multi-agent paradigm. We use three types of agents: proactive agents for supervision, reactive agents for resource management and mobile agents for task execution. Apart from essential task constraints that are propagated as probability values, the state of one participant's workflow instance is hidden from business partners. We implemented the methodology in a multi-agent test bed and executed a number of randomly generated workflows. Results show that the optimal schedule is found in a large majority of test runs, in spite of limited observability.

13:40
FM5.3: Concept Mining for Distributed Alliance in Multi-agent Based Virtual Enterprises

Ping Jiang, Yonghong Peng, *Quentin Mair
University of Bradford, UK; *Glasgow Caledonian University, UK

Complex system manufacturing, such as that which takes place in the aerospace and automotive industries, is becoming increasingly dependent on distributed product development and is increasingly being conducted within the context of globally hosted virtual enterprises. These involve dynamic alliances and are characterized by a particular lifecycle: from partnership seeking, partnership cooperation to partnership dissolution. One of the basic problems in a distributed alliance is how to get an agent to find the best competent individual as a partner for a given task. The semantic web and its associated new standards appear very promising as candidates to support a new generation of virtual enterprises based on heterogeneous systems integration and distributed alliances. Whilst knowledge can be represented in a machine interpretable way using the semantic web, an agent can support automatic partner searching and documents processing in the web. This paper proposes a matchmaking scheme for allocating tasks among agents based on the announcements of tasks and the capability of agents in DAML, where agents advertise their skills and local knowledge in a community and a task initiator seeks out the best-matched partners to form a dynamic alliance. Due to the autonomy of agents, the announcements are often from the agent's local perspective and the semantics of the announcements must be taken into account. To address this issue, a concept-mining scheme is then presented to reveal the actual meaning behind the announcements based on the ontology definition of a community. Consequently, distributed alliances in a virtual enterprise can take place in an automated/semi-automated way.

14:00
FM5.4: Hopfield Neural Network approach for Single Machine Scheduling Problems
Maheswaran Rathinam, *Ponnambalam S.G, Nithin Samuel D., **Ramkumar A.S
MEPCO Schlenk Engineering College, Sivakasi, India; *Monash University Malaysia, Malaysia; **Amrita Institute of Technology, Coimbatore, India

This paper presents a Hopfield neural network approach for the problem of scheduling n jobs in a single machine to minimize total weighted tardiness. A binary encoding scheme is introduced to represent the solutions, together with a heuristic to decode. A 10-job problem is solved by sequencing the job using different methods viz. weighted shortest processing time (WSPT) rule, Earliest Due Date (EDD) rule, binary representation and Hopfield Neural Network. The results show that the Hopfield neural network performs better over others.

14:20
FM5.5: An Effective Two-Phase Dynamic Capacity Allocation Methodology for Production Resources
Yan Wen Jing, Chua Tay Jin, Wang Feng Yu, Cai Tian Xiang, Liu Ming Wei
Singapore Institute of Manufacturing Technology, Singapore

Effective utilization and management of production capacity have significant impact to the success of a manufacturing enterprise. In a complex manufacturing environment, the development of a feasible capacity allocation mechanism is a challenging task. In this paper, the issue of achieving balanced capacity allocation for effective planning of production resources was addressed in a medium- to long-term capacity planning framework. A two-phase dynamic capacity allocation methodology was developed which adopts a proportional loading method using weighted capacity and considers product and machine

loading priorities and bottleneck operation constraint. The first phase of the capacity allocation process is to consume dedicated production resources while the shared production resources will be dealt with in the second phase, considering the bottleneck constraint. The incorporation of actual operational constraints in the capacity planning process provides a realistic and practical solution, which enhances the enterprise's ability to react quickly to ad-hoc customer enquiries and dynamic demand changes.

14:40
FM5.6: The Influence Parameters Beta 1 and Beta 2 Have on Bibeta Spline Curved Surface
Xumin Liu, Houkuan Huang, Weixiang Xu
Beijing Jiaotong University, China

This paper discusses how Beta spline curve with geometric continuity is influenced by the change of parameters beta 1 and beta 2, offers the range of parameters beta 1 and beta 2, and presents the algorithm principles of bibeta spline curved surface that is controlled by double parameters. Based on all above, a Freedom Surface Modeling System (FSMS) is designed and some examples are verified and analyzed.

15:00
FM5.7: An APS Architecture for Web Services Based Enterprise Integration
FengYu Wang, Tay Jin Chua, William Liu, WenJing Yan
Singapore Institute of Manufacturing Technology, Singapore

Web Services are widely discussed and proposed to address enterprise integration within company or cross-organizations due to its language and operating system independency and support of loosely coupled integration. This paper presents an architecture for APS (Advanced Planning and Scheduling) system by describing its messaging model and service model, attempting to solve integration issues among APS, MES, ERP and other manufacturing systems that could not be handled properly using current approaches. In addition, a prototype of enterprise integration constructed for a semiconductor packaging company using Java Web Services enabling technologies will demonstrate the advantages and benefits of the solution.

SESSION: FM6   **Penang 2**
Human/Computer Interaction
Chair: Francisco Sepulveda
Co-Chair: Ingo Boesnach

13:00
FM6.1: Cluster Separation Index Suggests Usefulness of Non-Motor EEG Channels
Francisco Sepulveda, Matthew Meckes, *Bernie Conway
University of Essex, United Kingdom; *University of Strathclyde, United Kingdom

The aim of the study was to select the best electroencephalogram features and channel locations for detection of wrist movement intentions. The detected intentions can be used in brain-computer interfaces (BCIs) either for direct control of an artificial or virtual hand, or they can be used as an underlying binary code for execution of other tasks. 28 channel EEG was recorded while a subject performed wrist movements in four directions. Four basic feature types were extracted in the time and frequency domains for each channel following optimized filtering of the signals. The signals were split into planning and execution segments, respectively. Various delays and anticipation lengths were taken into account for each of the features, thus totaling 93 different features. The potential performance of each feature and channel for use in the classification of the EEG signals was analyzed by estimating the relative class overlap using the Davies-Bouldin Index (DBI), a widely used measure for estimating

cluster separation. The best feature/channel configurations contained both channels that were close and channels that were far from motor areas. A statistical test using the channel/feature configurations that yielded the lowest 5% DBI values for motor and for non-motor channels yielded no significant difference (alpha= 0.05) between these two channel populations. The scope and depth of the study was limited. Important parts of the signal had to be discarded to rule out interference stemming from saccadic eye movement. However, our results do suggest more attention should be paid to non-motor areas in earlinked EEG data even when investigating movement related BCIs.

13:20
FM6.2: Autonomous virtual human research for dialog system
Saori Sugiyama, Norihiro Abe, Kazuaki Tanaka, *Hiroaki Taki, **Tetsuya YAGI
Kyushu Institute of Technology, Japan; *Wakayama University, Japan; **Osaka University, Japan

With the development of data processing technology, the number of people using a computer is rapidly growing now. And they came to use it in the everyday life of ordinary homes. However, it is hard for elderly people and disabled persons to treat an interface device such as a mouse and a keyboard. For this reason, the dialog system is needed that permits them to dialog with a computer. A virtual human called avatar is introduced into virtual space. Users can talk to him as if he talked to a real person. When a man talks in real space, the partner chimes in according to a speaker's utterance. By synchronizing utterance with a behavior, a partner can understand a speaker's intention correctly. Moreover, relation between a listener and a speaker is not always fixed in man's conversation, and the relation interchanges. This research proposes how to understand the conversation accompanied with the pointing behavior.

13:40
FM6.3: Reciprocating vision and auditory sensation through network
Hiroaki Matsuura, Norihiro Abe, Kazuaki Tanaka, *Hirokazu Taki
Kyushu Institute of Technology, Japan; *Wakayama University, Japan

Recently, the virtual reality has progressed rapidly in the field of the science and technology. The coverage includes extremely various fields such as communication, design, entertainment, etc. Various VR space have been proposed and constructed by present. However, threre are no VR system that realizes real time simulation based on the same physical law as it works in the real world. Then, we construct a virtual air hockey game based on rigid dynamics in this research. Moreover, to provide the presence with users, two sensations (the visual and auditory sensation) are synchronized. This paper describes various problems and their solutions in construction of the system, and utilities for synchronizing the two sensations.

14:00
FM6.4: Toward construction of a mobile system with long-range RFID sensors.
Takahiro Mishima, *Norihiro Abe, *Kazuaki Tanaka, **Hiroaki Taki
Kyusyu Institute of Technology Graduate School, Japan; *Kyusyu Institute of Technology, Japan; **Wakayama University, Japan

A simple mobile system is described for humans and robots with a radio- frequency identification (RFID) tag sensor. In this paper, the system assumes to be used in a hospital to identify the location of patients and recognize their state. At first we use one positive RFID sensor. The range of this directional antenna is long (about 5 meters, 2 meters) and

an RIFD antenna is set on a rotating pan-tilt platform we made, making the best use of the directional sensor. It is difficult to recognize a person with an ID tag because the microwave output from the antenna attenuates by human's moisture. However, we confirm the effectiveness of this RFID system against the people who have a tag by experiments. Experimental results show that this system is available for identifying a person. At last we were able to make the extended system, using three RFID sensors without the rotating platform.

14:20

FM6.5: Adaptive Sensor-Planning Algorithm with Q-Learning

Masahiro Maeda, Noriji Kato, Hirotsugu Kashimura

Fuji Xerox, Co., Ltd., Japan

In this paper, we propose an adaptive learning technique for ``sensor-planning'', that is how to control PTZ (Pan-Tilt-Zoom) camera sensor for human finding without prior environment information. Our idea is based on Q-learning with positive and negative rewards as Optical-flow result and camera motion respectively. Additionally, an adaptive learning rate mechanism enables us to change the control sequence quickly to adapt situation change. This planning method has advantages of real-time processing, on-line learning and quick adaptation. We show a simulation experiment in pseudo room environment to compare our method with traditional methods. Our algorithm can detect moving object 21 percent faster than probabilistic method.

14:40

FM6.6: Man and Machine Bidirectional Communication Interface Using Voice and Pointing Action

Yasuhiro Watanabe, Koichi Nishimura, Saori Sugiyama, Norihiro Abe, Kazuaki Tanaka

Kyushu Institute of Technology, Japan

In this research, we have constructed a dialog environment between human and computers, and proposed and verified the method of operating the information which unified the verbal information represented using the voice and the non-verbal information and a pointing action. Now, the interface environment of information equipments such as a computer does not change with the former one. For example, elderly people cannot use it very easily. In Japan, if the interconnection of various apparatus is carried out with the arrival of ubiquitous network society and new various functions are available in addition to the conventional functions, it is thought that products which need the complicated operations will be developed. It is expected that even people who can use the functions will feel it difficult to use new ones while growing older. Then, dialog environment which permits both a system and a user to use much easier operations is desired. In this research, the environment is constructed witch allows a user to communicate using a voice and gesture with the personification agent who is a salesman in a virtual store selling fountain pens. The specification using a pointing action and voice such as 'Would you show me this pen?' will make it possible foe user to specify the pen he wants to buy from fountain pens in a showcase. If the distance between his fingertip and the pen is distant, it may be difficult for the agent to infer which pen the user wants. This needs the further communication using voice.

15:00

FM6.7: Classification of Phases in Human Motions by Neural Networks and Hidden Markov Models

Ingo Boesnach, Jörg Moldenhauer, Christoph Burgmer, Thomas Beth

University of Karlsruhe, Germany

A proper modeling of human motions plays a crucial role for many motion processing tasks. In particular, models for the automatic classification of elementary motion phases are highly important for the interaction between man and machine. In this work, we present different approaches for this modeling task based on neural networks and hidden Markov models. Both ap-proaches yield reliable classification results. We show that even simple instances of the models work well if proper motion features are determined. A comparison of the different ap-proaches shows the reasons for this behavior and leads to essen-tial consequences for further modeling approaches.

SESSION: FM7	Malacca 2
Knowledge Acquisition and Engineering	

Chair: Satoshi Ono
Co-Chair: Francisco Sepulveda

13:00

FM7.1: Automatic Acquisition of Dialog Strategies for Concept Learning through Interaction among Agents

Ryo Taguchi, Kouichi Katsurada, Tsuneo Nitta

Toyohashi University of Technology, Japan

This paper describes automatic acquisition of dialog strategies for efficient concept acquisition applied to the interaction among Infant Agents (IAs). The following two topics are emphasized: (1) what the influence of dialog strategies over concept acquisition is, (2) how cooperative dialog strategies are acquired. In order to acquire efficient strategies, Q-learning is applied to a strategy acquisition mechanism. Experiments are carried out through the interaction between two IAs; one is teaching IA (T-IA) that has all the concepts and teaches them to the other IA, and the other is learning IA (L-IA) that acquires concepts. In the experiments, 100,000 times of dialogs are iterated and both IAs acquire dialog strategies. We first fix the number of initial concept of the L-IA to zero and compare the acquired strategies with a base line strategy of Random-Strategy, which makes the act of IA randomly, to investigate the above-mentioned topics of (1) and (2). The experimental results showed that the resultant strategy, which follows Grice's maxim of "quantity", makes the concept acquisition efficient, however, the T-IA using this strategy exhibits the same behavior no matter how the L-IA asks. This is not the cooperative behavior. In the second experiment, zero to ten initial concepts are randomly given to the L-IA for setting actual dialog situation. The results showed that both IAs acquire cooperative strategies that can efficiently eliminate ambiguities. The behavior of IAs using the cooperative strategies is similar to the one that is seen in human-human interaction.

13:20

FM7.2: Modelling Knowledge Based Systems Using The eXecutable Modelling Framework (XMF)

Mohd Syazwan Abdullah, Andy Evans, Ian Benest, Richard Paige, Chris Kimble

University of York, United Kingdom

There is no standardised approach to modelling knowledge-based systems; where modelling is adopted, the techniques used are those from the software engineering domain. These tend to be used in an ad hoc way and are highly dependent on the experience of the knowledge engineers. This paper presents the adoption of a profile mechanism for the design of knowledge-based systems. The profile is created using the meta-model extension approach of UML and is based on XMF (eXecutable Meta-modelling Framework). XMF is an extension to the existing standards for meta- models: MOF, OCL and QVT. XMF offers an alternative approach in profile design, which allows modification or the addition of new modelling constructs that are easily integrated with the core meta-model of UML.

13:40

FM7.3: Interactive Email Filtering - Learning From Misclassified Examples

Ding Yi Chen, Zhaoyang Dong, Xue Li, Paul Smith
University of Queensland, Australia

Learning from mistakes has proven to be an effective way of learning in the interactive document classifications. In this paper we propose an approach to effectively learning from mistakes in the email filtering process. Our system has employed both SVM and Winnow machine learning algorithms to learn from misclassified email documents and refine the email filtering process accordingly. Our experiments have shown that the training of an email filter becomes much effective and faster.

14:00
FM7.4: Interior Coordination Using Case-Based Reasoning and Constraint Satisfaction Paradigm
Satoshi Ono, Tatsuki Izumi, Ayako Fujiyama, Christopher Ashley, Shigeru Nakayama
Kagoshima University, Japan

This paper proposes an interior coordination method which uses model rooms made by furniture manufacturers, distributers, stores, designers and so forth. Interior coordination involves furniture selection, in which inhabitants' preferences, generation, life style must be considered, and furniture placement, in which many conditions for building a functional, comfotable room must be satis ed. The proposed method adopts case-based reasoning for furniture selection and constraint satisfaction paradigm for furniture placement. The method allows users to specify ambiguous, incomplete request, and enables them to obtain an interior coordination of furniture effciently without the use of an interior designer. Examples of the output produced by the proposed method are also shown in this paper.

14:20
FM7.5: An Efficient Turnkey Agent for Repeated Trading with Overall Budget and Preferences
Ivan Vermeulen, Koye Somefun, Han La Poutré
Center for Mathematics and Computer Science (CWI), Amsterdam, Netherlands

For various e-commerce applications autonomous agents can do the actual trading on behalf of their users. We consider an agent who trades repeatedly on behalf of his user, given an overall budget and preferences per time step, both specified at the start. For many e-commerce settings such an agent has limited computational resources, limited prior information concerning price fluctuations, and little time for online learning. We therefore develop an efficient heuristic that requires little prior information to work well from the start, even for very roughed nonsmooth problem instances. Extensive computer experiments conducted for a wide variety of customer preferences show virtually no difference in performance between a dynamic programming (DP) approach and the developed heuristic carrying out the agent's task. The DP approach has, however, the important drawback of generally being too computationally intensive.

14:40
FM7.6: Reasoning Relation among RDF/RDFS Resources Using PROLOG Rules and Facts
Hyun Gun Park, *Sa-Joon Park, *Jae-Ho Kim, *Ki-Tae Kim
University of Soong-Sil, Korea; *Chung-Ang University, Korea

This paper proposes a method for the prospective semantic inference in the web documents, catching the relation among RDF/RDFS resources using PROLOG. For the semantic extraction, at first, we derive various kinds of facts caught intuitively from RDF/RDFS recommendation of W3C and stored them as facts in a knowledge base. Secondly, we produce rules from the various definitions of the recommendation and stored them as rules in a knowledge base, too. We choose the translation to the prolog, because the prolog is similar to the FOL representation. If there is a prolog compiler, we can easily confirm the inference process with the knowledge base. Rules and facts which represent the relation among the elements of the web documents will be helpful for semantic inference, provide the foundation available to agents.

15:00
FM7.7: Descriptive vs. Machine-Learning Models of Vastus Lateralis in FES-Induced Knee Extension
Francisco Sepulveda, Jean-Baptiste Huber
University of Essex, United Kingdom

The aim of this study was to compare the predictive performance of pure machine-learning models of muscles under functional neuromuscular electrical stimulation (FES) to that of descriptive Hill type models incorporating various levels of machine-learning in some of their elements. Inputs to the models were FES pulse width and vastus lateralis length and velocity, while the output was the vastus lateralis contractile force. Three types of models were developed for comparison purposes: 1) a Hill-based descriptive model without machine-learning elements, 2) 2 types of Hill-based models with several machine-learning elements, and 3) pure machine learning models using Multilayer Perceptron (MLPs) and Adaptive NeuroFuzzy Inference Systems (ANFIS). The results revealed that the pure descriptive Hill model and two of the pure machine learning model configurations were the most inadequate in modeling electrically stimulated muscle. On the other hand, mixed models (i.e., Hill models that incorporated several machine learning elements), yielded the best results, giving mean force prediction errors of less than 3.3 % for the testing set.

SESSION: FM9	Level 2a Foyer
Posters	

FM9: Fuzzy Discrete Event Supervisory Control Capable of Temporal Reasoning in Urban Traffic Management
Ali Akramizadeh, Mohammad Akbarzadeh, Morteza Khademi
Ferdowsi University of Mashhad, Iran

In this paper, a discrete event fuzzy based supervisory controller is applied to an urban traffic control problem also modeled from a discrete event perspective via state flow formalism. Time varying nature of intersections, involvement of human behavior in the system and distributed nature of the problem at large makes the urban traffic control a challenging problem. Specifically, because of this distributed time varying nature, it is important for the decision making paradigm to consider historical values of the linguistic variables as well as their current values. Hence, we establish a novel fuzzy system which imposes green time event based on future-based temporal fuzzy rules, which has a great effect on coordination among intersections. Simulation results present the effectiveness of the proposed method.

FM9: Induction Machine Broken Bar Detection Using Neural Networks Based Classification
Mohammad Reza Rafimanzelat, Babak Nadjar Araabi, *Elham Khosroshahli
Department of Electrical and Computer Engineering, University of Tehran, Iran; *Niroo research institute, Tehran, iran.

This paper addresses the developing of a fault diagnosis system for detection of broken rotor bars, a common mechanical fault in cage induction machines, using efficient feature extraction techniques and a neural network classifier. The proposed algorithm uses the stator current and motor speed as inputs. Fast Fourier Transform is utilized to obtain the frequency spectrum of the current

signal. An efficient algorithm is then used to extract suitable features out of the frequency spectrum of the signal. The relevance of the features for the purpose of fault detection is investigated and verified. A neural network classifier is then developed and applied to distinguish different motor conditions. A series of data collected from experiments on a three phase 3 hp cage induction machine performed in different load and fault conditions are used to provide data for training and then testing the classifier. Experimental results confirm the efficiency of the proposed algorithm for detection of broken bar faults.

FM9: Feature Selection Using Genetic Algorithm and Its Applications to Face Recognition
Mehrtash Harandi, Majid Nili Ahmadabadi, Babak N. Araabi, Caro Lucas
Control and Intelligent Processing Center of Excellence, Iran

A new method for feature selection based on Generic algorithm and its application in face recognition is proposed. Simulation results show the superior performance of the proposed algorithm over the Eigenface original method. In comparison to Evolutionary Pursuit method, the proposed method has a faster training phase and the ability of finding and searching more features using our novel fitness function

FM9: AN ANN Based Approach to Improve the Distance Relaying Algorithm
Hassan Khorashadi-Zadeh, Mohamad Reza Aghaebrahimi
Birjand University, Iran

This paper presents an artificial neural network (ANN) based approach to improve the performance of distance relaying algorithm. The proposed distance relay uses amplitudes of voltages and currents signals to learn the hidden relationship existing in the input patterns. Simulation studies are preformed and the influence of changing system parameters such as fault resistance and source impedance is studied. Details of the design procedure and the results of performance studies with the proposed relay are given in the paper. Various simulation studies are performed and capabilities of the extended algorithm are investigated. Performance studies results show that the proposed algorithm is very accurate. Some of the simulation results are presented in the paper.

FM9: Development of a Vector-Based Fuzzy Logic Approach for Motion Planning
Xiaojun Wu, Qing Li, Kok Hui Heng
Nanyang Technological University, Singapore

Due to its potential ability in reasoning linguistic terms, the fuzzy logic approach has been widely applied to robot motion planning. The existing fuzzy logic planners for robot motion planning mainly deal with planar manipulation or navigation. Further, the existing planners operate only on fuzzy scalar variables. However, for a general robot motion in 3-D Cartesian space, both the pose of a manipulator end- effector and the position of a mobile robot relative to other objects or coordinate frames contain both magnitude and orientation information. In this paper, as an attempt towards a general and effective robot motion planning in 3-D space, a new fuzzy logic approach operating on fuzzy vector variables is proposed. For this purpose, a set of new membership functions suitable to operate fuzzy vector variables is defined. Simulation studies on an Underwater Robotics Vehicle (URV) in a simulated oceanic scenario, a typical example operating in 3D space, have demonstrated the effectiveness of this new fuzzy motion planner.

FM9: A New Proxy Blind Signature Scheme with Warrant
Qingshui Xue, Zhenfu Cao

Shanghai Jiao Tong University, China

In a proxy signature scheme, an original signer delegates his/her singing power to a proxy signer and the proxy signer can sign messages on behalf of the original signer. Blind signature can ensure anonymity of electronic coins. Unforgeability and unlinkability are its two main properties. The proxy blind signature scheme ensures security properties of the two kinds of signature schemes. All of proposed proxy blind signature schemes based on discrete logarithm problems (DLP) can't provide strong unlinkability. To overcome the weakness, a new and practical proxy blind signature scheme with warrant is proposed. The new scheme outperforms Tan et al's scheme and is nearly the same as Lal et al's scheme in terms of computational complexity. However, the new scheme is securer than Tan et al's scheme and Lal et al's scheme.

FM9: An Adaptive Fuzzy Model based Process State Identification for Prediction and Control
Meng Tang, Wolfgang H Koch
Norwegian University of Science and Technology, Norway

In this paper at first an integrated intelligent model for process state identification and behavior prediction for complex processes is introduced based on the results in [14]. In the model, Fuzzy Neural Networks (FNNs) are applied as process state classifiers for process state (fault) detection. Various Neural Networks (NNs) are used for system identification of process characteristics in different process states. The model detects process states and predicts process output according to process input variables and historical output. The whole model is constructed based on Fuzzy TS dynamic Nonlinear AutoRegressive with eXogenous input (NARX) models. Secondly, two different model optimization schemes are investigated for model adaptability to cover time depending process changes. Thirdly, a specific state space equation of a discrete time varying system is being derived from the Adaptive Fuzzy Model. Based on this state space equation, corresponding process control methods can be used. Finally, an application case has been studied for products supply forecasting with this model. It indicated that the model has good performance and that it can be applied for process state (fault) detection, prediction and predictive control.

FM9: An Unconstrained Optimal Set of Discriminant Vectors
Xian-gui Zeng, Shao-fa Li, Wen-ming Zuo
South China University of Technology, China

Under circumstances of orthogonal constraints, the vectors that make the Fisher discriminant criterion function attain the maximum values are F-S optimal set of discriminant vectors. In this paper, an optimal set of discriminant vectors, which need not fill any constraint condition, has been presented, together with the solution for the set. In addition, when the number of training samples is smaller than the dimensions of training samples (i.e. small number of training samples problem), the within-class scatter matrix is singular. Under this circumstance, to acquire both F-S optimal set of discriminant vectors and Unconstrained Optimal Set of Discriminant Vectors presented here becomes unfeasible. To solve this problem, an approvedFisher discriminant function is presented. The result of experiment on ORL face database show that the algorithms presented here have strong ability in discrimination.

FM9: A Hybrid Scheme for Off-line Chinese Signature Verification
Wen-ming Zuo, Shao-fa Li, Xian-gui Zeng
South China University of Technology, China

Based on characteristics of off-line Chinese signatures, a

novel hybrid signature verification scheme with static and dynamic features extraction is proposed. Pseudo-Zernike invariant moments are used for static features due to their scale and translation invariance. When dynamic features are considered, firstly global and local HDFs (High-Density Factors) are obtained. Then weighted relative gravity center of global high density image is computed to generate another feature. In addition, an important feature is extracted using wavelet transform on normalized gray level histogram. Then ten orders of pseudo-Zernike moment invariants and seven dynamic features compose the eigenvector. At last for each class of signatures, a BP(back-propagation) network that was trained with 5 genuine signatures and forgeries that other signatures act as is built to verify unknown samples. A collection of 290 signatures is used to test the verification system. As a result of this experiment, the FAR (False Acceptance Rate) and FRR (False Rejection Rate) can achieve 7.84% and 6.89% respectively.

Friday, 3 Dec 2004, 15:50-17:50

SESSION: FP4	Temasek 4
Image Processing II	

Chair: Mazlan Mohamad
Co-Chair: Zhen Jia

15:50
FP4.1: Bayesian Learning for Object Based Image Segmentation
Zhen Jia, Arjuna Balasuriya
Nanyang Technological University, Singapore

This paper proposed an algorithm using Bayesian on-line learning for object based video image segmentation. First the strengths of image pixel's spatial location, color and motion segments are weighted and then unified in one framework for image clustering and segmentation. Here the appropriate modeling of Probability Distribution Functions (PDF) of each feature cluster is obtained through Gaussian Distribution. In this paper unsupervised Bayesian learning is implemented to identify these distribution parameters. The online Bayesian learning process is carried out with the previous clustered image pixels information and feature clusters Gaussian PDF information. This algorithm has shown good results on different video files.

16:10
FP4.2: Automatic Detection of Hilum and Parenchymal Bands on HRCT Lung Images
Mamatha Rudrapatna, Arcot Sowmya, *Peter Wilson, **Phil Lucas
University of New South Wales, Australia; *Medical Imaging Australasia, Australia; **1283

High-Resolution Computed Tomography (HRCT) images have been found to be more sensitive than chest radiographs and conventional CT in diffuse lung disease diagnosis. Parenchymal bands are a type of reticular opacity commonly seen in patients with Asbestosis. We have developed automated techniques to detect parenchymal bands on HRCT images of the lung that can help reduce the amount of data radiologists must process to arrive at a diagnosis. This technique also includes detection of the hilum an anatomical landmark, which is essential to parenchymal band detection. Preliminary results are presented.

16:30
FP4.3: The Utilization of Closing Algorithm and Heuristic Information for Broken Character Segmentation
Worapoj Peerawit, Warat Yingsaeree, Asanee Kawtrakul
Kasetsart University, Thailand

In Thai Printed Character Recognition systems, an important problem that decreases the accuracy is broken characters. These characters could cause the error in segmentation process. To solve this problem, a method for broken character segmentation in Thai printed document is presented. It consists of two main steps: text line detection, for extracting text lines from an image, and character segmentation, for extracting broken characters from a text line. The character segmentation consists of four steps: Gap reduction using closing algorithm, Character segmentation using space, Large character splitting and Small character merging using heuristic information. The advantage of this approach is the ability to segment broken character even when it is split into a large number of segments. The experimental result shown that our method achieves 91.09%.

16:50
FP4.4: Analog CMOS Circuit Implementation of Motion Detection with Wide Dynamic Range Based on Vertebrate Retina
Kimihiro Nishio, Kenji Matsuzaka, Nozomi Irie
Yonago National College of Technology, Japan

Analog complementary metal oxide semiconductor (CMOS) circuits for edge detection were proposed based on the vertebrate outer retina. A simple analog CMOS circuit for generating the motion signal, which inputs the edge signal, was also proposed based on the amacrine cell in the inner retina. The simulation results with the simulation program with integrated circuit emphasis (SPICE) showed that the proposed edge detection circuits can detect edge positions with a dynamic range of 5 decades. The simulation results with SPICE showed that the proposed circuit can generate the motion signal of the edge. A chip for processing a moving image in real time with the wide dynamic range can be realized by applying the proposed circuits.

17:10
FP4.5: A System for Automated BGA Inspection
Wen-Yen Wu, Chih-Chung Chen
I-Shou University, Taiwan

For the advantages of high I/O count and small size, ball grid array (BGA) package techniques have been developing very fast in recent years. In this paper, a vision-based algorithm was proposed. The BGA grayscale images captured by CCD camera, and some image processing methods were applied to segment and enhance the image of solder ball. Three kinds of feature size were employed here: area, centroid and roundness of solder ball. The defects were detected by matching these features to the template data. The inspection items included missing ball, extra ball, ball bridging, oversize or undersize, offset and deformation. In this research, the speed execution time of inspecting one BGA image is also taken into consideration.

17:30
FP4.6: Channel Assignment Optimisation Using a Hyper-heuristic
Mazlan Mohamad, Graham Kendall
The University of Nottingham, UK

The channel assignment problem is a real world problem from the mobile communications industry. The primary objective is to find the minimum frequency bandwidth given different traffic demand distribution within the mobile network. Besides fulfilling the channel demand requirement, we must also consider the minimum channel reuse distance in order to avoid the effect of call interference within the same cell or adjacent cells. Previous approaches have used graph-colouring algorithms, heuristic search, neural networks, simulated annealing and genetic algorithms (GA). In this paper, we propose a hyper-heuristic methodology and compare our approach against channel assignment problems from the literature.

SESSION: FP5   **Penang 1**
Systems

Chair: Roger Jianxin Jiao
Co-Chair: Hsiung Cheng Lin

15:50
FP5.1: Design of Multiple-Level Tree Classifiers for Intrusion Detection System
Cheng Xiang, May Yee Chong, Hanle Zhu
National University of Singapore, Singapore

Intrusion detection system (IDS) has recently emerged as an important component for enhancing information system security. To effectively build corresponding rules and patterns of computer attack scenarios and system vulnerabilities, data mining has been widely used in constructing and maintaining IDS. Based on statistical characteristics of specific intrusion types, a novel approach of using multiple-level tree classifiers is proposed in this paper to identify intrusions. Performance of this new algorithm is compared to other popular approaches such as MADAM ID.

16:10
FP5.2: A Security Blueprint for E-Business Applications Based on the Three-Tier Architecture
Jun Du, *Jianxin (Roger) Jiao, *Xiaodong Li
Tianjin University, China; *Nanyang Technological University, Singapore

Building a secure e-business environment becomes top critical to e- business applications. However, security can't be attained by simply applying security protection systems like firewalls, IDS or anti-virus. This paper develops a security blueprint for e-business applications based on the three-tier e-business architecture. The security blueprint provides best practices in general, including security controls layered from physical access, network communication, operating system, to application; and management processes staged from planning, deployment, administration, to auditing. Moreover, the paper discusses the applicability of this security blueprint using a Singapore multinational corporation as a case study. Also discussed are security control analysis, management process analysis, and cost/benefits analysis.

16:30
FP5.3: Power System Harmonics Measurement Uusing Graphical Programming Tool
Hsiung-Cheng Lin
Chien Kuo Technology University, Taiwan

Traditional methods to measure power system harmonics employ the power harmonic analyser or the software package such as Matlab. They, however, have limitations in capability of graphical programming environment and extension to the Internet connection for remote monitoring and control. This paper presents an alternative approach using a virtual instrument (VI) that can carry out power system harmonics measurement based on Fast Fourier Transform (FFT) is proposed. The experimental results testify its well performance and unstable harmonic measurement capability.

16:50
FP5.4: Performance of SCTP over High Speed Wide Area Networks
Dhinaharan Nagamalai, Jae-Kwang Lee, *Yong Jin Lee, *Jae Kwang Lee
Hannam University, South Korea; *1047

The Stream control Transmission protocol (SCTP) is a reliable transport protocol to tackle the limitations of TCP and UDP. SCTP was originally designed to transport PSTN signaling messages over IP networks, but is also capable of serving as a general-purpose transport protocol. SCTP provides attractive features such as multi-streaming and multi-homing that may be helpful in high-mobility environment and additional security against denial-of-service attacks based on SYN flooding. SCTP congestion control mechanisms are based upon TCP congestion principals with the exception of the fast recovery algorithm. Original SCTP congestion control can perform badly in high-speed wide area networks because of its slow response with large congestion window. The challenge for any alternative protocol is to better utilize networks with high bandwidth delay products in a simple and robust manner without badly interacting with existing traffic. We propose a new congestion control scheme based on the simple congestion window modification for SCTP to improve its performance in high-speed wide area networks. The results of several experiments proved that our new suggested congestion control scheme for SCTP in high speed network improved the throughput of the original SCTP congestion control scheme significantly.

15:10
FP5.5: Intention Recognition of a Human Commanding a Mobile Robot
Karim Tahboub
University of Freiburg, Germany

This article discusses intention and plan recognition ideas applied to human-machine interaction. Agents capable of intention recognition of other agents can interact and cooperate effectively without much a need for communication. Dynamic Bayesian networks are used to infer for the agent intentions. A simplified example related to the motion of a mobile robot is worked out with details to clarify the proposed methodology. Further, the article discusses the difference between intention and plan recognition and shows that a reactive intention recognition approach suffices for compliant human-machine interaction. The proposed intention-recognition approach does not require the full knowledge of the environment, as information gathered by typical local sensors suffices.

17:30
FP5.6: Clustered Water and Bio-signal Networks
Jingong Pan, *Lee H Lorenzen, **Francisco Carrillo, ***Huawen Wu, Zhi Y. Wang
NJIT, USA; *Institute for Cluster Research, USA; **Spanish Hospital, Mexico; ***Hong Kong Quantum Science & Technology Institute, China

The Meridian system conceived by the ancient Chinese has been described and referenced for thousands of years. We previously proposed a hypothesis that it might be a bio-signal network via the cluster water- wire. Such wire is not only a good carrier for energy and nutrition, but also proton or electron resonant frequency signals. The foundation is that cluster water (CW) may have certain memory-holding properties. To measure the frequency signals in water directly, we performed a series of resonant frequency imprinting studies using Quantum FAFA equipment. The resonant frequency valley of CW is found to be significantly different from that of distill water (DW). In another experiment, we used regular CW as the reference, while another CW was imprinted with additional low frequency signal. The result shows that several new resonant frequency peaks have been detected in the new imprinted CW compared with non-imprinted CW control. We believe that the research may open a novel way to tackle the mystery of the Meridian system and related bio-signal networks.

SESSION: FP6   **Penang 2**
Human/Machine Systems

Chair: Kar Ann Toh
Co-Chair: Yoshiyuki Tanaka

15:50
FP6.1: Adaptation to Changes in Multimodal Biometric Authentication
Quoc-Long Tran, Kar-Ann Toh, *Dipti Srinivasan
Institute for Infocomm Research, Singapore; *National University of Singapore, Singapore

Multimodal biometric authentication is gaining more and more attention recently. In \cite{Toh3}, a Reduced Multivariate Polynomial model has been used to combine the biometric classifiers with good performance. Although the model parameter can be solved very quickly, it may not be suitable in case when new registration is a frequent task. Moreover, due to wear and tear of sensors, the distribution of match scores can change with time and hence the performance of a fixed classifier may be affected. In this paper, we introduce an adaptive algorithm to track these changes. The new algorithm is demonstrated to address both the registration and match scores distribution changing problems using two biometrics.

16:10
FP6.2: Analysis of Human Hand Impedance Regulation Ability
Yoshiyuki Tanaka, Toshio Tsuji
Hiroshima University, Japan

This paper investigates human impedance regulation ability for the purpose of developing a skill-level training method for sports and rehabilitation. The training system to experiment on human impedance regulation was constructed using impedance-controlled robot. In the experiments, a subject is instructed to regulate his/her hand impedance to the desired impedance as closely as possible according to the visual biofeedback information including EMG signals from muscles, joint angles of the upper limb, and estimated hand impedance. Experimental results demonstrate that a human can greatly improve his/her regulation ability of hand impedance by repetitive training.

16:30
FP6.3: A Query by Musical Impression System Using N-gram Based Features
Tadahiko Kumamoto, Kimiko Ohta
National Institute of Information and Communications Technology, Japan

Impression-based music retrieval is not suitable for retrieving specific musical pieces from the huge volume of a music database, but enables users to find musical pieces that suit their preferences, feelings, or mental states. We have therefore been developing an impression-based music retrieval system that enables this. In this paper, we define the form of vectors that numerically express impressions of musical pieces, and propose a method of generating such a vector from a musical piece. The most significant attribute of this method is that it uses n-gram statistics of information on pitch, strength, and length of every tone in that musical piece as features extracted from it. We also present the results of evaluating the performance of the system.

16:50
FP6.4: Analysis of Human Wrist Joint Impedance: Does Human Joint Viscosity Depend on Its Angular Velocity?
Yusaku Takeda, Makoto Iwahara, Takashi Kato, Toshio Tsuji
Hiroshima University, Japan

A novel model for the mechanical joint impedance, which takes into account the force-velocity relationships of skeletal muscles, is proposed. First, velocity-dependent viscosity changes are formulated using the equation proposed by A. V. Hill. Then, human wrist joint impedance is estimated by a conventional model (a linear model) and the proposed novel model (a nonlinear model) for

comparison. The estimated moment of inertia indicates approximately constant value in all muscle contraction levels, and the joint stiffness estimated from the both models increases with the increment of muscle contractions. However, when joint angular velocity starts to change, the estimated joint viscosity dramatically decreases with the increment of joint angular velocity.

17:10
FP6.5: Development of a Tactile Camera for Deformable Surfaces
Kyu Yong KIM, Akio YAMAMOTO, Toshiro HIGUCHI
The University of Tokyo, Japan

The tactile display for virtual reality and telepresence or telexistence systems is continuously being enhanced to create an effective human-environment interface. Among the key elements in telepresence systems, the tactile observing device, called the tactile camera, plays the important role of obtaining tactile information from tactile objects. Previous systems based on haptic feedback systems provide only limited superficial information. This paper presents the development of a new tactile camera that explores beneath a deformable surface as well as providing surface information. Experiments verified that this device is capable of exploring a complex tactile object.

17:30
FP6.6: 3D Object Recognition System Using Multiple Views and Cascaded Multilayered Perception Network
Muhammad Khusairi Osman, Mohd. Yusoff Mashor, Mohd. Rizal Arshad
University Sains Malaysia, Malaysia

This paper proposes an effective method for recognition and classification of 3D objects using multiple views technique and neural networks system. In the processing stage, we propose to use 2D moment invariants as the features for modeling 3D objects. 2D moments have been commonly used for 2D object recognition. However, we have proved that with some adaptation to multiple views technique, 2D moments are sufficient to model 3D objects. In addition, the simplicity of 2D moments calculation reduces the processing time for feature extraction, hence increases the system efficiency. In the recognition stage, we propose a cascaded multilayered perceptron (c-MLP) network for matching and classification. The c-MLP contains two MLP networks which are arranged in a serial combination. This proposed method has been tested using two groups of object, polyhedral and free-form objects. We also compare our method with standard MLP network. Our results show that the proposed method can successfully be applied to 3D object recognition. In addition, the proposed network also achieved better performance and faster convergence rate compared to the than standard MLP

SESSION: FP7	Malacca 2
Decision Support Systems	

Chair: Kar Ann Toh
Co-Chair: Erick Abwao Robert Swere

15:50
FP7.1: Exploiting Petri Net Graph to Model the FSM of Modulo-P Counter
Jih-Fu Tu, Yin-Tuei Hsu
St. John's & St. Mary's Institute of Technology, Taiwan

Traditionally, the basic abstract of a system is described by the general static machine. If we want to model the transactions of the discrete-event system (DES), the finite state machine model does not clearly and evidently to illustrate the state transition. For illustrating and modeling a high-performance state transition system, we can use the Petri nets (PNs) graph to replace the concepts of traditional finite state machine (FSM). In this paper, we will issue some novel kinds of elements of the Petri net to replace the

FSM, furthermore, to illustrate the state transition. In order to make the focal points stand, we give an example, in which we use the Petri net graph to illustrate the combination logic control circuit of Modulo-p counter, to prove our assumption.

16:10
FP7.2: Knowledge-based Collaborative Decision Making System for Product Design
Yuan Fu Qiu, Yoon Ping Chui, Helander Martin
Nanyang Technological University, Singapore

In this paper, based on the analysis of decision making process, the knowledge in product design is identified. A knowledge-based collaborative decision making system for product design is constructed. The problem solving process of the system is illustrated by hierarchical task analysis method. The support of the system to knowledge access and utilization in product design is analyzed. Factors influencing the system are analyzed and a methodology on performance measurement is suggested.

16:30
FP7.3: Efficient Incremental Decision Tree Generation for Embedded Applications
Erick Swere, David Mulvaney, *Ian Sillitoe
Loughborough University, UK; *University of Borås, Sweden
This paper describes a frequency table-based decision tree algorithm for embedded applications. The table contains a compact statistical representation of the training set feature vectors and can be used in conjunction with a variety of learning methods. The use of the table allows a priori knowledge of the memory requirement and reduces the time for incremental tree generation by a factor of at least 10. The paper illustrates the method with an example of incremental decision tree learning applied to robot navigation. The performance of the method is compared with that of an existing incremental decision tree algorithm.

16:50
FP7.4: Modeling the Decision Process of the Lane-Change Maneuver Using a Situation-Operator Model
Elmar Ahle, Dirk Söffker
University of Duisburg-Essen, Germany

This contribution demonstrates the application of a situation-operator modeling (SOM) technique to the modeling of the lane-change maneuver including the decision and planning process. The core of the approach is the assumption that changes of the world are understood as a sequence of scenes and actions. These parts are modeled using a special situation and operator calculus. The presented example describes the system vehicle-environment, whereby the vehicle is driving on a multilane road and different goals, e.g. drive as fast as possible, are provided. With the description of the real system as situation-operator model, planning of actions according to the goal is realized, i.e. which action has to be applied in which situation depending on the given goal. The decision is not necessary rule-based; it follows directly from the situation. Furthermore, this formulation is independent of the given goal.

17:10
FP7.5: Personalized Learning and Decision for Multimodal Biometrics
Kar-Ann Toh
Institute for Infocomm Research, Singapore

In this paper, we address the multi-modal biometric decision fusion problem. By exploring into the user-specific approach for learning and threshold setting, four possible paradigms for learning and decision making are investigated. Since each user requires a decision hyperplane specific to him in order to achieve good verification accuracy, those tedious iterative training methods like the neural network approach would not be suitable. We propose to use a model, which requires only a single training step for this application. The four global and local learning and decision paradigms are then explored to observe their decision capabilities. Besides proposal of a relevant receiver operating characteristic performance for local decision, extensive experiments were conducted to observe the verification performance for fusion of three biometrics.

17:30
FP7.6: Decision Making of Selecting Manufacturing Partner Based on the Supply Chain: Study on TOPSIS Method Application
Xiaolin Wang, *Yun Zhang, Zhaobo Qing
Jiliang University of China, China; *Zhejiang University of Science and Technology, China

In the supply chain management, main manufactures attach increasing importance to their partnerships' effect. In order to select partnerships properly, certain attributes of the partnerships should be carefully analysis. A latent vector method is adopted to solve the weights of these attributes, so that every attributes important degree is determined. Then the priority sequencing of partnerships can be determined through using a TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method for multi-object decision making. A simulation example shows implementing procedures and effectiveness of the proposed methods

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