CIS-RAM 2010

2010 4th IEEE International Conference on Cybernetics and Intelligent Systems

2010 4th IEEE International Conference on Robotics, Automation and Mechatronics

28 – 30 June 2010
Singapore

Program & Abstracts

Organized by

IEEE Systems, Man & Cybernetics (SMC)
Singapore Chapter

IEEE Robotics & Automation (R&A)
Singapore Chapter

IEEE
SINGAPORE SECTION

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Centre for Intelligent Control
National University of Singapore, Singapore

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2010 IEEE Conference on

Cybernetics and Intelligent Systems (CIS 2010)

&

2010 IEEE Conference on

Robotics, Automation and Mechatronics (RAM 2010)

28–30 June 2010
Grand Copthorne Waterfront Hotel
Singapore

PROGRAMME & ABSTRACTS

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IEEE Systems, Man & Cybernetics (SMC), Singapore Chapter

IEEE Robotics & Automation (R&A), Singapore Chapter

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Brief Contents

Welcome Message

On behalf of the Organizing Committee, we would like to welcome you to 2010 IEEE International Conference on Cybernetics and Intelligent Systems (CIS) and 2010 IEEE International Conference on Robotics, Automation and Mechatronics (RAM). This is the fourth CIS and RAM conferences and they are back to Singapore this time round. The purpose of this biennial joint conference is to promote activities in various areas of Cybernetics, Intelligent Systems, Robotics, Automation and Mechatronics. At the same time, it provides a forum for ideas exchange, presentations of technical advancement, and discussions on future research directions.

The two conferences are jointly organized by the IEEE Systems, Man and Cybernetics, Singapore Chapter; IEEE Robotics and Automation, Singapore Chapter; and IEEE Singapore Section. They are technically supported by the Center for Intelligent Machines of the Nanyang Technological University, Center for Intelligent Control of the National University of Singapore, and Mechatronics Group of the Singapore Institute of Manufacturing Technology.

As in the previous event, we have received paper submissions from many different countries and regions from around the world. These submissions include both regular and invited papers. All the submitted papers have been peer reviewed by the members of International Program Committee, which were coordinated by the Program Chairs and Invited Sessions Chairs. The International Program Committee has assembled a comprehensive technical program that covers a broad spectrum of topics in Cybernetics, Intelligent Systems, Robotics, Automation, and Mechatronics.

The technical program is scheduled on 28 June 2010 and 29 June 2010. It comprises 24 oral sessions in 4 parallel tracks. The proceedings are provided in CD-ROM version, thanks to the great effort by our Publication Chair. We are grateful to have two distinguished speakers: Prof Homayoon Kazerooni (USA) and Professor Michel Parent (France) offering plenary lectures on "Lower Extremity Exoskeleton Systems for Medical Applications" and "Cybercars: the New Market for Robotics?", respectively. These two lectures will show how theoretical research works of our fellow researchers can be applied to solve real challenges encountered by modern society. The paper sessions cover a broad spectrum of topics and emerging areas addressing informatics, intelligent transportation systems, human/computer interaction, RFID/wireless sensors, mechatronics system design, kinematics and dynamics modeling, bio-inspired robots, medical robotics, micro/nano robots, etc. Besides original works on abstractions, algorithms, theories and methodologies, we also have technical papers which demonstrate the applications of advanced research tools to solve challenges in the areas of CIS and RAM.

To facilitate interaction among our delegates, we have organized a welcome reception on Sunday evening (27 June 2010) and the conference banquet on Tuesday evening (29 June 2010). We hope these events will allow our delegates to get to know each other, meet with old friends and at the same time, enjoy the local delicacies, etc. For the full fee paying delegates, we have also planned a half-day social event (pre-registration is required) on 30 June 2010. This social event will let our international delegates explore Singapore. Our delegates will be able to experience the colorful and unique culture of Singapore. We also encourage our international delegates to make use of free time to visit other attractions of Singapore.

Finally, we would like to express our sincere gratitude to everyone involved in making these conferences a success. Many thanks to our advisory board members, the organizing committee members, the plenary speakers, and the invited session organizers, the program committee and reviewers, the conference

participants, and of course, all the contributing authors who will be sharing the results of their research. It is our great pleasure to have you with us in CIS-RAM 2010. We wish everyone a fruitful meetings and a memorable stay in Singapore!

Chee-Meng Chew
General Chair — CIS & RAM 2010

Hai Lin
Program Chair — CIS 2010

Han Wang
Program Chair — RAM 2010

About CIS & RAM 2010

CIS 2010

The goal of the **CIS 2010** is to bring together experts from the field of cybernetics and intelligent systems 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 CIS 2010 is held together with the IEEE Conference on Robotics, Automation and Mechatronics (RAM 2010). The conference welcomes paper submissions from researchers, practitioners, and students in but not limited to the following areas:

Cybernetics Control of Uncertain Systems, Cooperative Systems and Control, Multi-Agent Systems, Discrete Event Systems, Supervisory Control, Hybrid Systems, Networked Dynamical Systems, Mechatronics.

Intelligence Computational Intelligence, Swarm Intelligence, Soft Computing, Fuzzy Systems, Neural Networks, Genetic Algorithm, Evolutionary Computation, Image Processing, Computer Vision.

Systems System Modeling & Control, Smart Sensor Networks, Power Systems, Environmental Systems, Systems Biology, Human/Machine Systems, Intelligent Transportation Systems, Manufacturing Systems, Decision Support Systems.

RAM 2010

The goal of the **RAM 2010** is to bring together experts from the field of robotics, automation and mechatronics 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 RAM 2010 is held in conjunction with the IEEE International Conference on Cybernetics and Intelligent Systems (CIS 2010). The conference welcomes paper submissions from academics, researchers, engineers, and students worldwide in but not limited to the following areas:

Robotics and Automation in Unstructured Environment, Personal and Service Robotics, Underwater Robotics, Medical Robots and Systems, Robotics and Automation Applications, Sensor Design, Integration, and Fusion, Computer and Robot Vision, Human-Robot Interfaces, Haptics, Teleoperation, Telerobotics, and Network Robotics, Micro/Nano, Distributed, Cellular, and Multi Robots, Biologically-Inspired Robots and Systems, Sensor Based Robotics, Intelligent Transportation Systems, Modeling, Planning and Control, Kinematics, Mechanics, and Mechanism Design, Legged Robots, Wheeled Mobile Robots, Dynamics, Motion Control, Force/Impedance Control, Architecture and Programming, Methodologies for Robotics and Automation, Discrete Event Dynamic Systems, Petri Nets, Virtual Reality, Manufacturing System Architecture, Design, and Performance Evaluation, Computer Aided Production Planning, Scheduling, and Control, Total Quality Management, Maintenance, and Diagnostics, etc.

Acknowledgements

The Conference and Organizing Committee Chairs wish to thank all the international advisors and members of the Organizing Committee for the contributions in organizing this conference. The Chairs also wish to acknowledge all the sponsors for their generous support and all others who have in one way or another contributed towards the success of this conference.

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General Information

Session Information

All Chairpersons and Speakers are requested to be in their respective session rooms at least 10 minutes prior to the commencement of each session.

A total of 20 minutes has been allocated for each oral presentation, including time for questions. Session chairpersons will strictly enforce this limit. Presenters are requested to keep their presentation within the stated time limits.

For presentations, a video projector will be made available. No slide projector will be provided.

General Conference Information

The Grand Copthorne Waterfront Hotel Singapore reflects the way most of us would like to live: amongst resort and exquisite lifestyle decor and a relaxing atmosphere along with great comfort. As one of Asia's premier 5-star choices, the 574-room hotel is nestled next to the Singapore River and close to the Central Business District and Orchard Road. Lifestyle and business-enabling conveniences are offered to facilitate travelers' needs with health and leisure facilities, executive accommodation, wireless connectivity and business support services. Just as your sense of comfort is appeased, your sense of taste in this luxury hotel in Singapore will reach new peaks with dishes from our award-winning restaurants.

The Grand Copthorne Waterfront Hotel Singapore, where luxury is a lifestyle....

For more information on Grand Copthorne Waterfront Hotel, you can visit the website at *http://www.millenniumhotels.com.sg/grandcopthornewaterfront/index.html*

Conference Venue

Our conference will be located on the second floor of the hotel. Opening ceremony and plenary sessions will be held at the Waterfront ballroom I. Breakout sessions will be held in Riverfront I, II, and III and Penguin Room. Secretariat room will be located at the Seagull Room on the second level.

Coffee/Tea Breaks

Daily coffee and tea breaks is from 10:00 to 10:30 hrs and from 15:30 to 16:00 hrs.

Lunch

Lunch will be served at the Waterfront Ballroom at 12:30 PM. Lunch coupons are required.

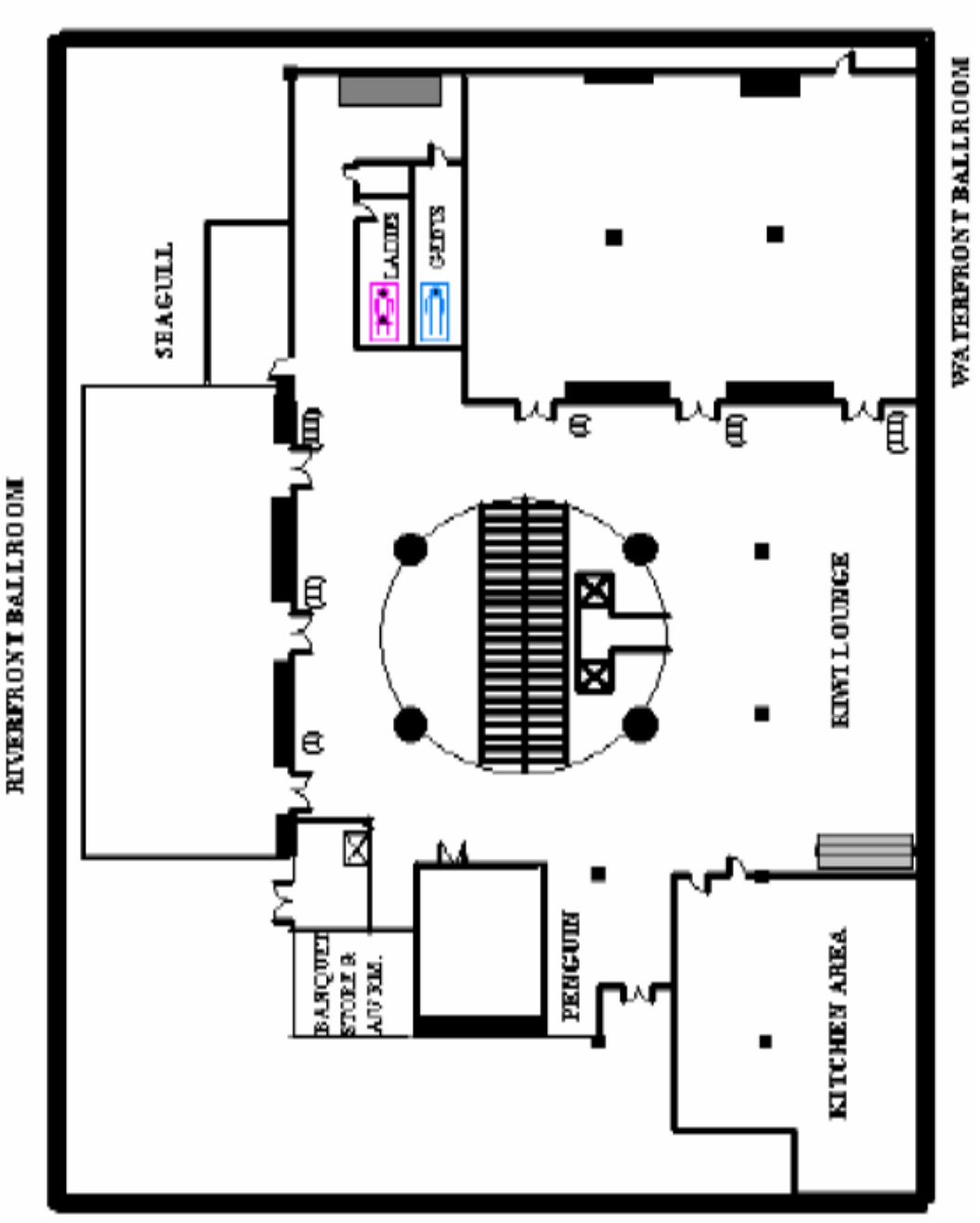
Conference Contact

If you need our assistance, please contact our conference secretariat at ivan@mymicenet.net.

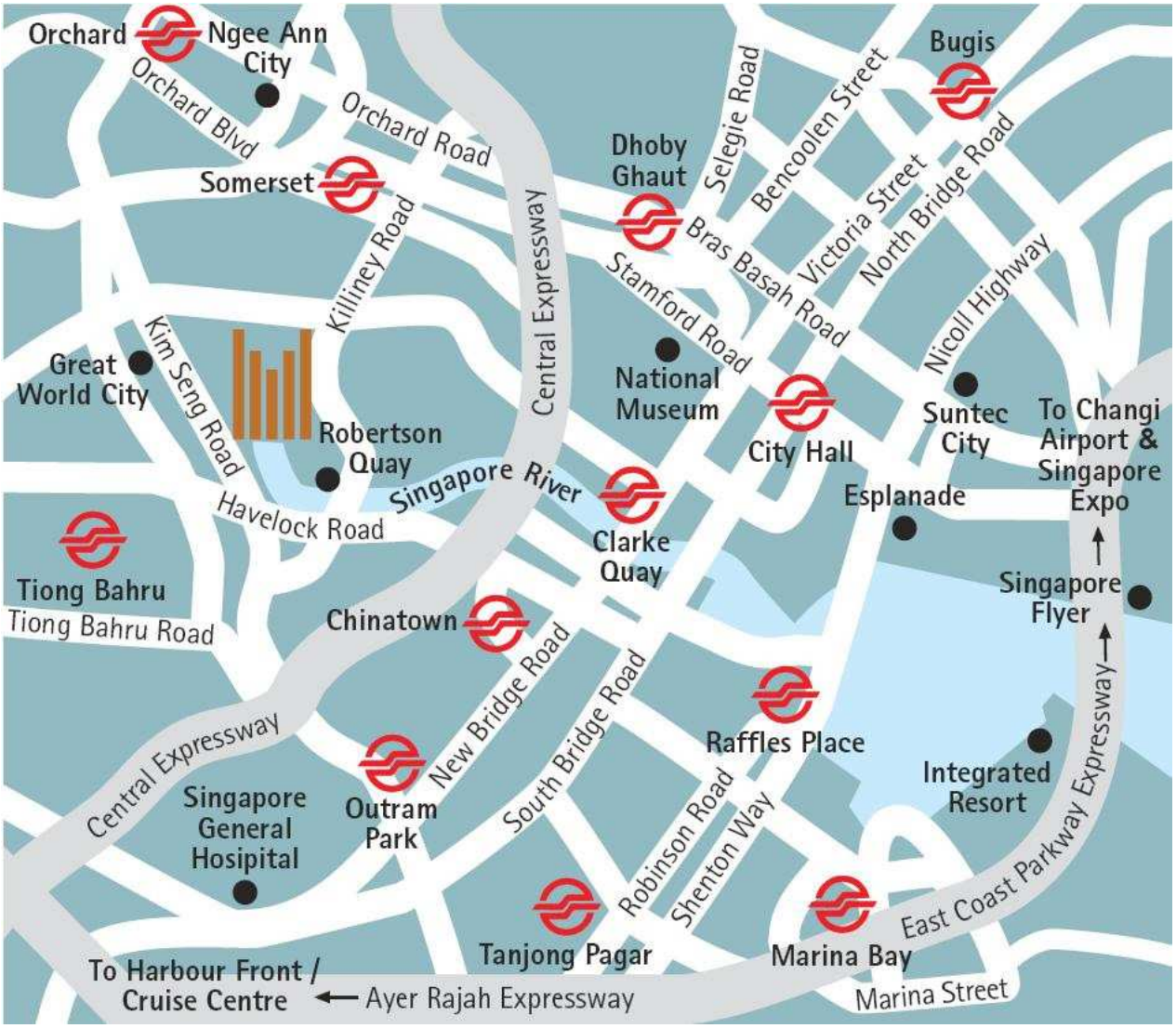
Conference Location & Floor Plan

Grand Copthorne Waterfront Hotel Singapore
392 Havelock Road, Singapore 169663
Tel: +65 6733 0880

Map: Second Floor



Map: Transportation



The hotel is ideally situated on the corner of Havelock Road and Kim Seng Road. Along the banks of the historic Singapore River, as a Singapore hotel in the Central Business District (CBD) guests can enjoy convenient access to the financial hub of the country and easily access entertainment areas of Chinatown and famous Orchard Road.

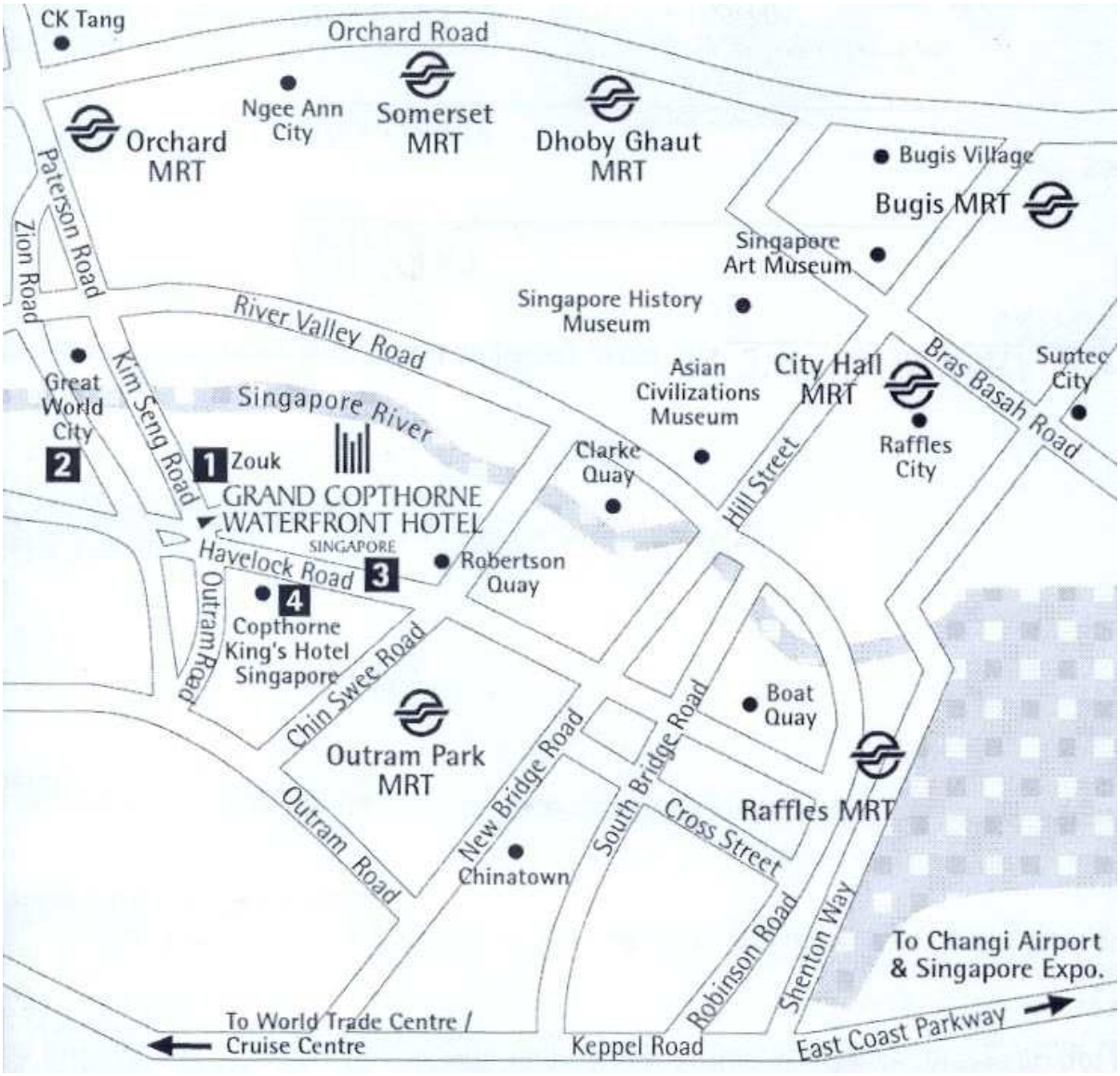
World Trade Centre 2 km W
Suntec City Convention Centre 2 km E
Botanic Gardens 2 km N

From Changi International Airport

On leaving the airport take the Pan Island Expressway (PIE). Exit at Stevens Road. Proceed straight ahead towards Scotts Road. From there, head straight all the way through Paterson Road and Kim Seng Road. The hotel's main entrance is located on the left off Kim Seng Road.

Changi International Airport 22 km Ne; Seletar Airport 24 km N
Taxi cost: 20 SGD (estimated)

Map: Public Transportation Around the Hotel



(Entrance via Kim Seng Road/Jiak Kim Street)

Kim Seng Road (Grand Copthorne Waterfront Hotel)

Bus No.	From	To
5	Pasir Ris MRT, Newton MRT	Tiong Bahru MRT, Red Hill MRT
16	Raffles City, Orchard MRT	Tiong Bahru MRT, Red Hill MRT
75	Holland Village, Botanic Garden	Outram Park MRT, Shenton Way, CBD, Suntec City
175	Lavender MRT, Geylang Lorong 1, Orchard MRT	Clementi Interchange
195	Suntec City, Raffles City	Tiong Bahru MRT
970	Holland Village	Outram Park MRT

Zion Road (Food Centre)

Bus No.	From	To
5	Tiong Bahru MRT, Red Hill MRT	Newton MRT, Pasir Ris MRT
16	Tiong Bahru MRT, Red Hill MRT	Raffles City, Orchard MRT
75	Outram Park MRT, Shenton Way, CBD, Suntec City	Holland Village, Botanic Garden
175	Clementi Interchange	Orchard MRT, Lavender MRT, Geylang Lorong 1 Terminal
195	Tiong Bahru MRT	Suntec City, Raffles City
970	Outram Park MRT	Holland Village

Havelock Road (Riverview Hotel)

Bus No.	From	To
51	Jurong East, Alexandra	Chinatown, Bugis
64	Red Hill MRT	Little India
123	Bukit Merah	Orchard MRT
186	Queenstown MRT	CBD
608	Bukit Merah	CBD

Havelock Road (Copthorne King's Hotel)

Bus No.	From	To
51	Chinatown, Bugis	Jurong East, Alexandra
64	Little India	Red Hill MRT
123	Orchard MRT	Bukit Merah
186	CBD	Queenstown MRT
608	CBD	Bukit Merah

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58 cm / 23''

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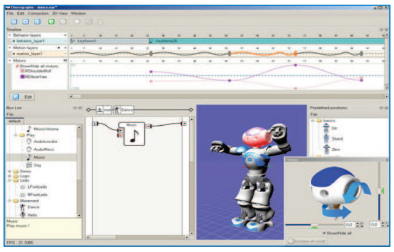
Nao is a humanoid robot developed and manufactured by Aldebaran Robotics, a French company based in Paris, France.
The demonstration will show how the robot interacts autonomously and the capacities of high level programming through Choregraphe software.

Nao stands tall in all points amongst its robotic brethren. Platform agnostic, it can be programmed and controlled using Linux, Windows or Mac OS. The hardware has been built from the ground up with the latest technologies providing great fluidity in its movements and offering a wide range of sensors. Nao contains an open framework which allows distributed software modules to interact together seamlessly. Depending on the user's expertise, Nao can be controlled via Choregraphe®, our user friendly behaviour editor, by programming C++ modules, or by interacting with a rich API from scripting languages.

In addition to the high level API, advanced users can take advantage of low level access to sensors and actuators and can, if they wish, replace our code with custom adaptations. In order to allow users to validate motion sequences, simulators are available for Microsoft Robotics Studio and Webots.

ALDEBARAN ROBOTICS was founded in 2005 in Paris to develop and market humanoid home robot companions.

Since May 2008, Aldebaran is shipping its first generation robot. Nao is a 58cm tall friendly robot that includes a computer and networking capability at its core. Delivered with a full set of development tools, NAO addresses the needs of universities including RoboCup players and research labs around the world. It's an evolving platform, which is unique in its ability to handle multiple applications. Today Aldebaran's regroups more than 80 people including +35 first class engineers and PhDs involved in R&D and production.



Choregraphe

Contact us at
academics@aldebaran-robotics.com

ALDEBARAN Robotics

Conference Activities

Registration

Registration desks are located at the Foyer of the Riverfront Ballroom on level 2 of Grand Copthorne Waterfront Hotel. The registration is opened on:

27 June 2010	17:30 to 20:30
28 June 2010	08:00 to 16:00
29 June 2010	08:00 to 14:00

Welcome Reception

Veranda room (Second Floor)

We would like to welcome you to our conference on Sunday, June 27th from 06:00 PM for a welcome reception at the Veranda room, which is located on the second floor of the hotel.

Dress code is smart casual.

Conference Banquet Dinner at Grand Shanghai

Grand Shanghai Restaurant
King's Centre #01-01, 390 Havelock Road Singapore 169662
Tel: 6836 6866

Note: for the Banquet Dinner, a coupon will be distributed to all attendees with a full registration (author)

We would like to invite you to conference banquet dinner on Tuesday, June 29th at 19:00 (07.00 pm). Grand Shanghai Restaurant is located just outside the Grand Copthorne Waterfront Hotel. Dinner banquet required. Dress code is smart casual. Relive the nostalgia of Shanghai in the 1940s in cosmopolitan Singapore. At Grand Shanghai, Grand Copthorne Waterfront Hotel's hottest unique dining concept, gourmets can enjoy the varied yet authentic cuisine of this wondrous city. Come for the good food and be enchanted by the musicians.

Social Tour

The organizers have arranged for a city tour on the 30th June 2010. This is the City Experience Tour. The **City Experience Tour** showcases the contrast between old and new and the blend of East and West. Experience the history, culture and the lifestyle of multi-racial Singapore, the exciting heart of New Asia-Singapore. We will visit the Colonial district for a view of Padang, The Esplanade — Theatres on the Bay and The Merlion — a mythical beast, Singapore's original half lion, half fish. Next stop, a visit to Little India, Chinatown and Gem Factory, admire the best of Asian craftsmanship. Last stop, visit the 52 hectares of primarily jungle and gardens, the famed Botanic Gardens.

(a) Tour departs from Grand Copthorne Waterfront Hotel.

(b) Tour departs at 09.30 am sharp on the 30th June 2010.

(c) The tour duration is 3.5 hours.

(d) The tour does not include lunch.

(e) The tour will end at Grand Copthorne Waterfront Hotel.

Note: The social tour is only for full fee paying delegates who have pre-registered for the tour itself.

Plenary Session

Plenary Speech 1

Date/Time: Monday, 28 June, 2010 / 9:00 – 10:00
Session Chair: Wang Han
Venue/Room: Waterfront Ballroom I

Lower Extremity Exoskeleton Systems for Medical Applications

Prof. H. Kazerooni
Department of Mechanical Engineering
University of California, Berkeley, California 94720
CTO, Berkeley Bionics
E-mail: kazerooni@berkeley.edu

Biography

Dr. Kazerooni holds a Doctorate in Mechanical Engineering from MIT and is currently a Professor in the Mechanical Engineering Department at the University of California, Berkeley. Dr. Kazerooni is the director of the Berkeley Robotics and Human Engineering Laboratory. He has published over 180 articles on Robotics, Control Sciences, Artificial Locomotion, Assist Devices and Mechatronics. He is the holder of twenty pertinent patents where most of them have been licensed. Dr. Kazerooni has served in a variety of leadership roles in the robotics community; served as associated editor of two journals: ASME Journal of Dynamics Systems and Control and IEEE Transaction on Mechatronics. Dr. Kazerooni was the recipient of the outstanding ASME Investigator Award, Discover Magazine Technological Innovation Award, and the McKnight-Land Grant Professorship. His research was recognized as the most innovative technology of the year in New York Times Magazine; December 2004. Dr. Kazerooni is also the founder and CTO of Berkeley Bionics which designs and manufactures lower extremity exoskeletons to augment human strength and endurance during locomotion.

Abstract

Berkeley Robotics and Human Engineering Laboratory at UC, Berkeley is the birthplace of the exoskeleton systems being adopted by Lockheed Martin. During the last 20 years, this laboratory has been devoted to uncovering all basic issues associated with the control, design and power of exoskeleton systems. The adoption of exoskeletons by Lockheed Martin for DOD applications is just a beginning of a much larger bionics field especially in the medical field. Patients who have difficulty walking often use wheelchairs for mobility.

It is a common and well-respected opinion in the field that postponing the use of wheelchairs retards the onset of other types of secondary disabilities and diseases. The ramifications of long-term wheelchair use are secondary injuries including: hip, knee, and ankle contractures; heterotopic ossification of lower extremity joints; frequent urinary tract infection; spasticity; and reduced heart and circulatory function.

The objective of our research is to develop smart, powered exoskeleton orthotic systems to be used for individuals with otherwise limited mobility. These exoskeletons are powered and allow their wearers to walk upright without the energetic drain associated with existing orthotic devices. These smart exoskeletons will replace wheelchairs and enable many individuals who cannot walk due to neurological disorders, muscular disorders or aging to walk again.

Plenary Speech 2

Date/Time: Tuesday, 29 June, 2010 / 9:00 – 10:00
Session Chair: Lin Hai
Venue/Room: Waterfront Ballroom I

Cybercars: The New Market for Robotics?

Prof. Michel Parent
INRIA, Domaine de Voluceau, B.P. 105,
78153 Le Chesnay, France
E-mail: michel.parent@inria.fr

Biography

Michel Parent is currently the program manager at INRIA of the R&D team on advanced road transport (IMARA research group). This group focuses on research and development of information and communication technologies for road transport and in particular on fully automated vehicles (the cybercars).

Before his current position which he holds since 1991, Michel Parent has spent half of his time in research and academia at such places as Stanford University and MIT in the USA and INRIA in France, and the other half in the robotics industry. He is the author of several books on robotics, vision and intelligent vehicles, and numerous publications and patents. He was the coordinator of the European Project CyberCars between 2001 and 2004 and the follow-up project CyberCars2 (2006–2009). He was involved in many other French European projects on ITS.

Michel Parent has an engineering degree from the French Aeronautics School (ENSAE), a Masters degree in Operation Research and a Ph.D. in Computer Science, both from Case Western Reserve University, USA.

Abstract

During the last decades, mobile robots have been a classic subject for robotics researchers, covering a large number of topics ranging from image processing, SLAM (Simultaneous Localisation and Mapping), all the way to control technologies and swarm techniques. However, these techniques did not see many applications in road transport until the Prometheus Project in Europe (1986–1994) and the AHS (Automated Hignway Systems) in Japan and in the USA and for a long time it was considered by many to be impossible to implement safety critical function in large production road vehicles.

However, some robotics techniques are now finally arriving in production vehicles with systems involving sensing, decision making and control of the vehicle. The first such systems concerned the "longitudinal control" of the vehicle with a radar (or lidar) sensing the distance (and sometime their lateral position) to the vehicles ahead and controlling the acceleration and braking of the "ego vehicle" to maintain a safe distance. Now vision systems can assist the driver to keep his or her vehicle on the lane ("lateral control"). So, how far are we from a fully autonomous vehicle? The DARPA challenges in 2004 and 2005 have shown us that automated vehicles are feasible in "simple" environments and in particular when we do not have to consider other moving vehicles. The following challenge from DARPA in 2008 (Urban Challenge) tried to address this problem with some promising results. However, we are still far from operating a fully autonomous vehicle in daily traffic, especially in urban environments where the scene complexity is very large. In order to operate

fully autonomous vehicles in a realistic way, we therefore have to take the same approach as in the manufacturing industry when the first robots were introduced: simplify the environment.

This is the approach which is being taken now with the cybercars. These vehicles are designed for a fully automated urban transport of passengers or goods and they operate on a road network for on-demand, door to door transport. At the moment, these roads are more or less protected from intrusions by people or other types of vehicles. The cybercars that have been designed and tested in the early 2000's are now being put in operation in various cities throughout Europe (www.citymobil-project.org). Although their environment has been somewhat simplified, they must use advanced robotics technologies to avoid obstacles and plan their trajectories even when they have to cross the path of other similar vehicles (with which they communicate). One of the challenging problems is the definition of common rules so that interoperability of different vehicles on a same infrastructure is guaranteed.

Technical Program

Monday, 28 June 2010

Session:	**Plenary**
Date:	Monday, 28 June 2010
Time:	09:00 – 10:00
Chair(s):	***Wang Han***
Venue:	Waterfront Ballroom I

Plenary Speech 1

Lower Extremity Exoskeleton Systems for Medical Applications
H. Kazerooni, University of California, USA

Session:	**MA1 — Systems Biology & Biomedical Engineering**
Date:	Monday, 28 June 2010
Time:	10:30 – 12:30
Chair(s):	***Jianxin Xu and Xianming Qing***
Venue:	Room 1

Session:	***MA2 — Artificial Intelligence & Computational Optimization***
Date:	Monday, 28 June 2010
Time:	10:30 – 12:30
Chair(s):	***Chu Kiong Loo and Tong Yuen Chai***
Venue:	Room 2

Session:	**MA3 — Wearable Sensors and Haptic Devices for Healthcare and Biomechanics Applications**
Date:	Monday, 28 June 2010
Time:	10:30 – 12:30
Chair(s):	***I-Ming Cheng, Zhiqiang Luo and Chee Kian Lim***
Venue:	Room 3

Session:	**MA4 — Design & Performance Evaluation**
Date:	Monday, 28 June 2010
Time:	10:30 – 12:30
Chair(s):	***Kyung-Soo Kim and Wang Liping***
Venue:	Room 4

Session:	**MB1 — Computer Vision**
Date:	Monday, 28 June 2010
Time:	13:30 – 15:30
Chair(s):	***Marco Paleari and Biao Wang***
Venue:	Room 1

Session:	**MB2 — Computational Intelligence**
Date:	Monday, 28 June 2010
Time:	13:30 – 15:30
Chair(s):	***Luis Paulo Reis and Wee Chiat Alan Tan***
Venue:	Room 2

Session:	**MB3 — Medical Robots and Systems**
Date:	Monday, 28 June 2010
Time:	13:30 – 15:30
Chair(s):	***Louis Phee and Yi Xiang***
Venue:	Room 3

Joshua Chong Yue Lai and Louis Soo Jay Phee

Paper ID: RAM-013 **Pg. 25**

Optimal Design and Control of a Hand Exoskeleton

M. F. Orlando, H. Akolkar, A. Dutta, A. Saxena and L. Behera

Paper ID: RAM-081 **Pg. 25**

Design of a Robotic Transcranial Magnetic Stimulation System

Xiang Yi and Robert Bicker

Paper ID: RAM-155 **Pg. 26**

Model-based Design Analysis for Programmable Remote Center of Motion in Minimally Invasive Surgery

L. Yang, C. B. Chng, C. K. Chui and D. P. C. Lau

Paper ID: RAM-090 **Pg. 26**

ReachMAN to Help Sub-acute Patients Training Reaching and Manipulation

Che Fai Yeong, Karen Baker, Alejandro Melendez-Calderon, Etienne Burdet and E. Diane Playford

Paper ID: RAM-222 **Pg. 26**

Low Power Ultra-wideband Wireless Telemetry System for Capsule Endoscopy Application

Yuan Gao, Shengxi Diao, Chyuen-Wei Ang, Yuanjin Zheng and Xiaojun Yuan

Paper ID: RAM-220 **Pg. 27**

A Systematic Graph-based Method for the Kinematic Synthesis of Non-anthropomorphic Wearable Robots

Fabrizio Sergi, Dino Accoto, Nevio Luigi Tagliamonte, Giorgio Carpino, Lakshmi Pathiyil and Eugenio Guglielmelli

Session: ***MB4 — Dynamics and Motion Control***
Date: Monday, 28 June 2010
Time: 13:30 – 15:30
Chair(s): ***Pauline Hamon and Boyang Hu***
Venue: Room 4

Paper ID: RAM-131 **Pg. 27**

Sensorless Drive of Permanent Magnet Brushless DC Motor with 180 Degree Commutation

Boyang Hu and Swamidoss Sathiakumar

Paper ID: RAM-138 **Pg. 27**

On the Dynamics of the Flexible Robot Arm in a Real Deployment Profile

P. Bagheri Ghaleh and S. M. Malaek

Paper ID: RAM-172 **Pg. 28**

ZPETC Path-Tracking Gain-Scheduling Design and Real-Time Multi-Task Flight Simulation for the Automatic Transition of Tilt-Rotor Aircraft

Chih-Cheng Peng, Thong-Shing Hwang, Shiaw-Wu Chen, Ching-Yi Chang, Yi-Ciao Lin, Yao-Ting Wu, Yi-Jing Lin and Wei-Ren Lai

Paper ID: RAM-174 **Pg. 28**

A Technical Approach to H2 and H∞ Control of a Flexible Transmission System

Mahdi Sojoodi and Vahid Johari Majd

Paper ID: RAM-185 **Pg. 28**

Dynamic Identification of Robot with a Load- Dependent Joint Friction Model

P. Hamon, M. Gautier, P. Garrec and A. Janot

Paper ID: RAM-204 **Pg. 29**

Trajectory Analyses for Five-axis Machine Tools

Rong-Shine Lin and Tsong-Han Lin

Session:	**MC1 — Image Processing**
Date:	Monday, 28 June 2010
Time:	16:00 – 18:00
Chair(s):	***Chin-Wei Bong and Raymond Jarvis***
Venue:	Room 1

Paper ID: CIS-107 **Pg. 11**

Horizon Detection from Pseudo Spectra Images of Water Scenes

Rahul Walia and Raymond A Jarvis

Paper ID: CIS-015 **Pg. 11**

Digital Image Edge Detection using an Ant Colony Optimization based on Genetic Algorithm

Javad Rahebi, Zahra Elmi, Ali Farzam Nia and Kamran Shayan

Paper ID: CIS-091 **Pg. 11**

Multi-objective Nature-inspired Clustering Techniques for Image Segmentation

Bong Chin Wei and Rajeswari Mandava

Session: ***MC2 — Intelligent Control***
Date: Monday, 28 June 2010
Time: 16:00 – 18:00
Chair(s): ***Insu Song and M. Shawkat Ali***
Venue: Room 2

Session: **MC3 — Wheeled Mobile Robots**
Date: Monday, 28 June 2010
Time: 16:00 – 18:00
Chair(s): ***Luis Paulo Reis and Ming Yang***
Venue: Room 3

Paper ID: RAM-030 **Pg. 31**

Shared Control for Obstacle Avoidance in Intelligent Wheelchairs

Marcelo R. Petry, Antonio Paulo Moreira, Rodrigo A. M. Braga and Luis Paulo Reis

Session:	***MC4 — Sensors and Mixed Topics***
Date:	Monday, 28 June 2010
Time:	16:00 – 18:00
Chair(s):	***Chu Kiong Loo and Y. S. Wong***
Venue:	Room 4

Paper ID: RAM-083 **Pg. 31**

Implementation of Asymmetric Multi Processing Framework in Humanoid Robot

Wei Kin Wong, Tze Ming Neoh, Chu Kiong Loo, Ying Wei Liew and Eng Kean Lee

Paper ID: RAM-208 **Pg. 32**

Design and Simulation of Flexure-based Planar Force/Torque Sensor

Pham Huy Hoang and Vo Doan Tat Thang

Paper ID: RAM-249 **Pg. 32**

Time of Flight Based Two Way Ranging for Real Time Locating Systems

Danwei Wang, Ramprashanth Kannan, Liu Wei and Bertrand Tay

Paper ID: RAM-214 **Pg. 32**

Simultaneous Periodic Output Feedback Control of a Smart Cantilever Beam with Data Fusion

J. Arunshankar and M. Umapathy

Paper ID: RAM-109 **Pg. 32**

Self-aggregation in Multi-agent Shape Control

Reza Haghighi and Chien Chern Cheah

Paper ID: RAM-094 **Pg. 33**

HMM with Explicit State Duration for Prognostics in Face Milling

Wu Yue, G. S. Hong and Y. S. Wong

Paper ID: CIS-065 **Pg. 33**

Inferential Estimation of Biopolymer (Polyester) Quality using Bootstrap Re-sampling Neural Network Technique

Rabiatul 'Adawiah Mat Noor and Zainal Ahmad

***** DAY 1 END ******

Tuesday, 29 June 2010

Session:	**Plenary**
Date:	Tuesday, 29 June 2010
Time:	09:00 – 10:00
Chair(s):	***Lin Hai***
Venue:	Waterfront Ballroom I

Plenary Speech 2

Cybercars: the New Market for Robotics?
Michel Parent, INRIA, France

Session:	**TA1 — Networked Dynamical Systems**
Date:	Tuesday, 29 June 2010
Time:	10:30 – 12:30
Chair(s):	***Dwight Deugo and Panida Jirutitijaroen***
Venue:	Room 1

Session: **TA2 — Modeling, Planning and Control I**
Date: Tuesday, 29 June 2010
Time: 10:30 – 12:30
Chair(s): ***Yu-Sheng Lu and Jun Xu***
Venue: Room 2

Session:	**TA3 — Sensors and Mixed Advances in Social Humanoid Robotics**
Date:	Tuesday, 29 June 2010
Time:	10:30 – 12:30
Chair(s):	***Carlos Acosta and Zhou Changjiu***
Venue:	Room 3

Session:	**TA4 — Robotics and Automation Applications**
Date:	Tuesday, 29 June 2010
Time:	10:30 – 12:30
Chair(s):	***Ching Seong Tan and Hamid Abdi***
Venue:	Room 4

Session: **TB1 — Methodologies for Robotics and Automation**
Date: Tuesday, 29 June 2010
Time: 13:30 – 15:30
Chair(s): ***Alireza Partovi and Hai Lin***
Venue: Room 1

Session:	**TB2 — Modeling, Planning and Control II**
Date:	Tuesday, 29 June 2010
Time:	13:30 – 15:30
Chair(s):	***Brigida Monica Faria and Jian Xu***
Venue:	Room 2

Session: **TB3 — Computer and Robot Vision I**
Date: Tuesday, 29 June 2010
Time: 13:30 – 15:30
Chair(s): ***Evangelow Georgiou and Chingseong Tan***
Venue: Room 3

Session:	**TB4 — Underwater & Flying Robots**
Date:	Tuesday, 29 June 2010
Time:	13:30 – 15:30
Chair(s):	***Simon Watson and Albert Albers***
Venue:	Room 4

Session:	**TC1 — Intelligent Transportation**
Date:	Tuesday, 29 June 2010
Time:	16:00 – 18:00
Chair(s):	***Roland Wischenewski and Yong Chia Tan***
Venue:	Room 1

Session:	**TC2 — Dynamics and Motion Control; Biologically-Inspired Robots and Systems**
Date:	Tuesday, 29 June 2010
Time:	16:00 – 18:00
Chair(s):	***Hamid Abdi and Zhao Liu***
Venue:	Room 2

Session:	**TC3 — Computer and Robot Vision II**
Date:	Tuesday, 29 June 2010
Time:	16:00 – 18:00
Chair(s):	***Ray Jarvis and Mehmet Guzel***
Venue:	Room 3

Session:	**TC4 — Legged Robots**
Date:	Tuesday, 29 June 2010
Time:	16:00 – 18:00
Chair(s):	***Thanhtam Ho and Alberus Adiwahono***
Venue:	Room 4

***** DAY 3 END ******

CIS 2010 Abstracts

Monday, 28 June 2010

Session: MA1
Systems Biology & Biomedical Engineering

Date: Monday, 28 June 2010
Time: 10:30 – 12:30
Chair(s): Jianxin Xu and Xianming Qing
Venue: Room 1

[CIS-019]

STUDY ON C. ELEGANS BEHAVIORS USING RECURRENT NEURAL NETWORK MODEL

Jian-Xin Xu[a], Xin Deng and Dongxu Ji

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With the complete knowledge on the anatomical nerve connections of the nematode Caenorhabditis elegans (C. elegans), the chemotaxis behaviors including food attraction and toxin avoidance, are modeled using dynamic neural networks (DNN). This paper first uses artificial DNN, with 7 neurons, to model chemotaxis behaviors with single sensor neurons. Real time recurrent learning (RTRL) is carried out to train the DNN weights. Next, this paper split the single sensor neuron into the left and right pair (dual-sensor neuron), with the assumption that C. elegans can distinguish the input difference between left and right, and then the model is applied to learn to reproduce the chemotaxis behaviors. The simulation results conclude that DNN can well model the behaviors of C. elegans from sensory inputs to motor outputs both in single sensor and dual-sensor neuron networks.

Keywords: C. elegans, Recurrent neural network, Chemotaxis.

[CIS-206]

ROBUST STABILITY ANALYSIS OF STOCHASTIC GENETIC REGULATORY NETWORKS WITH DISCRETE AND DISTRIBUTED DELAY IN BOTH MRNA AND PROTEIN DYNAMICS

Alireza Salimpour[a], Mahdi Sojoodi[b] and Vahid Johari Majd[c]

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This paper addresses robust stability of genetic regulatory networks (GRNs) with stochastic perturbation and discrete and distributed time-varying delays. Aside from discrete delays, there are few results about stability of GRNs with distributed delay. In this paper, noise perturbation and delays have been considered in both mRNA and protein dynamics. Based on Lyapunov functional approach and linear matrix inequality (LMI) techniques, sufficient conditions are established to guarantee the robust stability of genetic regulatory networks. Stability conditions are derived in the form of LMIs, which are very easy to be verified. An example is presented to verify the theoretical results.

Keywords: Genetic regulatory networks, Stochastic stability, Uncertainty, LMI, Systems biology.

[CIS-100]

REACHABILITY ANALYSIS BASED MODEL VALIDATION IN SYSTEMS BIOLOGY

Yang Yang[a] and Hai Lin[b]

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Systems biology is an emerging multi-disciplinary area, which aims to understand the underneath regulatory mechanisms of the biomolecular interaction networks inside the cell through dynamical system approaches. The first challenge in systems biology is how to obtain an accurate and predictable computational model for the biomolecular networks under study. However, due to limited experimental data, it

is unavoidable to have incomplete or even wrong models. Therefore, it is a critical task in systems biology to check the model's correctness, which is called model validation problem. This paper will focus on this issue, and propose a (un-)reachability analysis based model validation method. In particular, Petri net models are investigated, and the validation process is evaluated by the reachability of state equations. It is shown that the reachability can be checked by the existence of integer solutions of Diophantine equations. Two methods are proposed to solve the equations. The first one is by Smith normal form test, and the other is by integer programming. Two case studies are provided to demonstrate these two approaches. These tests can screen out the unreachable states and offer the hints to modify the model structure, which provides us more insights of the regulatory mechanism and helps biologists to generate hypotheses and design experiments.

Keywords: Systems biology, Petri nets, Reachability analysis.

[CIS-223]

RF TRANSMISSION CHARACTERISTICS IN/THROUGH THE HUMAN BODY

Xianming Qing[a], Zhi Ning Chen[b], Terrence Shie Ping See[c], Chean Khan Goh[d] and Tat Meng Chiam[e]

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In this paper, the RF transmission characteristics in/through human body are investigated experimentally and numerically. An experimental methodology to characterize the RF transmission of human body is presented. The proposed method addresses the challenge to characterize the RF transmission accurately and reliably without the body tissue effect on the antennas under test. The proposed methodology of using tissue-embedded antennas is validated at 403 MHz band (Medical Implant Communication Service, MICS).

Keywords: RF transmission, MICS, Biomedical applications.

[CIS-014]

A CONTINUOUS-TIME VACCINATION RULE FOR THE SEIR EPIDEMIC MODEL

M. De la Sen[a] and S. Alonso-Quesada[b]

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This paper presents a simple continuous-time linear vaccination-based control strategy for a SEIR (susceptible plus infected plus infectious plus removed populations) propagation disease model. The model takes into account the total population amounts as a refrain for the illness transmission since its increase makes more difficult contacts among susceptible and infected. The control objective is the asymptotically tracking of the removed-by-immunity population to the total population while achieving simultaneously that the remaining populations tend asymptotically to zero.

Keywords: Epidemic models, Control, SEIR-epidemic models, Stability.

[RAM-238]

IDENTIFICATION AND CONTROL OF QUANTUM SYSTEMS

Zhengui Xue[1,a], Hai Lin[2,b] and Tong Heng Lee[1,2,c]

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This paper aims at finding the real-valued dynamics that is equivalent to the Schrödinger equation and then implementing quantum control by making use of the well developed classical control theory. Firstly, pure state identification approaches are presented for two-level, three-level and n-level systems, respectively. Secondly, based on the discussions on the pure state identification, real-valued dynamics that are equivalent to the Schródinger equations are deduced for both two-level and three-level systems. Finally, a control strategy based on Lyapunov approach is proposed by making use of the obtained real-valued dynamics. Different from the existing Lyapunov control based on the Schródinger equation, the proposed control strategy can achieve state convergence to its goal state without any constraints on the internal Hamiltonian. Simulation results are included to demonstrate the effectiveness of the approach.

Keywords: Pure state identification, Quantum control, Lyapunov control.

Session: MA2
Artificial Intelligence & Computational Optimization

Date: Monday, 28 June 2010
Time: 10:30 – 12:30
Chair(s): Chu Kiong Loo and Tong Yuen Chai
Venue: Room 2

[CIS-044]

DESIGN SPACE EXPLORATION OF A 2-D DWT SYSTEM ARCHITECTURE

Ishmael Sameen[1,a], Yoong Choon Chang[1,b], Ng Mow Song[2,c], Bok-Min Goi[2,d] and Chee Siong Lee[3]

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[3] *Penang Design Center, Intel Microelectronics Sdn. Bhd, Penang, Malaysia. E-mail: chee.siong.lee@intel.com*

This paper proposes a programmable 2-D DWT system architecture designed for the JPEG-2000 standard. The proposed system architecture, derived from an iterative design space exploration process using Altera's C2H compiler, provides a significant performance acceleration of 2-D DWT when compared to an optimized 2-D DWT software implementation and is capable of real-time video processing performance up to 720p (1280×720) image resolutions when synthesized and tested on an Altera DE3 Stratix III FPGA board.

Keywords: Discrete wavelet transform (DWT), Field-programmable gate array (FPGA), Design space exploration.

[CIS-050]

EDGE SHARPENING FOR DIABETIC RETINOPATHY DETECTION

Haniza Yazid[a], Hamzah Arof and Norrima Mokhtar

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People with diabetes may face eye problem as a complication of diabetes. These eye problems can cause vision loss and even blindness. There are several lesions that appear such microaneurysms, hemorrhages, cotton wool spots and exudates. Exudates tend to form ring, around area of diseased vessel and appeared as yellowish-white deposits with well-defined edges meanwhile cotton wool spots are grayish-white with poorly defined fluffy edges. Exudates can be highlighted from the background easier rather than cotton wool spots since it has well defined edge. In order to detect these lesions, a proper technique is needed to segment the cotton wool spots and exudates from the background. Therefore, this paper is proposed to sharpen the edge to simplify the segmentation process for cotton wool spots and exudates through ramp width reduction.

Keywords: Edge sharpening, Exudates detection, Diabetic retinopathy.

[CIS-048]

LOGABOUT MAPPING OF SELF QUOTIENT IMAGE

Mohd Amir Fawwaz Mat Jusoh[1,a], Mohammad Shazri Shahrir[1,b], Fazly Mohd Yusop[1,c] and Chai Tong Yuen[2]

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[2] *Department of Mechatronic & Biomedical Engineering, Universiti Tunku Abdul Rahman (UTAR), Kuala Lumpur, Malaysia. E-mail: chaity@utar.edu.my*

An illumination normalization technique for face recognition by the fusion of Self Quotient Image (SQI) and LogAbout has been proposed. The proposed method is evaluated by using internal face database and Yale face database. The proposed method had shown promising result from the Equal Error Rate (EER) point of view. Our method reported nearly 10% of improvements on average compared to SQI and LogAbout.

Keywords: Face recognition, Illumination normalization, Self quotient image, Log about.

[CIS-053]

WAVELET PCA/LDA NEURAL NETWORK EYE DETECTION

Mohammad Shazri[1,a], Najib Ramlee[1,b] and Chai Tong Yuen[2]

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[2] *Department of Mechatronic & Biomedical Engineering, Universiti Tunku Abdul Rahman (UTAR), Kuala Lumpur, Malaysia. E-mail: chaity@utar.edu.my*

Eye detection is an important step for face recognition and verification because it provides a reference point to normalize not only location but also the

flat 2d orientation of face relative to the image border. The base technique that is referred to shows how Wavelet Transformation works hand in hand with Neural Networks. In this paper a proposition of a system that regiment the wavelet coefficient is introduced, as such it includes a reduction methods, namely Principle Component Analysis (PCA) and Linear Discriminant Analysis (LDA) on top of the Wavelet Transform as a feature extraction technique and Neural Network as an eye-detector classifier. Experimental results showed an increased performance (Internal 10%, ORL 9.2% and Yale 7.5%) across three datasets by using the proposed method (PCA) and 7% overall increase of performance when changing from PCA to LDA Eigen Vectors.

Keywords: Eye detection, Wavelet transform, Neural network, Principle component analysis, Linear discriminant analysis.

[CIS-063]

SWIPING WITH LUMINOPHONICS

Shern Shiou Tan[1], Tomas Henrique Bode Maul[1], Neil Russel Mennie[2] and Peter Mitchell[2]

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[2]*School of Psychology, The University of Nottingham, Malaysi Campus, Jala Broga, 43500 Semenyih, Selangor Darul Ehsan, Malaysia*

Luminophonics is a system that aims to maximize cross-modality conversion of information, specifically from the visual to auditory modalities, with the motivation to develop a better assistive technology for the visually impaired by using image sonification techniques. The project aims to research and develop generic and highly-configurable components concerned with different image processing techniques, attention mechanisms, orchestration approaches and psychological constraints. The swiping method that is introduced in this paper combines several techniques in order to explicitly convert the colour, size and position of objects. Preliminary tests suggest that the approach is valid and deserves further investigation.

Keywords: Image processing, Computer vision, Auditory display, Image sonification.

[CIS-082]

PARAMETER CONTROLLED CHAOTIC SYNERGETIC NEURAL NETWORK FOR FACE RECOGNITION

Wee Ming Wong[a], Chu Kiong Loo and Alan WC Tan

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Neural network plays a major role in the field of pattern recognition. For pattern recognition, a major drawback with traditional neural networks is that neural networks may easily be trapped in spurious states. Synergetic neural network (SNN) has been proposed in the literature to overcome this problem, however, when applying synergetic neural network on face recognition, the results are not satisfactory for large image databases due to low memory capacity. Therefore, the chaotic dynamic property is introduced to the conventional synergetic neural network in order to resolve the problem. In this paper, an additional control parameter is introduced to the chaotic synergetic neural network (CSNN) in order to terminate the recognition process whenever an image is recognized. This helps to alleviate processing memory demand which often accompanies such networks. Various imagery defects are tested and the accuracy of both methods is evaluated based on incremental sample size.

Keywords: Chaotic neural network, Synergetic neural network, Face recognition, Auto-correlation associative model.

Session: MB1
Computer Vision

Date: Monday, 28 June 2010
Time: 13:30 – 15:30
Chair(s): Marco Paleari and Biao Wang
Venue: Room 1

[CIS-251]

VISION AIDED MOTION ESTIMATION FOR UNMANNED HELICOPTERS IN GPS DENIED ENVIRONMENTS

Feng Lin[a], Ben M. Chen[b] and Tong H. Lee[c]

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Determining the motion of an unmanned aerial vehicle in GPS-denied environments is a challenging work. In this paper, we present a systematic design and implementation of a vision aided motion

estimation approach for an unmanned helicopter in such a condition. A hierarchical vision scheme is proposed to detect a structured landmark, and find the correspondence between the 3D reference points and the projected 2D image points. Based on the obtained correspondence, a motion estimation scheme is presented to compute the relative position and velocity of the vehicle with respect to the local reference. The robust and accurate estimates are achieved by using the Kalman filter fusing the vision information with outputs of the inertial measurement unit (IMU). The robustness and efficiency of the proposed motion estimation approach is verified by using the data collected in ground and flight tests.

Keywords: Motion estimation, Unmanned aerial vehicle, Computer vision, GPS-denied, Kalman filtering.

[CIS-250]

CASCADED CONTROL OF 3D PATH FOLLOWING FOR AN UNMANNED HELICOPTER

Biao Wang[a], Xiangxu Dong[b] and Ben M. Chen[c]

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The objective of the paper is to design the control system of following a predefined 3D path while maintaining a specified flight speed and considering the timing constraint. This can be accomplished by a cascaded solution framework based on theoretical dynamic error modeling. The controller for each loop can thus be designed separately so that the design problem is simplified and the control system can be implemented easily in pratice. A promising performance has be demonstrated by an accurate nonlinear simulation at current stage.

Keywords: Unmanned helicopters, Path following, LQR, Feedback linearization.

[CIS-136]

MULTI-LEVEL LOCAL FEATURE CLASSIFICATION FOR BLEEDING DETECTION IN WIRELESS CAPSULE ENDOSCOPY IMAGES

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This paper presents a novel multi-level approach for bleeding detection in Wireless Capsule Endoscopy (WCE) images. In the low-level processing, each cell of $K \times K$ pixels is characterized by an adaptive color histogram which optimizes the information representation for WCE images. A Neural Network (*NN*) cell-classifier is trained to classify cells in an image as bleeding or non-bleeding patches. In the intermediate-level processing, a block which covers 3×3 cells is formed. The intermediate-level representation of the block is generated from the low-level classifications of the cells, which captures the spatial local correlations of the cell classifications. Again, a *NN* blockclassifier is trained to classify the blocks as bleeding or nonbleeding ones. In the high-level processing, the low-level cellbased and intermediate-level block-based classifications are fused for final detection. In this way, our approach can combine the low-level features from pixels and intermediate-level features from local regions to achieve robust bleeding detection. Experiments on real WCE videos have shown that the proposed method of multi-level classification is not only accurate in both detection and localization of potential bleedings in WCE images but also robust to complex local noisy features.

Keywords: Wireless capsule endoscopy (WCE), Bleeding detection, Feature extraction, Adaptive color histogram, Block classification, Neural network (NN) and Machine-learning.

[CIS-164]

3D SHAPE RECOVERY BY SUPERQUADRICS MODEL USING OBJECT SILHOUETTES AND STEREO DISPARITY

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This paper describes a 3D shape reconstruction method using vision sensors targeted at domestic robotics applications. We propose a new method to fuse stereo disparity map and Shape from "Silhouette" (SFS). What we mean by silhouette in this paper is different from the existing silhouette definition. The silhouette here is not obtained from back projecting the object contour to the image plane but rather foreground/background stereo segmentation. Therefore, we impose the restraint that objects must be placed on a richly textured background. Furthermore, we use only three views to obtain the SFS. Preliminary results on domestic objects suggests that our method can distinguish objects such as cylinder, box and ball shapes.

Keywords: Silhouette, Stereo, Superquadrics, 3D reconstruction, Shape, Robotics.

[CIS-158]

FEATURES FOR MULTIMODAL EMOTION RECOGNITION: AN EXTENSIVE STUDY

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The ability to recognize emotions in natural human communications is known to be very important for mankind. In recent years, a considerable number of researchers have investigated techniques allowing computer to replicate this capability by analyzing both prosodic (voice) and facial expressions. The applications of the resulting systems are manifold and range from gaming to indexing and retrieval, through chat and health care. No study has, to the best of our knowledge, ever reported results comparing the effectiveness of several features for automatic emotion recognition. In this work, we present an extensive study conducted on feature selection for automatic, audio-visual, real-time, and person independent emotion recognition. More than 300,000 different neural networks have been trained in order to compare the performances of 64 features and 11 different sets of features with 450 different analysis settings. Results show that: (1) to build an optimal emotion recognition system, different emotions should be classified via different features and (2) different features, in general, require different processing.

Keywords: Emotion recognition, Facial expressions, Vocal expressions, Prosody, Affective computing.

[CIS-149]

FACE FEATURE TRACKING WITH AUTOMATIC INITIALIZATION AND FAILURE RECOVERY

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Face feature tracking is a well known and quite challenging area in computer vision. This paper mainly focuses on two important aspects of feature tracking, viz., automatic initialization and automatic detection of tracking failure followed by system update. We present a dynamic framework to automatically initialize and update the face feature tracking process. In addition, a novel approach to self-occlusion handling is also presented. The system consists of — initialization, feature tracking and system update modules. A reliable and efficient technique, that can quickly initialize a face feature tracking system in subject independent manner, has been presented. The initialization module relies on a scale independent accurate feature positioning algorithm based on binarized motion differencing approach. Face feature tracking module is based on the multi-resolution motion tracking algorithm. The system also enables automatic tracking failure detection and re-initialization, with practically minimal subject intervention. In the end, a new technique, to handle the problem of features occlusion, has been proposed. The combined model not only makes the tracking system more efficient and quicker but also helps it to act in a self supervised manner.

Keywords: Feature tracking, Eye detection, Occlusion handling.

Session: MB2
Computational Intelligence

Date: Monday, 28 June 2010
Time: 13:30 – 15:30
Chair(s): Luis Paulo Reis and Wee Chiat Alan Tan
Venue: Room 2

[CIS-005]

ELECTRIC LOAD FORECASTING BY SVR WITH CHAOTIC ANT SWARM OPTIMIZATION

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Support vector regression (SVR) has revealed the strong potential in accurate electric load forecasting, particularly by employing effective evolutionary algorithms to determine suitable values of its three parameters. Based on previous research results, these employed evolutionary algorithms themselves also have drawbacks, such as premature convergence, slowly reaching the global optimal solution, and trapping into a local optimum in parameters determination of a SVR model. This paper presents a short-term electric load forecasting model which applies a novel algorithm, namely chaotic ant swarm optimization (CAS), to improve the forecasting performance by searching suitable parameters combination in a SVR forecasting model. The proposed CAS combines with the chaotic behavior of single ant and self-organization behavior of ant colony in the foraging process to overcome premature local optimum. The empirical results indicate that the SVR model with CAS (SVRCAS) results in better forecasting performance than the other methods, namely SVRCPSO (SVR with chaotic PSO), SVRCGA (SVR with chaotic GA), regression model, and ANN model.

Keywords: Support vector regression (SVR), Chaotic ant swarm optimization (CAS), Electric load forecasting.

[CIS-110]

PARTICLE SWARM OPTIMIZATION IDENTIFICATION OF IPMC ACTUATOR USING FUZZY NARX MODEL

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In this paper, a novel inverse fuzzy NARX model is used for modeling and identifying the IPMC-based actuator's inverse dynamic model. The highly nonlinear features of the IPMC-based actuator are thoroughly modeled based on the inverse fuzzy NARX model-based identification process using experimental input-output training data. This paper proposes the novel use of a modified particle swarm optimization (MPSO) to generate the inverse fuzzy NARX (IFN) model for a highly nonlinear IPMC actuator system. The results show that the novel inverse fuzzy NARX model optimized by MPSO yields outstanding performance and perfect accuracy.

Keywords: Ionic polymer metal composite (IPMC), IPMC-based actuator, Modified particle swarm optimization (MPSO), Fuzzy NARX model, Inverse dynamic identification.

[CIS-229]

MANAGING SEARCH IN A PARTITIONED SEARCH SPACE IN GA

Farhad Nadi[a] and Ahamad Tajudin Khader[b]

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Converging to suboptimal solutions in genetic algorithms prevents the search from reaching the global optima. Search space could have several suboptimal but one optimal solution. As the suboptimal solutions are within the search space, dividing the search space would bound them in different divisions. Thus, searching in each division separately would increase the probability of reaching the global optima. In other words, the optimal solution would be bounded in one of the divisions and then searching that division would result in finding the optimal solution. Although, the suboptimal solutions could be in the same division as optimal solution but the chance of finding the optimal solution in this case would be more compared to the cases that have no division. The proposed methodology divide the search space into partitions called regions. Individuals will be assigned to each region. The search continues while each set of individuals are focused in searching a region. Preliminary results shows a fair improvement in the performance and efficiency compared to genetic algorithm.

Keywords: Genetic algorithm, Search space, Partitioning, Tabu list, Diversity.

[CIS-045]

SEMI-SUPERVISED CLASSIFICATION FOR INTRUSION DETECTION SYSTEM IN NETWORKS

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We propose a semi supervised classifier for intrusion detection. In our approach, we classify the data entering the computer network. To achieve this, we start with two broad classes of data namely, malicious data and good data. We use Support vector machine based classifier with spherical decision boundaries to classify a chosen subset of malicious data taken as training samples. In the Intrusion Detection System (IDS) database, all data identified as malicious data according to our classifier is included as signature (of attack). Using our classifier for testing the out-of-sample data samples, we observe that the accuracy of the system is 72% for web log data.

Keywords: Kernel method, Lagrange multipliers, Quadratic programming, Semi-supervised classification, IDS.

[CIS-089]

FOOTBALL SCIENTIA — AN AUTOMATED TOOL FOR PROFESSIONAL SOCCER COACHES

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A soccer game can be seen as a confrontation between two teams of agents where each player, communicating with his teammates, try to interpret in the best way as possible the game situations, achieving its main goals. Today the most important factors in a soccer clubs life and in its coach success are the game results they achieve. They represent the success of the club and in many cases the coachs future. Because of that club coaches usually use automated tools to measure their teams performance all over a soccer competition. Based only in Cartesian coordinates and in a sequential time frame analysis, this research work presents an automatic tool capable to calculate many technical aspects in a soccer match. For the validation tool process, games of simulation 2d RoboCup international competition were used. The results achieved were quite satisfactory. In what concerns to the set of statistics collected more than 92% of the total events were detected and only for the shot event this number dropped to between 74% and 85%. The future work will be concerned in incorporating this project with a real time tracking system and increasing the number of technical aspects calculated by the system.

Keywords: Robotics, Robotic soccer, Soccer heuristics, Game events detection.

[CIS-135]

INTELLIGENT SYSTEMS AND POLYNOMIAL SOLVABILITY OF NP-COMPLETE PROBLEMS

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Many fundamental problems in automated theorem proving are known to be NP-Complete. In [4], we have given a polynomial algorithm for 3-SAT, one of the first NP-Complete problems. The result is unexpected and has deep consequences for the design of intelligent systems; hence, in this paper, we review our algorithmic approach for 3-SAT, and we give simplified analysis of our approach to demonstrate the polynomial bound of $O(n^{13})$ operations. We also indicate the immediate and important consequences of our polynomial algorithm for 3-SAT for the design of intelligent systems.

Keywords: Theorem proving, Algorithms-analysis of algorithms, Theory of computation-complexity measures.

Session: MC1
Image Processing

Date: Monday, 28 June 2010
Time: 16:00 – 18:00
Chair(s): Chin-Wei Bong and Raymond Jarvis
Venue: Room 1

[CIS-107]

HORIZON DETECTION FROM PSEUDO SPECTRA IMAGES OF WATER SCENES

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Horizon detection is a pre-cursor to vision processing in air and water robotics. This paper makes three contributions to horizon detection. First, a theoretical framework for generating pseudo spectra images (PSI), from spectrum analysis of XYZ colorspace is presented. Second, wavelengths in the visible spectrum are identified, at which the PSI has similar intensities for sky and clouds. Generating PSI at these wavelengths minimizes artifacts due to clouds in the sky, resulting in well defined horizon. Third, fitting ellipses are presented as an alternate to Hough Transform for horizon detection. Ellipses have lower computational complexity than Hough Transform and can accommodate curved edges as candidates for horizon.

Keywords: Horizon detection, Spectrum analysis, Otsu's threshold, Ellipses.

[CIS-015]

DIGITAL IMAGE EDGE DETECTION USING AN ANT COLONY OPTIMIZATION BASED ON GENETIC ALGORITHM

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In this paper a new method for enhancement of digital image edge detection using ant colony optimization based on genetic algorithm has been used. In the proposed method first by the series of answers has been formed by artificial ants and then formed in a manner i.e. useful for genetic algorithm, then the answers played the role as initial population for genetic algorithm and the next population is made by genetic algorithm. Our method compared with Jing Tian method enjoys higher speed, less processing time and more answer's optimum. Also the proposed method has a better edge than other classical methods (such as sobel, etc.).

Keywords: Edge detection, Ant colony optimization, Genetic algorithm.

[CIS-091]

MULTI-OBJECTIVE NATURE-INSPIRED CLUSTERING TECHNIQUES FOR IMAGE SEGMENTATION

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Image segmentation aims to partition an image into several disjointed regions that are homogeneous with regards to some measures so that subsequent higher level computer vision processing, such as object recognition, image understanding and scene description can be performed. Multi-objective formulations are realistic models for image segmentation because objectives under consideration conflict with each other, and optimizing a particular solution with respect to a single objective can result in unacceptable results with respect to the other objectives. In this paper, we present the current multi-objective nature-inspired clustering (MoNiC) techniques for image segmentation. We are able to diagnose the requirements and issues for modelling this specific technique in the image segmentation problem. Three identified important phases include intelligence, design and choice with respect to the issues of clustering problem of image segmentation and multi-objective clustering algorithm design.

Keywords: Clustering, Image processing, Nature-inspired techniques.

[CIS-199]

OPTIMIZATION AND INTEGRATION OF ELECTRONIC IDENTITY AUTHENTICATION USING A BIOMETRIC INDICATOR AND RFID

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In this article, individual's biometric index, radio frequency identification (RFID), and image processing are brought together in order to offer a new model

of identity authentication. The suggested system has been designed in two phases: Producing identity authentication card and identity confirmation. The individual's biometric image are put on a contact-less card equipped with an RFID tag and for each identity authentication, the data on the card are compared with the online biometric image. If the individual's identity is authenticated, then there will be no need for him/her to punch in the personal information since his/her information will be retrieved from the database through their electronic personal code (EPLC).

This article has made use of the HMAX model which works hierarchically based on human's and some animals' visual system for extracting the features of images. Template matching has been done on the features of image taking a threshold of 0.9. To test the mentioned model, FVC2008 standard dataset containing 800 fingerprint images (8 images for 100 people) was employed. The experiments indicate that not only does the above-mentioned model show invariance to picture rotation and its scale but it also proves to be 98 percent responsive on the given dataset.

The experimented pictures were also fed into the PCA model. The experiments show that the PCA has a lower identification coefficient than the HAMX model (70 percent) and it responds favorably only under controlled circumstances.

Keywords: Identity authentication, Electronic interactions, Biometric indicator, Authentication, RFID, Contact-less card, EPLC, HMAX, PCA model.

[CIS-031]

BLIND SOURCE SEPARATION BASED ROBUST DIGITAL IMAGE WATERMARKING USING WAVELET DOMAIN EMBEDDING

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In a digital watermarking scheme, it is not convenient to carry the original image all the time in order to detect the owner's signature from the watermarked image. Moreover, for those applications that require different watermarks for different copies, it is preferred to utilize some kind of watermark-independent algorithm for extraction process i.e. dewatermarking. Watermark embedding is performed in the blue channel, as it is less sensitive to human visual system. This paper proposes a new color image watermarking method, which adopts Blind Source Separation (BSS) technique for watermark extraction. Single level Discrete Wavelet Transform (DWT) is used for embedding. The novelty of our scheme lies in determining the mixing matrix for BSS model during embedding. The determination of mixing matrix using Quasi-Newton's (BFGS) technique is based on texture analysis which uses energy content of the image. This makes our method image adaptive to embed the watermark into original image so as not to bring about a perceptible change in the marked image. BSS based on Joint diagonalization of the time delayed covariance matrices algorithm is used for the extraction of watermark. The proposed method, undergoing different experiments, has shown its robustness against many attacks including rotation, low pass filtering, salt n pepper noise addition and compression. The robustness evaluation is also carried out with respect to the spatial domain embedding.

Keywords: DWT, BSS, BFGS, Mixing matrix, Attacks, Dewatermarking.

[CIS-097]

DEVELOPMENT OF A FACIAL EXPRESSION RECOGNITION SYSTEM FOR THE LAUGHTER THERAPY

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This paper proposes a facial expression recognition system for the laughter therapy. The proposed system takes two steps: face detection and facial expression recognition. At the face detection stage, candidate facial areas are detected in real time from images taken by a camera in consideration of Haar-like features, followed by the application of a SVM (Support Vector Machine) classifier to detect face images in a more correct way. Next, histogram matching-based illumination normalization is used to mitigate the influence of lighting on the detected images. At the facial expression recognition stage, PCA (Principle Component Analysis) is used to capture features of the face, and real-time laugher recognition is made via a multi-layer perceptron artificial neural network. From the findings of this study, we conclude that the proposed method can improve facial expression recognition through illumination normalization based on histogram matching and by testing candidate facial images with a SVM.

Keywords: Facial expression recognition, Support vector machine, Histogram matching, Principal component analysis, Perceptron arfiticial neural network.

Session: MC2
Intelligent Control

Date: Monday, 28 June 2010
Time: 16:00 – 18:00
Chair(s): Insu Song and M. Shawkat Ali
Venue: Room 2

[CIS-252]

A FEATURE-BASED DATA-DRIVEN APPROACH FOR CONTROLLER DESIGN AND TUNING

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Traditionally controller tuning is model based. In many practical applications, however, the process model cannot be obtained and model-free tuning is imperative. In industrial control the huge amount of data is available, but we lack effective controller tuning schemes that are data driven instead of model driven. To address this issue, in this paper we first introduce the concept of feature space that can capture the characteristics of a control process, either in the time domain, frequency domain, or others. (data space to feature space, dim reduction) Next we introduce the control basis function space and control parameter space. The features and parameters form a mapping relationship. The controller tuning process can thus be formulated into the inversion of the mapping that yields appropriate control parameters and minimizes the mistaching between reference features and actual features. When the inversion is not analytically solvable, the iterative learning tuning method can be used.

Keywords: Feature-based tuning, Data-driven, Basis function space, Parameter searching.

[CIS-242]

DYNAMIC MATRIX CONTROL ALGORITHM FOR NETWORKED CONTROL SYSTEMS WITH DELAY AND DATA PACKET DROPOUT

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A new control strategy based on dynamic matrix control algorithm is proposed in this paper to deal with delay and data packet dropout from sensor to controller as well as from controller to actuator in the networked control system. Through the port setting and sequence controlling at the controller and actuator, the new output of predictive model and the new sequence of predictive control are utilized effectively to compensate the delay and the probable data packet dropout so as to promote the robustness and fault-tolerance capability against the fluctuating QoS.

Keywords: Networked control system, Delay, Dynamic matrix control, Data packet dropout.

[CIS-224]

FUZZY CLUSTERING IN CORPORATE GOVERNANCE

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There are many aspects where the shareholders look into a company before, during and after their investment decision. Corporate governance is one of them. The demand for sound corporate governance becomes stronger in recent times to regain public confidence which has been depreciated significantly due to giant corporate failures caused by bad corporate governance practices. Many companies have been practicing corporate transparency (CT). However, good corporate governance (CG) rather than corporate transparency should be a greater concern. Corporate status in adopting sound CG practices may be evaluated either from individual company's perspective or from a group. Individual achievement has been evaluated through index values in different earlier researches. Current research extends the earlier researches where companies are grouped. It proposes a general Algorithm for developing and deploying automated corporate governance categorizing software system which categorizes the corporate governances system in four groups; namely Excellent, Good, Average and poor based on different Features. Feature analysis is introduced to construct an all-rounded performance variable.

Keywords: Corporate governance, Fuzzy clustering, FCM.

[CIS-068]

LAYERED ARGUMENTATION FOR FUZZY AUTOMATION CONTROLLERS

Insu Song[1,a], Guido Governatori[2] and Joachim Diederich[1,b]

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We develop a layered argumentation system (LAS) for efficient implementation of Fuzzy automation controllers. LAS extends a logic based proposal of argumentation with subsumption concept and varying degree of confidences in beliefs. We show that this argumentation system can be used to model Fuzzy automation controllers. The argumentation system is based on a nonmonotonic logic, the computational complexity of which is known to be linear to the size of the knowledge base. LAS theories can also be mapped into RTL-VHDL (Register Transfer Level-VLSI Hardware Description Language) or RTL Verilog for very efficient hardware implementation of Fuzzy automation controllers.

[CIS-043]

AN ALTERNATIVE APPROACH TO DESIGN A FUZZY LOGIC CONTROLLER FOR AN AUTONOMOUS UNDERWATER VEHICLE

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This paper presents a control scheme that provides an efficient and a simple way to design a Fuzzy Logic Controller (FLC) for the autonomous underwater vehicle (AUV). The proposed method, known as the Single Input Fuzzy Logic Controller (SIFLC), condenses the conventional two-input FLC (CFLC) to a single input single output (SISO) controller. The SIFLC significantly reduces the rules and simplifies the tuning of control parameters. Practically, it can be easily implemented by a look-up table using a low cost microprocessor due to its piecewise linear control surface. To verify the effectiveness of the designed controller, the control algorithm is simulated using the Marine Systems Simulator (MSS) on the Matlab/Simulink® platform. The result clearly indicates that both the SIFLC and CFLC give almost identical response to the same input sets. However SIFLC requires very minimum tuning effort and its execution time is in the orders of two magnitudes less than CFLC.

Keywords: Fuzzy logic controller, Signed distance method, Single input fuzzy logic control, Autonomous underwater vehicle.

[CIS-124]

DESIGN FOR FUZZY BACKSTEPPING CONTROLLER OF PERMANENT MAGNET SYNCHRONOUS MOTOR

Ming Yang[a] and Xingcheng Wang

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A fuzzy backstepping controller design for permanent magnet synchronous motor (PMSM) is presented in this paper. In order to gain good dynamics and robustness, the parameters of nonlinear controller based on backstepping technique is adjusted by fuzzy logic control, and the fuzzy logic control is optimized by adaptive weighted particle swarm optimization (PSO). The adaptive weighted PSO is efficient for multi-objective and multi-dimensional problem. The proposed optimal controller is verified by simulation, and the results show that the controller has robust and good dynamic response.

Keywords: Nonlinear control, Backstepping control, Fuzzy logic control, Adaptive weighted particle swarm optimization (PSO).

[RAM-226]

ROBOT PATH PLANNING IN A SOCIAL CONTEXT

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Human robot interaction has attracted significant attention over the last couple of years. An important aspect of such robotic systems is to share the working space with humans and carry out the tasks in a socially acceptable way. In this paper, we address the problem of fusing socially acceptable behaviours into robot path planning. By observing an environment for a while, the robot learns human motion patterns based on sampled Hidden Markov Models and utilises them in a Probabilistic Roadmap based path planning algorithm. This will minimise the social distractions, such as going through someone elses working space (due to the shortest path), by planning the path through minimal distractions, leading to human-like behaviours. The algorithm is implemented in Orca/C++ with appealing results in real world experiments.

Keywords: Human robot interaction, Hri, Path planning, Motion models, Learning, Hidden markov models, HMM.

Tuesday, 29 June 2010

Session: TA1
Networked Dynamical Systems

Date: Tuesday, 29 June 2010
Time: 10:30 – 12:30
Chair(s): Dwight Deugo and Panida Jirutitijaroen
Venue: Room 1

[CIS-035]

ORTHOGONALITY AND OPTIMALITY IN NON-PHEROMONE MEDIATED FORAGING

Sanza Kazadi[a], James Yang[b], James Park[c] and Andrew Park[d]

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We describe the general foraging task, breaking it into two different subtasks: map-making and collection. Mapmaking is a task in which a map is constructed which contains the location(s) of an item or of items in the search area. Collection is the task in which an item is picked up and carried back to a central known location. We theoretically examine these tasks, generating minimal conditions for each one to be accomplished. We then build a swarm made up of two castes to accomplish this, theoretically motivating the design of the swarm. Finally, we demonstrate that the swarm is optimal in the class of swarms utilizing line of sight communication, and give performance measures for open and closed search spaces.

[CIS-007]

AN INTEGRATED SYSTEM FOR QOS PROVISIONING IN CELLULAR NETWORKS

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One of the most challenging issues for next generation cellular networks is the provision of Quality of Service (QoS) guarantees to the high number of multimedia applications with different Service Level Agreement (SLA). To improve the utilization of network resources and facilitate management and control, source types are organized into different traffic classes. Each traffic class requires different treatment from the network in terms of allocated bandwidth, delay, jitter, and packet loss. Due to this, traffic classification/differentiation is a main issue in network level QoS. Hence it is required to analyze the issues related to the design of AC, service class differentiation, scheduling mechanisms and compensation scheme. This paper proposes a framework for QoS provisioning and also considers how the key requirement of coexistence between fuzzy based admission control, scheduling and compensation technique could be accommodated in a cellular network system with experimental results.

Keywords: QoS, Admission control, Scheduling algorithms, Fuzzy logic, Cellular networks.

[CIS-051]

NETWORK LOCALIZATION FROM RANGE MEASUREMENTS: ALGORITHMS AND NUMERICAL EXPERIMENTS

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The problem of estimating node positions in sensor networks and multi agent formations has been extensively studied in the last decade for the purpose of enabling self-configurable and autonomous systems. A typical scenario involves the nodes to estimate their locations using relative measurements from neighbors. When full relative positions (coordinates or, equivalently, range and angle) between pairs of nodes are available, the problem reduces to linear estimation. Contrary, when distanceonly (range) measurements are available, the localization problem is strongly NP-hard, and convergence of general-purpose optimization techniques can no longer be guaranteed. In the present

paper we analyze three ad-hoc numerical techniques for solving the network localization problem under range-only measurements, namely an iterative Least-Squares algorithm, a Trust-Region method, and a Global Continuation method based on Gaussian smoothing. The global convergence properties of these techniques are then tested through numerical simulations.

Keywords: Network localization, Range measurements, Unconstrained optimization.

[CIS-246]

SHORT-TERM LOAD FORECASTING USING TIME SERIES ANALYSIS: A CASE STUDY FOR SINGAPORE

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This paper presents time series analysis for short-term Singapore electricity demand forecasting. Two time series models are proposed, namely, the multiplicative decomposition model and the seasonal ARIMA Model. Forecasting errors of both models are computed and compared. Results show that both time series models can accurately predict the short-term Singapore demand and that the Multiplicative decomposition model slightly outperforms the seasonal ARIMA model.

Keywords: Short-term load forecasting, Singapore data, Time series analysis.

[CIS-241]

SYSTEM STEADY-STATE ANALYSIS OF A LOW-VOLTAGE MICROGRID WITH VARIOUS DISTRIBUTED ENERGY RESOURCES

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The main purpose of this paper is to analyze the operation and nature of a low-voltage AC microgrid with various distributed energy resources (DERs). First, a 400 V low-voltage AC microgrid integrated with a 30 kW microturbine generator, a 13 kW photovoltaic generation system, a 10 kW fuel cell generation system, and a 10 kVA wind turbine generator was employed as the sample system. Second, a sequential three-phase power flow program was developed by implicit Z_{BUS} Gauss method. The program was tested in the Matlab environment to ensure its accuracy. Finally, system natural and steady-state operations of the proposed microgrid were analyzed and discussed by using the developed three-phase power flow program. The outcomes of this paper are helpful for researchers to realize the operation characteristics of AC low-voltage microgrids.

Keywords: Microgrids, Distributed energy resources, Steady-state analysis, Three-phase power flow, Low-voltage distribution system.

[CIS-253]

A LOAD TRANSFER SCHEME OF RADIAL DISTRIBUTION FEEDERS CONSIDERING DISTRIBUTED GENERATION

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This work proposes a load transfer scheme for radial distribution feeders with distributed generation units. A distribution feeder may be operated with distributed generation units in parallel. Conventional load transfer schemes do not consider this kind of operating condition. Hence, they are not suitable for power distribution systems including distributed generation units. In this paper, the load transfer scheme considering distributed generation is presented first. Then the difference between the proposed scheme and conventional one is explored. Second, the effects of distributed generation units on the operating states of supported distribution feeders after load transfer are analyzed via computer simulation. Final, a test case is carried out to examine the function of the proposed load transfer scheme.

Keywords: Load transfer, Distribution feeder, Distributed generation.

Session: TA2
Modeling, Planning and Control I

Date: Tuesday, 29 June 2010
Time: 10:30 – 12:30
Chair(s): Yu-Sheng Lu and Jun Xu
Venue: Room 2

[CIS-133]

EXPERIMENTAL EVALUATION OF A T-S MODEL-BASED SLIDING-MODE CONTROL SCHEME

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This paper presents the experimental evaluation of a fuzzy sliding-mode control scheme. The control law consists of three parts: a nominal controller, a sliding-mode disturbance observer (SMDO), and an adaptive fuzzy sliding-mode controller (AFSMC) that is based on a T-S model. The nominal controller is employed to specify the desired closed-loop dynamics whereas the SMDO as well as the AFSMC are designed to compensate for unknown perturbation. Nevertheless, the perturbation can be considered to comprise a modellable part and an unmodelable part, which are to be compensated for by the SMDO and the AFSMC, respectively. Experimental evaluations of the SMDO-AFSMC scheme are conducted by practically applying the scheme to a four-bar linkage system.

Keywords: Disturbance observer, Four-bar linkage, Fuzzy control, Sliding mode.

[CIS-165]

FDI OF DISTURBED NONLINEAR SYSTEMS: A NONLINEAR UIO APPROACH WITH SOS TECHNIQUES

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This paper presents a novel unknown input observer (UIO) design method for fault detection and isolation (FDI) of a class of nonlinear affine systems with disturbance. By using Lie geometry and sum-of-squares (SOS) theory as the main tools, a simple and systematic design procedure is proposed. Compared with the traditional UIO design, the rank constraint is much relaxed. Meanwhile, we show that the threshold can be easily obtained from a L_2 gain result using a SOS formulation.

Keywords: Fault detection and isolation, Nonlinear systems, Unknown input observer (UIO), Sums of squares (SOS).

[CIS-162]

MODELING AND INTELLIGENT CONTROL DESIGN OF CAR FOLLOWING BEHAVIOR IN REAL TRAFFIC FLOW

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The control of car following is essential to its safety and its operational efficiency. For this purpose, this paper builds a linear, continuous and time-delay model of car following. And then, presents a controller based on an adaptive network fuzzy inference system (ANFIS) for the car-following collision avoidance system to adaptively control the speed of the vehicle. The relative distance and relative speed to the in front car are measured and are applied to the controller. The output acceleration or deceleration rate of the controller is based on the characteristics of the vehicles. The presented ANFIS controller can solve the problems of the oscillations for final distance between the leader vehicle (LV) and the follower vehicle (FV) and their relative speed. The designed ANFIS controller is linked to the car following model. The simulation results show that the ANFIS control design is more effective and can provide a safe, reasonable, and comfortable drive than real driver.

Keywords: Car following, Modelling, Intelligent control, ANFIS.

[CIS-163]

COMPARISON OF EM ALGORITHM AND PARTICLE SWARM OPTIMISATION FOR LOCAL MODEL NETWORK TRAINING

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Local model networks (LMNs) offer a versatile structure for the identification of nonlinear static and dynamic systems. In this paper an algorithm for the construction of a tree-structured LMN with axis-oblique partitioning using particle swarm optimisation (PSO) is presented. The PSO algorithm allows the optimisation of arbitrary performance criteria but is only used for a certain subtask which helps to reduce the search space for the evolutionary algorithm very effectively. A comparison using an Expectation-Maximisation (EM) algorithm is presented. The differences and advantages of the LMN with PSO and the EM algorithm, respectively, are highlighted by means of an illustrative example. The practical applicability of the proposed LMN with particle swarm optimisation is demonstrated using real measurement data of an internal combustion engine.

Keywords: Local model network, Particle swarm optimisation, Expectation-maximisation.

[CIS-047]

QUESTION-ANSWER PROGRAMMING IN COLLABORATIVE DEVELOPMENT ENVIRONMENT

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This paper presents the question-answer approach to programming the designers activity during the collaborative development of software intensive systems. Such activity is aimed at the creative reuse of precedents in the real time when the human potential and power of computers are combined as a whole. The effectiveness of the common work can be increased essentially if the human part of the work will be fulfilled as an execution of the special kind of programs by "human processors" which use the models of question-answer reasoning. Such approach was investigated and evolved till the instrumental system providing the programming of the human processors combined with computer processors.

Keywords: Collaborative development, Question-answer, Reasoning, Pseudocode programming.

[CIS-042]

BPM EXCEPTION MONITORING BASED ON PROCESS KNOWLEDGE

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As enterprise business process (BP) becomes more dynamic and flexible, business process management system (BPMS) is required to strengthen its capability to monitor the operation of BP. Referring to the monitoring mode from IBM's "WebSphere Business Integration", this paper proposes the idea of monitoring BP based on process knowledge (PK), that is, utilizing PK extracted from BP to assist process management and monitoring. By means of providing process management staff with real-time running data, statistical historical data and alarm notification, the response to process exception, monitoring range and the capability to predict exception in BPMS are greatly improved enabling BPMS to take actions to prevent exception and to guarantee the successful running of BP.

Keywords: Exception handling, Process knowledge, Panel, Monitor.

[RAM-128]

OPEN-LOOP AND CLOSED-LOOP RECURSIVE IDENTIFICATION OF AN ELECTRO-HYDRAULIC ACTUATOR SYSTEM

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This paper presents experimental work on recursive identification of an electro-hydraulic system that represented by a discrete-time model in open-loop and closed-loop configurations. A recursive least square (RLS) method is used to estimate the unknown parameters of the system based on auto regression with exogenous input (ARX) model. Residual analysis is utilized for a model validation. Results are presented which show variations in parameters of the electro-hydraulic system. From the results obtained, position tracking for electro-hydraulic system can be implemented by using conventional proportionalintegral-derivative (PID) controller with the aim of the modeling validation.

Keywords: System identification, Recursive least square, Auto regression with exogenous input, Electro-hydraulic system, Open-loop identification, Closed-loop identification.

RAM 2010 Abstracts

Monday, 28 June 2010

Session: MA3
Wearable Sensors and Haptic Devices for Healthcare and Biomechanics Applications

Date: Monday, 28 June 2010
Time: 10:30 – 12:30
Chair(s): I-Ming Cheng, Zhiqiang Luo and Chee Kian Lim
Venue: Room 3

[RAM-126]

A LOW COST WEARABLE WIRELESS SENSING SYSTEM FOR UPPER LIMB HOME REHABILITATION

Chee Kian Lim[a], I-Ming Chen, Zhiqiang Luo and Song Huat Yeo

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Monitoring and guiding real time body motion permits corrective measures to be implemented for more effective rehabilitation results. Taking the rehabilitation practice at home can help stroke patients with movement disability to regain the motor skill. Existing systems for rehabilitation is either too costly, or complicated and bulky to be efficiently employed for personal use at home. In this current work, an innovative and unobtrusive wearable system for home use is being proposed. This compact and cost effective system effectively captures human joint angles and does that hinder limb motion as commonly encountered in other existing systems. The paper details the design and implementation of the proposed sensor and sensing methodology. The tested wireless sensor is able to detect the posture and movement of the human arm with particular attention to its application in upper limb rehabilitation. Real time experimental data are collected from a subject using a hand exerciser and compared with a commercial motion capture system. The results demonstrate the feasibility and viability of the proposed sensing system in tracking human arm postures and movement.

Keywords: Component, Formatting, Style, Styling.

[RAM-203]

AN INTERACTIVE THERAPY SYSTEM FOR ARM AND HAND REHABILITATION

Zhiqiang Luo[a], Chee Kian Lim[b], Weiting Yang[c], Keyen Tee[d], Kang Li[e], Chao Gu[f], Kim Doang Nguyen[g], I-Ming Chen[h] and Song Huat Yeo[i]

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The paper presents results from a virtual reality (VR)-based system for upper limb rehabilitation. The system incorporates a range of interchangeable direction sensing devices (the Optical Linear Encoder (OLE) and the inertial measurement unit (IMU) that can be adjusted to a large range of different arm and hand sizes, and interactive practice applications designed for motivating and seamlessly driving users to perform the functional and non-functional motor recovery tasks. We describe the kinematic models of both arm and hand, the technical details of two motion track components (the arm suit and the SmartGlove) and the design of the interactive scenarios. The system thus promises to be a valuable complement to conventional therapeutic programs offered in rehabilitation clinics.

Keywords: Body sensor network, Rehabilitation, OLE, IMU.

[RAM-101]

ENHANCEMENT OF SPATIAL ORIENTATION AND HAPTIC PERCEPTION FOR MASTER-SLAVE ROBOTIC NATURAL ORIFICE TRANSLUMINAL ENDOSCOPIC SURGERY (NOTES)

K. Yang[1,a], Z. L. Sun[1], A. P. Kencana[1], V. A. Huynh[1], M. Rasouli[1], S. J. Phee[1], D. Lomanto[2] and K. Y. Ho[2,b]

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Natural Orifice Transluminal Endoscopic Surgery (NOTES) has advantages in reducing postoperative abdominal wall pain, wound infection, hernia formation and adhesions. However, loss of spatial orientation and lack of haptic feedback during NOTES are two major technical barriers that hinder safe translation into full clinical practice. A complete solution for enhancing the spatial orientation and haptic perceptions for the surgeon during NOTES is needed to improve its safety and efficiency, and at the same time, reduce its complication and complexity. In this paper, we proposed an Interventional Navigation System (INS) and haptic feedback solution for a master-slave robot for NOTES to fulfill the above-mentioned goal.

Keywords: Interventional Navigation System (INS), Tracking, Haptic feedback, Endoscopic.

[RAM-180]

SEEKING PERCEPTUAL-BASED METRICS TO ASSESS THE VISUO-MOTOR LOOP IN MOBILE ROBOT TELEOPERATION

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This paper presents a study about the influence of visual feedback conditions on robot teleoperation and teleoperators' behavior for path following tasks. To objectively describe this influence we define three parameters: The spatial anticipation, the visuo-motor phase shift and the theoretical optical flow, which can be easily derived from experimental observations. The spatial anticipation is found to be correlated with the remote camera point of view, i.e height, pan, tilt. From the visuo-motor point of view, the movement of the joystick anticipates the movement of the head, that is linked with the unnatural conditions in the tele-operation of a non holonomic robot. Finally a logarithmic relation is found between the optical flow (the only information about the remote scenario the users perceive) and the spatial anticipation.

Keywords: Teleoperation, Perception, Vision, Motion, UGV, Robotics.

[RAM-181]

CAN OBSERVERS PERCEIVE DEPTH IN VIRTUAL ENVIRONMENTS WITHIN EXTRAPERSONAL SPACE?

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In this paper, we address extra-personal depth perception in virtual worlds. Mainly, we focus on the contribution of stereopsis in estimating the distance of virtual objects appearing around two meters and beyond far from the viewer. Our aim is to answer the following fundamental question: "do humans integrate similarly the stereoscopic disparity to derive virtual objects depths ranging from two meters to infinity"? In this work, we reduced the cue's set to the sole stereopsis or disparity by using the size-distance paradox. We believe that this reduction is necessary to deal with the complexity of the visual perception and the processes it involve. Indeed, many experimental studies have shown that technological constraints and conceptual limitations cause depth misestimations within stereoscopic displayed virtual environments. However, there is no clear idea about individual contributions of the visual cues and the ways they are integrated.

This paper presents the experiments we performed in order to quantify the contribution of the stereoscopic disparity. According to the obtained performances, we found two groups: a group of subjects able to perceive correctly depths and a second group misestimated depths. In addition, we found that the gender, age and inter-pupillary distance affect subjects performances.

Keywords: Virtual reality, Human machine interaction, Depth perception.

[RAM-221]

EMG-DRIVEN COMPUTER GAME FOR POST-STROKE REHABILITATION

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The key point of post-stroke rehabilitation is that exercises and therapy must begin as soon as possible after stroke in order to let the survivors regain their body movement functions. By playing the EMG-driven computer game, the patients can locate disused body parts and start training their muscles even when they have to stay on beds during the early stage of rehabilitation. Wearable EMG nodes for post-stoke rehabilitation are made in affordable price and a toy robot controlled by the computer game is used to communicate with the people.

Keywords: Rehabilitation, Emg, Computer game.

Session: MA4
Design & Performance Evaluation

Date: Monday, 28 June 2010
Time: 10:30 – 12:30
Chair(s): Kyung-Soo Kim and Wang Liping
Venue: Room 4

[RAM-023]

AUTOMATED FABRICATION OF THREE DIMENSIONAL POROUS MICROFIBER SCAFFOLDS FOR TISSUE ENGINEERING

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An alternative to electrospinning, an original, simple yet effective biomaterial microfiber fabrication method is reported, in this paper, for tissue engineering fibrous scaffold fabrication. The method was discovered and proved to work as a concept without too much thought given to the automation. Though effective, it was tedious and inconsistent. Thus, an automated method based on the manual observations is developed and tested. Both methods can be used to obtain polycaprolactone microfiber scaffolds, and the automated method has a superior feature which enables easy and fast fabrication of aligned microfibers.

Keywords: Automation, Microfiber, Tissue Engineering, Scaffold design.

[RAM-024]

STRUCTURAL ANALYSIS OF 600KGF HEAVY DUTY HANDLING ROBOT

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To design the heavy duty industrial robot manipulator, it must be tested and evaluated for the overall structure. The test and evaluation procedure may be followed after the parts configuration determined from the kinematics & dynamics analysis of the robot structure. During this research, we completed a feasibility study via simulation on each of the specifically designed assembly parts which determine the detailed figures and specifications of the heavy duty handling robot. First, we completed the simulation of the rigid body dynamics analysis for heavy load of 600 Kgf (max). & tare weight of robot body. As a result, we obtained the maximum reaction force for each joint that could be used for static rigidity analysis. Next, through the mode analysis, we estimated the natural frequency for the overall assembled structure and compared it with the experimental result to identify the accuracy and the reliability of the FEM models. Finally, we analyzed the elastic-rigid body dynamics to estimate the robustness of the parts during the working motion of the robot.

Keywords: Heavy duty, Robot, Manipulator, Structural, Analysis, Statics, Dynamics, Estimation.

[RAM-064]

GA-BASED DYNAMIC MANIPULABILITY OPTIMIZATION OF A 2-DOF PLANAR PARALLEL MANIPULATOR

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Dynamic manipulability is a very important issue that should be considered for problems of parallel manipulator design. In order to study the dynamic optimization of a 2-DOF planar parallel manipulator, which is used in a heavy duty hybrid machine, genetic algorithm (GA) is used in the dynamic

manipulability optimization. Based on the kinematic analysis, the dynamic equation of the 2-DOF parallel manipulator is derived using the virtual work principle method. Furthermore, global dynamic manipulability (GDM) is introduced to measure the dynamic performance of the manipulator. Then the dynamic optimization based GA method is analyzed. From the numerical simulation, it is proved that the dynamic optimization considering GDM proposed in this paper can ameliorate the dynamic performance of the parallel manipulator well.

Keywords: Dynamic manipulability, Parallel manipulator, Genetic algorithm.

[RAM-106]

A NEW COMPENSATION STRATEGY FOR AN AC CONTACTOR UNDER VOLTAGE-SAG EVENTS

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This paper aims at researching the effects of voltage-sag events upon AC electromagnetic contactor (abbreviated as AC contactor) and developing a compensation strategy based on feedback control approach. An AC contactor model is first analyzed when sags event is ensured occurrence as well as a novel voltage compensation strategy is designed for timely offsetting the coil voltage; therefore, the critical equipment in continuous process industries are safely protected and prevents the loss caused by downtime. A dynamic performance evaluation was conducted on governing numerical model of an AC contactor for analyzing the system performance when the proposed compensation strategy is introduced. The simulation results clearly depicted that contactors are critical component as it is unable to ride through 20% sag and longer than 48 milliseconds. The effectiveness and feasibility of the proposed coil voltage compensation strategy during voltage sag events occur is validated by using simulation approach. Moreover, the shading rings have the effect of the contactor's transient performance when voltage sags event occur is studied and discussed as well.

Keywords: Voltage compensation strategy, Voltage sags, AC contactor.

[RAM-127]

BLDC MOTOR DRIVEN ROBOT FINGER DESIGN USING THE SLIDING ACTUATION PRINCIPLE

Young June Shin[a], Kyung-Soo Kim[b] and Soohyun Kim[c]

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In this paper, we suggest a robot finger driven by BLDC motors utilizing the distributed actuation mechanism. The mechanism allows an additional design freedom to optimize the fingertip force, which implies the usage of the maximal capacity of actuators. By numerical analysis and experiments, the fingertip forces of the developed robot finger will be given to prove the effectivenss of the distributed actuation principle.

Keywords: Robot finger, Fingertip force, Optimization, Sliding actuation.

[RAM-230]

NON-RADIOLOGICAL COLONOSCOPE TRACKING IMAGE GUIDED COLONOSCOPY USING COMMERCIALLY AVAILABLE ELECTROMAGNETIC TRACKING SYSTEM

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A non-radiological method of visualizing the path of a colonoscope using a chain of electromagnetic sensor coils along the biopsy channel of the instrument has been developed. The electromagnetic imaging system has been introduced as an aid to colonoscopy, and reveals a great potential for assisting endoscopists. There is an existing model available on the market by Olympus, ScopeGuide; however, due to cost consideration and other factors concerned, some hospitals may not want to replace existing instruments. This paper discusses about the possibility of using a commercially available electromagnetic tracking system, the Northern Digital Aurora system and presents a simple algorithm employed to find a representation of the colonoscope path. A possibility of reducing the amount of sensor coils used in existing model is also discussed. The visual guidance is expected to provide the user with

a sense of assurance, which is often missing in the navigation of colonoscope. The work may be useful in locating the exact position when a lesion is found during the procedure, and to identify a loop when it is formed. It may also be useful as a navigational aid in colonoscopy training and teaching purposes.

Keywords: Conolonoscopy, Electromagnetic tracking, Surgical navigation, Image guided intervention, Colonoscope tracking.

Session: MB3
Medical Robots and Systems

Date: Monday, 28 June 2010
Time: 13:30 – 15:30
Chair(s): Louis Phee and Yi Xiang
Venue: Room 3

[RAM-151]

WIRELESS CAPSULE ENDOSCOPES FOR ENHANCED DIAGNOSTIC INSPECTION OF GASTROINTESTINAL TRACT

Mahdi Rasouli, Andy Prima Kencana, Van An Huynh, Eng Kiat Ting, Joshua Chong Yue Lai and Louis Soo Jay Phee[a]

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Wireless capsule endoscopy has become a common procedure for diagnostic inspection of gastrointestinal tract. This method offers a less-invasive alternative to traditional endoscopy and provides the opportunity for exploring inaccessible areas of the small intestine. Current capsule endoscopes, however, move by peristalsis and are not capable of detailed and on-demand inspection of desired locations. Here, we propose and develop two wireless endoscopes with maneuverable vision systems to enhance diagnosis of gastrointestinal disorders. The vision systems in these capsules are equipped with mechanical actuators to adjust the position of the camera. This may help to cover larger areas of the digestive tract and investigate desired locations.

Keywords: Wireless capsule endoscopy, Ingestible capsule, Medical robot, In-body medical device, Medical imaging.

[RAM-013]

OPTIMAL DESIGN AND CONTROL OF A HAND EXOSKELETON

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This paper deals with the optimal design and control of an exoskeletal robot. First, the motion data from the fingers of a normal subject was captured by a vision system. As the human finger joints cannot be modeled by single revolute joints due to changing instantaneous centre of rotation, we have used 4-bar mechanisms to model each joint. Optimal 4-bars have been designed using genetic algorithms, by minimizing the error between a coupler point and points traced by the finger links. It is shown that the designed 4-bars can accurately track the motion of the human fingers. The exoskeleton is controlled by using the EMG signals obtained from the subjects muscles. The relation between the EMG and finger motion is first learned, using a neural net. Based on the learned parameters, the subjects EMG signal is used to control a simulation of the exoskeleton joint motion. A comparison between Recurrent Neural Network and Multi Layer Perceptron for classifying and mapping the EMG to finger position was also carried out.

Keywords: Finger exoskeleton, EMG, 4-bar mechanism, Genetic algorithms, Neural networks.

[RAM-081]

DESIGN OF A ROBOTIC TRANSCRANIAL MAGNETIC STIMULATION SYSTEM

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Transcranial Magnetic Stimulation (TMS) is an excellent and non-invasive technique for studying the human brain. Accurate placement of the magnetic coil is required by this technique in order to induce a specific cortical activity. Currently, the coil is manually held in most of stimulation procedures, which does not achieve the precise clinical evaluation of the procedure. This paper proposes a robotic TMS system to resolve these problems as a robot has excellent locating and holding capabilities. The proposed system can track in real-time the subject's head position and simultaneously maintain a constant contact force between the coil and the subject's head so that it does not need to be restrained and thus ensure the accuracy of the stimulation result.

This paper focuses on the coil positioning technique. An optical tracking system is used in the system for guiding and tracking the motion of the robot and inadvertent small movements of the subject's head. The calibration between the tracking system and robot coordinate systems is solved using a mathematical method which yields a matrix equation of the form $AX = XB$. Finally, a tracking control algorithm is inferred and obtained using the relationship of relative coordinate systems which can be used in the real-time tracking strategy.

Keywords: Transcranial magnetic stimulation, Robot arm, Medical system, Calibration, Tracking.

[RAM-155]

MODEL-BASED DESIGN ANALYSIS FOR PROGRAMMABLE REMOTE CENTER OF MOTION IN MINIMALLY INVASIVE SURGERY

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Remote center of motion (RCM) is an important concept in the kinematics for robotic minimally invasive surgery (MIS). This work focuses on the kinematic modeling of mechanism design for programmable RCM in MIS. Programmable RCM uses multiple joints coordination to maintain the isocenter of surgical tool manipulation during MIS. In this work, the kinematic task requirement is studied using a multibody system analysis approach. A generalized model based on closed-loop kinematic chain was proposed. Next, an appropriate serial manipulator was conceptualized and kinematically modeled. Finally, simulation-based evaluations were performed on virtual models built with modeling software tools. The contribution of this work is the introduction of a model-based design analysis methodical approach. This will provide a framework for the implementation of a model-based control scheme in robotic minimally invasive surgery. In addition, this work could offer potential insights to better innovations for mechanical RCM system.

Keywords: Device design methodology, Medical robotics, Remote center motion, Simulation based design.

[RAM-090]

REACHMAN TO HELP SUB-ACUTE PATIENTS TRAINING REACHING AND MANIPULATION

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This paper presents the control strategy and efficient tasks for training with ReachMAN, a compact, portable 3 degree-of-freedom robot to train reaching, pronosupination and grasping, independently or in combination. A pilot study was performed with three sub-acute patients to evaluate the potential use of ReachMAN as a rehabilitation tool, and determine how it should be used. All subjects improved their motor function, and gains in the range and quality of movements were seen, which are not detectable by typical functional assessment.

Keywords: Robot rehabilitation therapy, Sub-acute stroke patients.

[RAM-222]

LOW POWER ULTRA-WIDEBAND WIRELESS TELEMETRY SYSTEM FOR CAPSULE ENDOSCOPY APPLICATION

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A low power wireless telemetry system for capsule endoscopy is presented in this paper. The proposed system is based on impulse-radio ultra-wideband (IR-UWB) technology, it consists of a UWB transmitter utilizing fast on-off LC VCO and a non-coherent UWB receiver using energy detection. The whole system is implemented in $0.18 - \mu$m CMOS process and integrated in a single chip with 3 mm $\times$ 4 mm chip size. The measurement results show that the transmitter consumes ultra low average power of 2.5 mW at 10 Mbps data rate and the receiver draw 40 mA current under 1.8 V power supply. An ex-vivo animal experiment shows that the proposed system

can successfully transmit the real-time image data out from the capsule to the external base station.

Keywords: Capsule endoscopy, Ultra-Wideband (UWB), Impulse radio, Transceiver, Wireless Body Area Network (WBAN).

[RAM-220]

A SYSTEMATIC GRAPH-BASED METHOD FOR THE KINEMATIC SYNTHESIS OF NON-ANTHROPOMORPHIC WEARABLE ROBOTS

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The choice of non-anthropomorphic kinematic solutions for wearable robots is motivated both by the necessity of improving the ergonomics of physical Human-Robot Interaction and by the chance of exploiting the intrinsic dynamical properties of the robotic structure for an optimal interaction with the human body. Under these aspects, this new class of robotic solutions is potentially advantageous over the one of anthropomorphic robotic orthoses. However, the process of kinematic synthesis of nonantrhopomorphic wearable robots is very complex and difficult to be tackled by human intuition and engineering insight alone. A systematic approach is more useful for this purpose, since it allows to obtain the number of independent kinematic solutions with desired properties. In this perspective, this paper presents a method which enables to list the possible kinematic solutions for wearable robotic orthoses, which generalize the set of solutions of the problem of kinematic synthesis of a non-anthropomorphic wearable robot. This method has been implemented to derive the atlas of topologies of robotic kinematic chains which can be employed to support a 1-DOF human joint.

Keywords: Non-anthropomorphic wearable robots, Topology, Graph theory.

Session: MB4
Dynamics and Motion Control

Date: Monday, 28 June 2010
Time: 13:30 – 15:30
Chair(s): Pauline Hamon and Boyang Hu
Venue: Room 4

[RAM-131]

SENSORLESS DRIVE OF PERMANENT MAGNET BRUSHLESS DC MOTOR WITH 180 DEGREE COMMUTATION

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The three-phase wye connected permanent magnet brushless dc motor is conventionally driven by 120 degree commutation. Two phases are conducting current and the other one is always floating without any torque produced in each conduction interval. Rather than the conventional 120 degree drive, all three phases of 180 degree commutation are expected to conduct current in all sectors, which results in more power delivered from inverter side to the motor side for the same power supply voltage. In this paper, a recently proposed sensorless algorithm is highlighted with well performance in low speed operation. Based on dSPACE, comparison of different dynamic conditions between 120 and 180 degree commutation is presented and analyzed comprehensively. Extensive experiment tests show excellent results on dynamic performance of 180 degree commutation, which matches the simulation results from Simulink/Matlab. 180 degree commutation is verified to work properly with the ability to deliver more power when compared with conventional 120 degree commutation.

Keywords: Brushless DC motor, Sensorless drive, Low speed, 120/180 degree commutation.

[RAM-138]

ON THE DYNAMICS OF THE FLEXIBLE ROBOT ARM IN A REAL DEPLOYMENT PROFILE

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The dynamics of the flexible robot arm subjected to tip mass during an actual deployment is studied. The Euler-Bernoulli beam theory and the real deployment are considered in the simulation. A new real axial velocity profile is developed. This new suggested profile simulates the actual deployment such that the arm movement starts from immovability and

after attaining the final required length comes back again to the static state. Using Lagrange's equation, the equations of motion of the system are derived to study the system dynamics in this suggested deployment profile. A series approximation is used to represent the lateral elastic displacements. Using variables separation and also some special shape functions satisfying the boundary conditions in the series, a system of ordinary differential equations governing the dynamics of the system is presented. Solving the ordinary differential equations, the response of the flexible robot arm during deployment is studied. The effects of deployment time and the payload mass which the arm carries, on the dynamic response of the system are investigated. The accuracy of the obtained response for the arm is dependent on the number of terms included in the considered series. The effects of the deployment time and payload mass on the "number of series terms" required to reach an acceptable solution convergence are investigated.

Keywords: Robot arm, Flexibility, Deployment profile.

[RAM-172]

ZPETC PATH-TRACKING GAIN-SCHEDULING DESIGN AND REAL-TIME MULTI-TASK FLIGHT SIMULATION FOR THE AUTOMATIC TRANSITION OF TILT-ROTOR AIRCRAFT

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The purpose of this research is to accomplish the ZPETC (Zero Phase Error Tracking Control) Path-Tracking gain-scheduling control design and real-time multi-task flight simulation for the automatic transition of tilt-rotor aircraft.

Firstly, we select 20 flight equilibrium points during the automatic transition through the trim operation. For each equilibrium state, we can get a set of Jacobian matrix A, B of the linearized equation by using the numerical linearization method and perform the flight control system design. Due to the highly instability of the system for the period of the dynamic transition maneuver, if we want to stabilize the unstable aircraft and do the desired path tracking for the vertical take off flight, then it is necessary to use the optimal controller and the ZPETC method.

In this research, we use the quadratic synthesis method to find an optimal control gain for each flight equilibrium point and then perform the desired VTOL (Vertical Take-Off and Landing) transition path tracking by using ZPETC method. Also we utilize real-time look-up control gain computation from the selected 20 flight equilibrium points to achieve the gain-scheduling control task.

Keywords: ZPETC path-tracking, Gain-scheduling, Real-time multi-task, Tilt-rotor aircraft.

[RAM-174]

A TECHNICAL APPROACH TO H_2 AND H_∞ CONTROL OF A FLEXIBLE TRANSMISSION SYSTEM

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In this paper, continuous-time H_2 and H_∞ control techniques for a flexible transmission system are presented. This system has two very oscillatory vibration modes subjected to large load variation, which makes the control of it be difficult. A set of design specification in time domain is to be met by a single controller on each of the three main plant models. Furthermore, the tracking problem in the presence of disturbance and load variation is investigated. Finally, the simulation results for H_2 and H_∞ controllers for three different loadings are given and compared. The simulation results show the good performance of the proposed controllers.

Keywords: H_2 control, H_∞ control, Flexible transmission system.

[RAM-185]

DYNAMIC IDENTIFICATION OF ROBOT WITH A LOAD-DEPENDENT JOINT FRICTION MODEL

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Usually, the joint transmission friction model for robots is composed of a viscous friction force and of a constant dry friction force. However, according to the Coulomb law, the dry friction force depends linearly on the load driven by the transmission. It follows that this effect must be taken into account for robots working with large variation of the payload or inertial and gravity forces, and actuated with transmissions as speed reducer, screw-nut or worm

gear. This paper proposes a new inverse dynamic identification model for n degrees of freedom (dof) serial robot, where the dry friction force is a linear function of both the dynamic and the external forces. A new identification procedure groups all the joint data collected while the robot is tracking planned trajectories with different payloads to get a global least squares estimation, in one step, of inertial and new friction parameters. An experimental validation is carried out with a 1 dof prismatic joint composed of a Star high precision ball screw drive positioning unit, which allows large and easy variations of the inertial and gravity forces.

Keywords: Robot, Modeling, Identification, Friction.

[RAM-204]

TRAJECTORY ANALYSES FOR FIVE-AXIS MACHINE TOOLS

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In order to achieve high accuracy, less machining time, and more machining variety, normally, additional two rotary axes are set up on top of traditional three-axis CNC machine tool, which is called five-axis machines. The tool motion for five-axis machines in this research includes both translating and rotating axis movements simultaneously. This research analyzes the contour errors for multi-axis machine tools that have coordinated motion for both rotating and translating axes. This error depends on the setup of the machine, the distance between the center of rotating axis and the workpiece, and the increment of the rotating axis. A computer software program is developed to calculate the contour errors and simulate actual tool trajectory for multi-axis machine tools. This contour error analyses can be used to produce more accurate 5-axis tool paths for the advanced CAD/CAM system. A demonstrated example is provided to implement the tool trajectory error analyses for five-axis machining.

Keywords: Five-axis, CNC, Contour error, Trajectory.

Session: MC3
Wheeled Mobile Robots

Date: Monday, 28 June 2010
Time: 16:00 – 18:00
Chair(s): Luis Paulo Reis and Ming Yang
Venue: Room 3

[RAM-057]

USING A DUAL COMPASS CONFIGURATION WITH SHAFT ENCODERS FOR SELF-LOCALIZATION OF AN AUTONOMOUS MANEUVERABLE NONHOLONOMIC MOBILE ROBOT

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This paper presents a novel approach to selflocalization for the maneuverable mobile robot. This system is predominantly adapted to mobile robots that require autonomous positioning information at a low computation cost for real time applications. This system combines telemetry from the wheel shaft encoders and the rotational position of two magnetic compasses, and uses analytical equations to solve for the mobile robot's relative position on a two dimensional Cartesian plane. The paper first presents a brief discussion on typical procedures used to achieve self-localization of non-holonomic mobile autonomous robots. Then, the developed double compass self-localization system is presented as it is integrated to a two wheel autonomous maneuverable mobile robot configuration. Finally, the theoretical solutions are presented that allow characterization of the performance of the self-localization system, illustrating the robustness and resilience of using an on-line analytical solution over an off-line computation-hungry numerical solution.

Keywords: Nonholonomic, Mobile robot, Self-localization, Double compass.

[RAM-058]

MODULAR RE-CONFIGURABLE ROBOT DRIVES

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We propose a modular platform for wheeled mobile robots that utilises a 6-edge honey-comb prism

as its basic building block to realize robot drives of diverse geometry. In terms of functionality, we designed a specific wheel suspension for a drive-module comb that can utilise both, a standard wheel or a Mecanum wheel. A quick-lock interconnection mechanism for the comb modules allows us to quickly configure/reconfigure various robot drives and enables us to realise autonomous wheeled robots with the ability to connect to other robots or even to reconfigure the robot's geometry. This configuration capability offers many interesting opportunities for robotics research since we can adapt a robot in terms of its kinematic functionality, payload and size.

Keywords: Modular robots, Wheeled robots, Reconfigurable robots.

[RAM-073]

PERFORMANCE ENHANCEMENT OF A STATICALLY UNSTABLE TWO WHEELED MOBILE ROBOT TRAVERSING ON AN UNEVEN SURFACE

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A Two Wheeled Mobile Robot (TWMR) is a highly nonlinear and open-loop unstable system. Dynamic analysis and control design to keep the body of the robot balanced has been an area of research in the last decade. This problem has been dealt by many researchers for the robot motion on flat surfaces. A few studies have addressed the motion control on constant sloped path. This work studies the control of TWMRs on an uneven surface. With respect to previous results in the literature, the main contributions of this study are the dynamical modeling and control design of a two-wheeled mobile robot while traversing on uneven surface, in particular a single bump. A criterion has been proposed for the system performance evaluation. The system response to a baseline control and proposed Gain Scheduling control is quantified in simulation through proposed criteria. The results show an improvement in system performance on an uneven surface.

Keywords: Two wheeled robot, Modeling, control, Uneven terrain.

[RAM-188]

POSTURE STABILIZATION OF SKID STEER WHEELED MOBILE ROBOTS

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This paper represents the posture stabilization of a Skid Steer Wheeled Mobile Robot (SSWMR). Although, in mobile robots lateral skidding of the wheels occurs when turning at high speed, wheels of a SSWMR laterally skid in every rotational maneuver even for low speeds yielded the non-skidding non-holonomic constraint to be violated. In order to compensate the effects of parameter uncertainties, an adaptive torque controller is developed based on tunable dynamic oscillator. The Globally Uniformly Ultimately Bounded (GUUB) stability of the system to an arbitrarily small neighborhood of the origin is proved. To demonstrate the performance of the proposed controller, modeling of a SSWMR was implemented through ADAMS.

Keywords: Posture stabilization, Skid steer, Robust adaptive, ADAMS.

[RAM-093]

MODEL PREDICTIVE CONTROL BASED OPTIMAL CRUSING CONTROL OF TWO-WHEELED MOBILE ROBOTS

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This paper describes an optimal crusing control using model predictive control for a two-wheeled mobile robot with a nonholonomic constraint. The proposed method yields the optimized control strategy while satisfying constraints imposed on input and state. The dynamics is modeled as a mixed logical dynamical system so that the model predictive control can be applied to it. Some simulation and experimental results illustrate the effectiveness of the proposed method.

Keywords: Model predictive control, Crusing control, Tracking control and hybrid dynamical system.

[RAM-114]

A COMPACT DESIGN OF ZERO-RADIUS STEERING AUTONOMOUS AMPHIBIOUS VEHICLE WITH DIRECT DIFFERENTIAL DIRECTIONAL DRIVE — UTAR-AAV

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The contribution of this autonomous amphibious vehicle (UTAR-AAV) includes the determination of vehicular requirements to serve its purpose of being a support and rescue unit on land and water with low turning radius and narrow space navigation ability. The vehicle is electrically powered and uses only a single mechanical drive system, i.e. the direct differential drive. The drive system features a zero-radius steering capability to facilitate maneuvering over both land and water. This reduces vehicle dead weight, bulkiness and simplifies controller design. The automated guided system is placed within the compact body of the vehicle. The vehicle can switch to autonomous mode as required when in the confined or narrow areas. The autonomous mode will activate automatically during communication link cut off. This paper presents the design and fabrication works for the UTAR-AAV.

Keywords: Autonomous amphibious vehicle, Differential direction drive, Obstacle avoidance.

[RAM-030]

SHARED CONTROL FOR OBSTACLE AVOIDANCE IN INTELLIGENT WHEELCHAIRS

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Intelligent wheelchairs operating in dynamic environments need to sense its neighborhood and adapt the control signal, in real-time, to avoid collisions and protect the user. In this paper we propose a robust, real-time obstacle avoidance extension of the classic potential field methodology. Our algorithm is specially adapted to share the wheelchairs control with the user avoiding risky situations. This method relies on the idea of virtual forces, generated by the user command (attractive force) and by the objects detected on each ultrasonic sensor (repulsive forces), acting on the wheelchair. The resultant wheelchairs behavior is obtained by the sum of the attractive force and all the repulsive forces at a given position. Experimental results from drive tests in a cluttered office environment provided statistical evidence that the proposed algorithm is effective to reduce the number of collisions and still improve the user's safety perception.

Keywords: Intelligent wheelchairs, Obstacle avoidance, Potential field.

Session: MC4
Sensors and Mixed Topics

Date:	Monday, 28 June 2010
Time:	16:00 – 18:00
Chair(s):	Chu Kiong Loo and Y. S. Wong
Venue:	Room 4

[RAM-083]

IMPLEMENTATION OF ASYMMETRIC MULTIPROCESSING FRAMEWORK IN HUMANOID ROBOT

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In this paper, the characteristics and implementation of a new asymmetric multiprocessing (AMP) framework in humanoid robot are discussed. This proposed framework is used to replace computer network as the high level processing unit for the humanoid robot that is designed to perform object localization based on visual and auditory information. In this AMP framework, a multi-core computer is divided into several smaller virtual machines that own a part of the physical resources including processing core, memory and input/output (I/O) devices. Each virtual machine executes a guest operating system (OS) and dedicated applications, including colored object localization, sound source localization and multisensory information fusion and motion control. Xen paravirtualization technology is used to conveniently manage these guest OSes.

Keywords: Asymmetric multi-processing, Multi-core, Humanoid robot, Paravirtualization.

[RAM-208]

DESIGN AND SIMULATION OF FLEXURE-BASED PLANAR FORCE/TORQUE SENSOR

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This paper presents the design of a flexure-based planar force/torque sensor. The sensor is built as a monolithic structure with flexure components and strain gauges. The strains on the flexure components caused by loads will be sensed by the strain gauges and will be used to calculate the appropriate loads. This paper also presented the studies on the sensibility and the appropriate positions for bonding strain gauges.

Keywords: Force/torque sensor.

[RAM-249]

TIME OF FLIGHT BASED TWO WAY RANGING FOR REAL TIME LOCATING SYSTEMS

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Node positions in a wireless sensor network are required to track the nodes in real-time, but normally no prior information is given on deployment. A locating mechanism is required for such a purpose and in this paper a method is described to determine the point-to-point distance between two sensor nodes in an asynchronous location positioning system. A time-of-flight (TOF) based two-way ranging method, independent of network synchronization, is used. One critical factor that influences the round-trip time of a signal is the offsets between the crystal oscillators and their resolutions. These factors can educe temporal errors in the order of nanoseconds and eventually distance errors in the order of decimetres. The main idea of the proposed ranging method is to improve the accuracy and stability of estimated round-trip time for low frequency oscillators with inherent drift. It is demonstrated that a simple and effective iterative ranging algorithm reduces ranging error significantly. The analytical results of the algorithm are further corroborated by simulations.

Keywords: Two way ranging, Time of flight ranging, Locating system.

[RAM-214]

SIMULTANEOUS PERIODIC OUTPUT FEEDBACK CONTROL OF A SMART CANTILEVER BEAM WITH DATA FUSION

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This paper presents the design and simulation of simultaneous periodic output feedback controller to minimize structural vibration using piezoelectric actuator and sensor. The vibrating modes are measured by two homogeneous piezoelectric sensors. Sensors output are applied to individual information filters for estimating the states and the states generated by these filters are fused, which is applied as input to the controller. The performance of the controller is evaluated by considering three smart cantilever beams which differ in length and mass. The controller is simulated by exciting the structures at resonance and it is observed that, data fusion improves the closed loop response of the system, as compared to the response obtained with single sensor.

Keywords: Piezoelectric, Information fusion, Data fusion, Simultaneous periodic output feedback control.

[RAM-109]

SELF-AGGREGATION IN MULTI-AGENT SHAPE CONTROL

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This paper presents a new interactive force in shape control to deal with group fragmentation during movement toward a desired shape. The proposed interactive force can maintain minimum distance between agents as well as group unity. Unlike other collective potential functions which have only one local minima, the proposed one has a local minima area which increase the flexibility of group during movement in obstacle based environment. In fact this potential function divides the area around each agent into four distinct areas: separation area, neutral area, attractive area and inactive area. Simulation results show the performance of the proposed interactive force during maneuvering of agents in multi-obstacle environment.

Keywords: Swarm robotics, Shape control, Self-aggregation, Flocking behavior, Adaptive control.

[RAM-094]

HMM WITH EXPLICIT STATE DURATION FOR PROGNOSTICS IN FACE MILLING

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In this paper, the development of hidden Markov model with explicit state duration (Variable duration HMM) for face milling residual life distribution prognostics is presented. An HMM with explicit state duration is constructed by involving explicit state duration probability. The HMM with explicit state duration offers significant advantages over the conventional HMM in prognostics. The reason why including explicit duration has been both verified theoretically and experimentally in this paper. Moreover, two types of state duration pdf (Gaussian and Weibull distribution) have also been studied. VDHMM based prognostics is demonstrated with the case study which is face milling application. In the case study, the mean residual life calculated from both conventional HMM and VDHMM has been compared with the natural mean residual life. The results of the case study has shown that including the state duration as both Gaussian and Weibull distribution perform better than the conventional HMM.

Keywords: Tool condition monitoring, Hidden markov model, Prognostics.

[CIS-065]

INFERENTIAL ESTIMATION OF BIOPOLYMER (POLYESTER) QUALITY USING BOOTSTRAP RE-SAMPLING NEURAL NETWORK TECHNIQUE

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Nowadays, biopolymer has been actively used in two important areas in our daily activities; packaging and medical devices. The growing importance of biopolymer has triggered researchers to focus on this matter. One of the important criteria in production of biopolymer is the quality of the product itself. The high quality product is absolutely desirable. Therefore, a method of controlling biopolymer quality is certainly indispensible in this matter. Medical devices certainly demand a high quality biopolymer as these devices always get along with strict specifications in their production. Biopolymerization furthermore is a very nonlinear process which requires a powerful tool to tackle the nonlinearity of the process. Neural network is apparently a powerful tool especially in modeling nonlinear and intricate process. Nevertheless, single network may face problem such as lack generalization capability which can lead to poor performance of the model. Hence, a good alteration to the network is essential to extenuate the problem. Bootstrap re-sampling method is one way to tackle such a job. This work presented a prediction of biopolymer quality using bootstrap resampling neural network technique.

Keywords: Neural networks, Bootstrap re-sampling, Biopolymerization, Molecular weight.

Tuesday, 29 June 2010

Session: TA3
Advances in Social Humanoid Robotics

Date: Tuesday, 29 June 2010
Time: 10:30 – 12:30
Chair(s): Carlos Acosta and Zhou Changjiu
Venue: Room 3

[RAM-144]

FALSE ALARM METRICS: EVALUATING SAFETY IN HUMAN ROBOT INTERACTIONS

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Human robot teams combining the complementary capabilities of robots and humans towards solving potentially complex service tasks are gaining wide spread popularity. Many of these tasks will involve close interactions between the robot and the human it serves thereby making safety a crucial parameter. Erroneous interaction that inevitably arises between human and the robot causes accidents in service robotic applications. Currently, there are no metrics available in human robot interaction community for analyzing erroneous interactions. In this paper, we put forward a new class of false alarm metrics to define, classify and quantify the effects of erroneous interactions in human robot teams and explore the relationship between false alarms, and safety in service robots. We extend the receiver operating characteristics (ROC) curve commonly used in signal processing community to classify robots based on their associated risks. We also show the utility of the designed false alarm metrics and extended ROC curve by applying them to a service robot, Robo-Erectus@Home across tele-operation and semi-autonomous modes of autonomy.

Keywords: Human robot teams, False alarms, Human robot interaction metrics, Service robots, Receiver operating characteristic curve and autonomy modes.

[RAM-156]

OPTIMAL ENERGY GAIT PLANNING FOR HUMANOID ROBOT USING GEODESICS

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A novel gait planning method using geodesics for humanoid robot is given in this paper. Both center of gravity (COG) and the exact Single Support Phase (SSP) are studied in our energy optimal gait planning based on geodesics. The kinetic energy of a 2-dimensional inverted pendulum is obtained at first. We regard the kinetic energy as the Riemannian metric and the geodesic on this metric is studied and this is the shortest line between two points on the Riemannian surface. This geodesic is the optimal kinetic energy gait for the COG because the kinetic energy along geodesic is invariant according to the geometric property of geodesics and the walking is stable and no impact. Then the walking in Single Support Phase is studied and the energy optimal gait for the swing leg is obtained using our geodesics method. Finally, experiments using traditional joint angles interpolating method and using our geodesics optimization method are carried out respectively and the corresponding currents of the joint motors are recorded. With the currents comparing results, the feasibility of this new gait planning method is verified.

Keywords: Humanoid robot, Gait planning, Biped walking, Geodesics, Riemannian geometry.

[RAM-103]

VISUAL PERCEPTION SYSTEM FOR A SOCIAL ROBOT

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This paper describes a visual perception system which allows a social robot to conduct several tasks. The central part of this system is an artificial attention mechanism which is able to discriminate the most relevant information from all the visual information perceived by the robot. This attention mechanism is composed by three modules or stages. At the preattentive stage, a set of uniforms blobs or 'pre-attentive objects' is obtained. [1] Once the most salient objects are obtained, the semiattentive stage identifies and tracks some of them according to the tasks to accomplish. This tracking process allows to implement the 'inhibition of return', avoiding revisiting an attended object. Finally, the attentive stage also fixes the field of attention to the most relevant object depending on the behaviours to accomplish. Three behaviours have been implemented which allow the robot to detect visual landmarks in an initially unknown environment and to recognize and capture the upper-body motion of people interested in interact with it.

Keywords: Social robots, Active vision, Attention mechanism, Human-robot interaction, Visual landmark detection.

[RAM-104]

RECIPES FOR DESIGNING HIGH-PERFORMANCE AND ROBUST SOFTWARE FOR ROBOTS

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Until now, high-performance has been the main objective in software for robotics and, as a result, the ad-hoc implementations have been optimized for specific hardware and platforms. Nevertheless, there is a renewed interest in designing robot control architectures to be reusable and maintainable as possible, so that existing software modules can be adapted to new platforms and requirements, thus reducing the cost and time-to-market of the complete system. This paper presents the most relevant conclusions of a joint-work between researchers from the telecommunications world (a domain with stringent requirements for distributed and real-time embedded systems) and researchers in the field of robotics. The challenge consisted of identifying the best practices and tools currently available in software engineering for embedded systems and protocols in order to define a precise methodology for the design of a highperformance and robust software control architecture of a robot. We outline the problems detected in current software developed for robots and then propose solutions to them.

Keywords: Robotics, Middleware, Distributed programming, Real-time requirements, Performance.

[RAM-189]

TEACHING NEW TRICKS TO A ROBOT LEARNING TO SOLVE A TASK BY IMITATION

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Learning by imitation represent a useful and promising alternative to programming robots. This paper presents an approach for learning by imitation based on two functional elements used by humans to understand and perform actions. One is the representation of the body that contains information of the body's capabilities. The other one is a snapshot of the body and its relation with the environment at a given instant. These elements are believed to interact to generate among other abilities, the ability to imitate. Learning new tasks is then achieved by imitating the actions' goal as demonstrated. The experimental results with a humanoid robot are presented to validate the approach.

Keywords: Robot imitation, Body representation, Action representation.

Session: TA4
Robotics and Automation Applications

Date: Tuesday, 29 June 2010
Time: 10:30 – 12:30
Chair(s): Ching Seong Tan and Hamid Abdi
Venue: Room 4

[RAM-017]

PERFORMANCE EVALUATION OF ACTIVE VIBRATION CONTROL SCHEMES FOR FLEXIBLE ROBOT MANIPULATOR

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This paper describes the use of angular position control approaches for a flexible robot manipulator with disturbance effect in the dynamic system. A nominal characteristic trajectory following (NCTF) controller is used to actively control the vibration of flexible structures. The controller design, which is comprised of a nominal characteristic trajectory (NCT) and PI compensator, is free from exact modelling and parameter identification. The NCT is determined from an openloop response and the PI compensator is used to make the manipulator motion to follow the NCT. The effectiveness of the NCTF controller is evaluated and compared with delayed feedback signal (DFS) controller through simulations. A complete analysis of simulation results for each technique is presented in time domain and frequency domain respectively. Moreover, performances of the controller are examined in terms of vibration suppression and disturbances cancellation.

Keywords: NCT control, DFS control, Flexible robot manipulator.

[RAM-060]

TASK COMPLETION WITH PARTIALLY-FAILED MANIPULATORS

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An effort to maintain the availability of partially failed manipulator is addressed based on redundant trajectories obtained by primitive constraints. The objective is to facilitate the existing manipulators to continue their point to point motion tasks when a non catastrophic fault occurs into a joint. The fault is assumed as a joint locked failure. This is achieved through fault to primitive constraints mapping which gives the primitive constraints due to the faults. Then they are applied to update the manipulator constraints for the trajectory planning. Then it purposes a new trajectory in the case of availability. Finally the method is applied for a 6DOF manipulator and validated under a fault scenario within a simulation study and the results are presented.

Keywords: Fault tolerant systems, Fault recovery, Nonlinear systems, Fault accommodation, Robotics manipulators.

[RAM-074]

PRELIMINARY DESIGN OF VERTICAL TAKE-OFF AND LANDING (VTOL) UAV WITH STEERABLE VERTICAL THRUST EFFECT

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This paper presents the preliminary design of an aerial vehicle testbed based on the GFS-UAV implementation, namely the "Coanda[JLT]Craft". The modified GFS-UAV design uses the Coanda principle to provide lift with enough Vertical Thrust (VT) generated by the Coanda flow. The lift coefficient of the Coanda profile is investigated in our laboratory. A novel steerable design is introduced. This novel design provides an alternative for directional controls and for enhancing the flight stability. Our experiment shows that the steerable configuration is valid up to 10 m/s of Coanda surface flow speed for indoor applications.

Keywords: Coanda, Unmanned aerial, VTOL, UAV.

[RAM-169]

A GENERIC MODEL FOR A ROBOTIC AGENT SYSTEM USING GAIA METHODOLOGY: TWO DISTINCT IMPLEMENTATIONS

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The emergence of multi-agent systems in the past years has led to a necessity of developing new methodologies to assist in the requirements and architectural analysis, and in the design phases of such a system, and as a consequence, several Agent Oriented Software Engineering (AOSE) methodologies have been proposed. In this paper, we analyze the GAIA methodology and some proposed extensions, and use this methodology to design an abstract generic system model for an open multi-robot application. We then derive two distinct specific models for two different applications — the first with the intention of using intelligent wheelchairs in a hospital environment, and the second targeting the use of teams of autonomous aircrafts. The successful adoption of the generic model in the design stages of the two distinct systems not only validates the proposed model and shows that it can be used in open multi-agent systems, but also shows it is also flexible enough to be used in systems as diverse as these. By adapting the GAIA methodology for the design of open systems, this work enables designers to model open systems in a faster and simpler form, decreasing the time needed to complete several tasks, while maintaining a high-level overview of the system.

Keywords: AOSE, GAIA, Open systems generic model, Mobile agents, Multi-robot systems.

[RAM-225]

AUTOMATIC DETECTION AND RECOGNITION OF TRAFFIC SIGNS

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Automatic detection of road sign is a challenging but demanding job. A new approach namely automatic detection and recognition of traffic signs (ADRTS) considering color segmentation, moment invariants, and neural networks has been proposed in this paper. Experimental result proves the superior performance in the detection and recognition of road signs. Computational time complexity is also quite low that makes it applicable for the real time system.

Keywords: Traffic sign, Automation, Neural network, Moment invariants, Hu moment.

[RAM-205]

DESIGN AND SIMULATION OF MICRO-LINEAR ACTUATOR

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Micro linear actuators are applied to many precision fields such as ultra-precise positioning, precision manufacturing, optics, etc. The design of a micro-linear actuator is presented in this paper. The micro linear actuator includes a stacked piezo and a novel flexure-based differential amplifier mechanism. Stiffness, one of the most important factor to the resolution, is considered in the design step via an optimization problem using both analytical and finite element methods. The simulation of the designed actuator is also presented in the paper. Two problems, contact and strain-electricity coupling, are analized based on the ANSYS model to get the relation between the displacment, the voltage and the load applied on the actuator.

Keywords: Flexure, Linear actuator.

Session: TB1
Methodologies for Robotics and Automation

Date: Tuesday, 29 June 2010
Time: 13:30 – 15:30
Chair(s): Alireza Partovi and Hai Lin
Venue: Room 1

[RAM-129]

REAL-TIME SIMULATION OF A 3-LEG 6-DOF PARALLEL MANIPULATOR BASED ON RT-LINUX OPERATION SYSTEM

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The real-time multi-task simulation of a 3-leg 6-DOF high performance platform system based on RT-Linux operation system is presented in this paper. The new architecture is setup by three extensible legs sliding on three linear slide-rail each actuated by a synchronous linear servo motor. The extensible legs are actuated by inductive AC servo motors. In the meantime, the inverse and forward kinematical equations describing the motion of the platform system are derived. This kind of architecture using the hybrid (linear and AC) motors yields high performance of motions, especially in speed and working space. The novel result of maximal working angles is the significant contribution of this architecture.

The platform system is operated in the RT-Linux real-time multi-task executive environment, which is superior to windows, including: (a) RT-Linux real-time is hard real-time, (b) RT-Linux real-time operation system is free, (c) Multi-task can be scheduled by the optimum preemptive static scheduling algorithm. We have demonstrated the dynamic behavior of platform in the RT-Linux window and the OpenGL 3D/VR multi-medium.

Keywords: RT-linux, Parallel manipulator, Real-time multitask simulation, Linear servo motor.

[RAM-145]

TASK PLANNING FOR SERVICE ROBOTS WITH OPTIMAL SUPERVISORY CONTROL

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The problem of task planning for multiple service robot using supervisory control of discrete event systems is considered. We apply the optimal supervisory control technique to obtain the cost efficient task planning without degrading the quality of service. Specifically the cost function is assigned to each state transition. Then, we introduce an algorithm to minimize the maximum cost. Through an example, we verify the usefulness of our algorithm.

Keywords: Optimal supervisory control, DES, Task planning, Service robot.

[RAM-210]

ACCURATE MATHEMATICAL MODEL FOR DESCRIBING ELECTROHYDRAULIC LOADING SYSTEM OF HELICOPTER PITCH ADJUSTING HYDROMECHANICAL SERVOS

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This paper deals with the establishment of the exact mathematical model for describing the electro-hydraulic load system which is applied to the earth-experiment of the hydromechanical servomechanism (hydraulic assistor) for the helicopter pitch adjusting. Based on the working principle analysis of the electro-hydraulic load system, the accurate mathematical model of electric-hydraulic loading system is established and the influence of the model on the system characteristics is deeply analyzed. It is proved that surplus force is concerned with not only the velocity but also the acceleration of rudderpost. Moreover, the traditional structure invariance principle is improved. Experiments in the paper validate the correctness of complex mathematical model, of which the guiding effect in eliminating the extraneous force is revealed also.

Keywords: Electro-hydraulic load system, Force control, Hydraulic assistor, Mathematical model, Surplus force.

[RAM-211]

FEED RATE SERVO CONTROL FOR SPINDLE-LESS VENEER LATHE

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This paper deals with the issue on the feed rate servo control for the spindle-less veneer. First, the working principle, transmission process of the spindle-less veneer lathe, and the expected feed rate function are studied and analyzed; then concluded that the key of peeling control is coordinating the feed rate of the tool post with the actual peripheral speed of the log. We use rotary encoders to detect the actual peripheral speed of the log and the feed rate of the tool post, and adopt a digital controller to control the feed process of the tool post. In order to control the feed rate, we design a compound control law with the forward feed and feedback control for the sensor-less vector controller of the asynchronous motor. Analysis and the practical application illustrate that the proposed control law has excellent application value and market development prospect.

Keywords: Error ratio, Feed-forward control, Fuzzy adaptive control, Servos, Spindle-less veneer lathe.

[RAM-243]

MULTI-LAYER FLIGHT CONTROL SYNTHESIS AND ANALYSIS OF A SMALL-SCALE UAV HELICOPTER

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In this paper, we present a systematic procedure for the design of a controller for an autonomous helicopter. The studied model of the helicopter is a semi-linearized model, which includes some nonlinear parts that are separated from the linear blocks. The controller structure is a hierarchical controller which consists of two layers: the *inner-loop controller* that covers the linear parts of the model and the *outer-loop controller* that handles the nonlinear parts. The inner-loop controller aims at the attitude control of the helicopter and the outer-loop is responsible for its position control. The performance of the designed controller is demonstrated through the simulation and actual flight tests in the hovering situation and the path-tracking mode.

Keywords: Unmanned aerial vehicles, Hierarchical control, Inner-loop controller, Outer-loop controller.

[RAM-244]

STRUCTURAL CONTROLLABILITY OF HIGH ORDER DYNAMIC MULTI-AGENT SYSTEMS

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Recently, the controllability problem of multi-agent systems is significantly explored; however, the majority of studies have been focused on the classical controllability approaches. This paper investigates the necessary and sufficient conditions of structural controllability for high order dynamic multi-agent systems. We consider a group of agents in a leader-follower framework under a fixed topology structure. It is assumed that, the agents interconnection is a weighted graph with freely chosen weights and each agent has a high order controllable canonical dynamic. Under this setup we show that the structural controllability of such a network is directly determined by agent interconnection. It is shown that a set of weights can be found which make the entire network controllable if and only if the graph is connected. Finally, we present a numerical example and simulation to illustrate the results.

Keywords: Multi-agent systems, Structural controllability, High-order dynamic agents, Graphs.

[RAM-183]

ROBOT PATH SIMULATION: A LOW COST SOLUTION BASED ON CAD

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The benefits of robot simulation technology have been recognized by scientists and engineers, with

applications ranging from simple robot path simulation to complete robotic cell layout simulation. Robot simulation is one of the essential elements of modern and agile manufacturing plants, as it allows to visualize and test a robotic system, even if it does not exist physically. High-growth industries and emerging manufacturing processes will increasingly depend on advanced robot technology such as robotic simulation. Robot path simulation is a very useful process to predict and pre-evaluate performance of robot programs generated off-line. This paper presents a simulation system where a relatively low cost and commercially available 3D CAD package is used as an interface to visualize/simulate preprogrammed robot paths. The developed system is intuitive and friendly, so that in a few minutes any user without knowledge of CAD and robot programming will be able to simulate robot paths and visualize it in a CAD environment. This way, this simulator can be useful for small and medium sized enterprises and for educational purposes. Three different experiments (simulation of robot motion/paths) are presented and discussed: a material handling task; a robot performing work in the footwear industry (shoes soles); and finally, the simulation of robot paths for a robot operating in a bending cell. The experimental results showed that the proposed system is flexible, easy to use and efficient. This paper also covers topics like how simulation makes robot programming easier, advantages and disadvantages of simulation in robotics, and the future trends in this field. Finally, the results of the experiments will be analyzed and discussed. The pros and cons of the system in relation to off-the-shelf robot simulation packages are analyzed.

Keywords: Robot, Simulation, CAD, Low cost.

Session: TB2
Modeling, Planning and Control II

Date: Tuesday, 29 June 2010
Time: 13:30 – 15:30
Chair(s): Brigida Monica Faria and Jian Xu
Venue: Room 2

[CIS-232]

DYNAMIC SHIFT MECHANISM OF CONTINUOUS ATTRACTORS IN A CLASS OF RECURRENT NEURAL NETWORKS

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Continuous attractors of recurrent neural networks (RNNs) have attracted extensive interests in recent years. It is often used to describe the encoding of continuous stimuli such as orientation, moving direction and spatial location of objects. This paper studies the dynamic shift mechanism of a class of continuous attractor neural networks. It shows that if the external input is a gaussian shape with its center varying along with time, by adding a slight shift to the weights, the symmetry of gaussian weight function is destroyed. Then, the activity profile will shift continuously without changing its shape, and the shift speed can be controlled accurately by a given constant. Simulations are employed to illustrate the theory.

Keywords: Continuous attractors, Dynamic shift mechanism, Shift speed, Symmetric gaussian function, Recurrent neural networks.

[CIS-184]

MACHINE LEARNING ALGORITHMS APPLIED TO THE CLASSIFICATION OF ROBOTIC SOCCER FORMATIONS AND OPPONENT TEAMS

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Machine Learning (ML) and Knowledge Discovery (KD) are research areas with several different applications but that share a common objective of acquiring more and new information from data. This paper presents an application of several ML techniques in the identification of the opponent team and also on the classification of robotic soccer formations in the context of RoboCup international robotic soccer competition. RoboCup international project includes several distinct leagues were teams composed by different types of real or simulated robots play soccer games following a set of pre-established rules. The simulated 2D league uses simulated robots encouraging research on artificial intelligence methodologies like high-level coordination and machine learning techniques. The experimental tests performed, using four distinct datasets, enabled us to conclude that the Support Vector

Machines (SVM) technique has higher accuracy than the k-Nearest Neighbor, Neural Networks and Kernel Naïve Bayes in terms of adaptation to a new kind of data. Also, the experimental results enable to conclude that using the Principal Component Analysis SVM achieves worse results than using simpler methods that have as primary assumption the distance between samples, like k-NN.

Keywords: Machine learning, Principal component analysis, Support vector machines, RoboCup, Soccer simulation.

[CIS-122]

AUTOMATIC 3D WIRE LOOP TRACING IN COMPUTED TOMOGRAPHY IMAGES USING EXTENDED GENERALIZED CYLINDER MODELING

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Automobile industry requires 100% inspection of every electronic component used. If a wire bonding device has a failure rate of 1ppm, it would have the consequence of 15 of 1000 cars would fail. In this paper, we propose a method for tracing and inspecting 3D wire loops in a sealed semiconductor device using X-ray CT. 3D primitives are detected in predefined planes with a subpixel transition detection algorithm. Potential wire centroids are then calculated with deformable generalized cylinders employing an adaptive shape constraint to minimize the interferences from beam-hardening artifacts. Tracing of wires are performed in 2D projection space and mappings are done to find 3D correspondences. To test the capability of the software, we scanned semiconductor wirebond devices with a low resolution X-ray CT system and process slices at present of large amount of artifacts. It is shown that wire loops can be detected reliably with subvoxel accuracy. The processing time for 10 wires is 30 seconds (using a laptop with Intel dual core 1,6G processor).

Keywords: Generalize cylinder model, 3D wire segmentation, CT image processing, Deformable model.

[CIS-028]

RFIDMANIA EXTENSIBLE AND ADAPTABLE RFID MIDDLEWARE AND SPECIFICATIONS

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Radio Frequency Identification technology is an emerging technology that allows objects to be electronically tagged and identified wirelessly. In recent years, many organizations have started to show interest in porting this technology to their existing business processes. With the increase in popularity of the technology, many vendor-specific RFID readers are being manufactured and sold to interested organizations. Deployment of such RFID readers to existing business processes is difficult as software developers need to understand each vendor-specific RFID reader, due to lack of standardization among RFID readers. This paper describes a scalable and adaptable middleware, called RFIDMania, designed to allow software developers to interact with any RFID reader without having to know the specifics of the reader. RFIDMania provides a framework to process data received from RFID tags, and translate, decode, filter and route the data to the application in the form of an event. RFIDMania is able to offer software developers a framework to deliver portable generic code that is not tightly coupled with hardware specific commands.

Keywords: RFID, Specification, XML, Java.

[RAM-216]

CO-ORDINATION IN ROBOCUP'S 2D SIMULATION LEAGUE: SETPLAYS AS FLEXIBLE, MULTI-ROBOT PLANS

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Strategic planning and multi-agent coordination are major research topics in the domain of RoboCup. Research was, in the first years, directed towards development of low level skills and positional co-ordination. The competitive level has in between risen to new standards, which makes the development of highlevel co-operation necessary.

The importance of the concept of *Setplay*, i.e., small multirobot plans to deal with particular situations, to structure a robotic soccer team behaviour, has been acknowledged by many researchers, but no general framework for the development and execution of generic *Setplay* has been introduced in the context of RoboCup. This paper presents such a framework for high-level *Setplay* definition and execution in the 2D simulation league, though applicable to any RoboCup co-operative league and similar domains. The framework is built upon a standard, flexible and league-independent language, which defines *Setplay* that are interpreted and executed at run-time, using inter-robot communication.

A major step in the development of the *Setplay* framework is its usage and testing in the scope of the FCPortugal team, which participates in the RoboCup 2D-simulation league, where it won several titles. After this successful implementation, described in this paper, the framework will be used in the mid-size league, and possibly in other new environments. Recent developments have made it possible to use *Setplays* in play-on situations, which had not been possible before. Also, a graphical tool for *Setplay* definition has been developed, and used in the context of this team.

[RAM-240]

SYNCHRONIZED TASK DECOMPOSITION FOR TWO COOPERATIVE AGENTS

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One of the most important issues in top-down cooperative control of multi-agent systems is to decompose the global specification in order to design the local supervisors such that the fulfilment of these sub-specifications by each individual agent, results in the satisfaction of the global specification as a team. Given the global desired behavior, represented as an automaton, and the distribution of its events into local plants, the question is whether it is always possible to decompose the task automaton into a finite number of sub-automata such that the parallel composition of sub-automata is bisimilar to the original task automaton, and if not, what are the necessary and sufficient conditions for such decomposability. It is shown that it is not always possible to do so. We then present the necessary and sufficient conditions for decomposability of a given task automaton such that the parallel composition of these local task automata bisimulates the original task automaton. It is found that the task automaton is decomposable if and only if it satisfies some symmetry properties, representing independence of the order and the choice of private events from different local event sets, and some properties on the interleaving of strings that share the same first appearing common event. This result will help to design the local controllers from the global logical specification, to be used in the top-down cooperative control of distributed systems.

Keywords: Task automaton decomposition, Cooperative control, Multi-agent systems.

Session: TB3
Computer and Robot Vision I

Date:	Tuesday, 29 June 2010
Time:	13:30 – 15:30
Chair(s):	Evangelow Georgiou and Chingseong Tan
Venue:	Room 3

[RAM-006]

RECOGNITION OF OCCLUDED OBJECTS BY FEATURE INTERACTIONS

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The main challenge for occlusion problem is that features from different objects tend to interact and cause recognition failures for traditional object recognition algorithms where even matched feature points do not necessarily lead to successful recognitions. Feature interactions may be the key to recognize occluded objects. In this paper, we propose a framework to integrate local feature interactions in terms of color, texture and geometry into spectral matching. Appearance similarity will serve as a *prior* to compensate the sensitivity of spectral matching towards noisy data caused by occlusions. Accordingly incorrect correspondences can be discarded by remaining the geometrical consistency in the formed affinity matrix. Because of our informative similarity matrix, objects under severe occlusions can still be recognized and matching errors dramatically reduced in recognizing both 2D and 3D occluded objects.

Keywords: Occlusion, Geometry, Appearance, Graph matching.

[RAM-008]

CONTOUR FEATURE DETECTION BASED ON GESTALT RULE AND MAXIMUM ENTROPY OF NEIGHBORHOOD

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A novel approach is presented to detect contour of object. Firstly, the zero-cross operator to imitate the visual receptive field is used to detect edge of image. Secondly, facing the large amount of noise in complex background, the neighborhood description operator is designed, and the neighborhood information of interesting point is analyzed as well. Then the contours of objects are acquired by combining with the Gestalt psychology theories. During the process, the maximum entropy and state transition probability of feature mode are introduced to ensure the effectiveness of contour detection. Finally, the experiments verify the validity of the proposed method.

Keywords: Contour detection, Gestalt rule, Maximum entropy.

[RAM-025]

A VISION-BASED STRATEGY FOR AUTONOMOUS LIFT OPERATION

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Efficiency and accuracy are two crucial factors for autonomous robot operation. In this paper, we present a visionbased strategy for autonomous lift operation including panel and button detection method using a webcam. Two key problems are (1) scale variance during lift operation and (2) image deformation caused by the angle between robot and target. The approach presented here demonstrates its capability of handling these problems. The process has three steps: (1) panel hunting for a coarse localization; (2) panel verification at a close distance; and (3) button detection and localization. Our method shows the weak perspective model outperforms the affine model.

Keywords: Weak perspective transformation, Autonomous robot, Affine transformation.

[RAM-056]

VISUAL SELF-LOCALIZATION FOR NONHOLONOMIC MOBILE ROBOTS USING A HYBRID SKIP-LIST INSPIRED SEARCH ALGORITHM WITH A GRADIENT POLICY

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This paper presents a novel approach of using visual odometry for the self-localization of a maneuverable mobile robot configuration. This system is predominantly adapted to mobile robots that require autonomous positioning information at a low computation cost for real time applications. This system uses an over-head camera that captures images of the maneuvering mobile robot with two non-natural marker tags that tracks the vehicle and returns the vehicles orientation and its relative positional coordinates. This paper presents a brief discussion on typical procedures used to achieve self-localization of nonholonomic mobile autonomous robots. The developed Hybrid Skip-list Deterministic Search Algorithm with a Gradient Policy self-localization system is presented as it is integrated to a two wheel autonomous maneuverable mobile robot configuration. Finally, the theoretical and experimental results are presented that allow characterization of the performance of the selflocalization system, illustrating the robustness and resilience of using a hybrid solution over a computation-hungry systematic solution.

Keywords: Visual odometry, Mobile robot, Nonholonomic, Self localization, Skip-list, Gradient policy.

[RAM-247]

MEASUREMENT OF THE EFFECTIVE FOCAL LENGTH BY THE CENTERLINE DETECTION OF LIGHT STRIPES

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A composite method for detecting the centerline of straight light stripe is presented in this paper. In order to locate the image of stripe, a conditional dilation algorithm based on mathematical morphology is proposed to extract the regions of interest (ROI), and a shape factor is applied to eliminate the disturbance regions, so the straight light stripes are determined finally. Barycenter method is used to detect the centerline of stripe, and the outliers on the detected centerline are removed by a method

based on probabilistic theory. The novel method has been used in the effective focal length measurement and the accuracy of measurement is better than 0.2%.

Keywords: Centerline detection, ROI extraction, Conditional dialtion algorithm, Effective focal length measurement.

[RAM-118]

PRELIMINARY STUDY ON VISUAL GUIDANCE FOR AUTONOMOUS VEHICLE IN RAIN FOREST TERRAIN

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In this paper, a review of visual guidance systems of autonomous vehicle is presented. The challenges of autonomous navigation in rainforest or tropical terrain are highlighted. There are several methods used in navigation system of the autonomous vehicle and it is shown that vision system remains a key-enabling component for successful navigation system. Color feature is used to examine the general requirement for visual guidance applied in rain forest terrain. The potential usage of polarizer to detect water bodies is demonstrated. The aim of this study is to give overview of visual guidance system and examining the key challenges in autonomous rain forest navigation.

Keywords: Visual guidance, Autonomous vehicle, Rainforest terrain, Unstructured terrain, Polarization.

[RAM-061]

THE DESIGN OF JUMP SHOT DECISION-MAKING SYSTEM FOR A BILLIARD ROBOT

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The objective of this research is to develop the jump shot and offensive/or defensive decision-making system for the billiard robot by using Extension theory. The purpose is to let billiard robot posses the imitation ability of how human beings make the jump shot and offensive/or defensive decision-making in the nine ball pool games. The billiard robot will make the straight shot if there is no block ball, otherwise execute jump shot, cushion offense shot or cushion defense shot automatically. The jump shot and offensive/or defensive decision-making system can choose the best strategy in the block ball game. If the ball game is not suitable for using jump shot attack, the offensive/or defensive decision-making system will be applied to make offense cushion shot or defense cushion shot.

Keywords: Billiard robot, Extension theory, Jump shot decision-making system, Offensive/or defensive decision-making system.

Session: TB4
Underwater & Flying Robots

Date: Tuesday, 29 June 2010
Time: 13:30 – 15:30
Chair(s): Simon Watson and Albert Albers
Venue: Room 4

[RAM-119]

USING MTF FOR AUTOMATED GATED IMAGING SYSTEM IN TURBID MEDIUM

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This paper introduces an auto-tuning range-gated imaging system in turbid medium. The automated gated imaging system is able to auto-tune the best image quality by using the MTF evaluation technique. For a typical gated system, the gated images are recorded into video format in increasing gate opening time, each frame of the video recorded is basically to slice the targets at different distance from camera (based on time of light). Each frame would only able to show the targets within the specifically "sliced" target distance, which limits the capability of gated imaging system. Thus, it is necessary to develop autotuning system that will overcome the limitation in turbid water condition. In this paper, all enhanced target images within the field of view (FOV) are fused into one 3D image, and this will increase the efficiency of the study and works under turbid medium condition. Works had been done in selecting a quantitative image quality index for automated tuning system so that images with better quality can be detected accurately in turbid conditions. The non-reference measuring index-Modulation Transfer Function (MTF) can perform better in analyzing images under turbid condition thus is selected for this application. Experiment

results show that the mid-band spatial frequencies from 21 to 61 demonstrate the degradation of image quality due to the turbid water backscattering noises. Thus, we propose to use MTF in the auto-tuning system to select best quality target from multiple images that scan thru the various gate timing. Subsequently, image fusion is performed to fuse multiple gate opening time images into a 3D extended targets turbid condition.

Keywords: Range gated imaging system, Turbid water, Image processing, Time of flight.

[RAM-021]

ON THE DEVELOPMENT OF AN UNMANNED UNDERWATER ROBOTIC CRAWLER FOR OPERATION ON SUBSEA FLEXIBLE RISERS

P. Chatzakos[1,a], V. Papadmitriou[1], D. Psarros[1], Ian Nicholson[2] and Tat-Hean Gan[2,b]

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Flexible risers are used for supplying oil from the deep sea to the offshore platforms and FPSOs. This paper presents the design and development of an unmanned robotic crawler for operation on subsea flexible risers. The goal is to provide the oil industry a tool for carrying equipment on flexible risers. The robot has been developed to crawl on the external surface of flexible risers. It moves along and around the riser using an inch-worm type motion. Novel under-actuated end effectors have been conceived and developed to hold the robot on the riser, without permanent influence to the flexible riser surface and geometry. In principle, the current design with modification could operate up to 2000 m sea depth. In this paper, customization of the robot operation principles to carry and deploy digital radiographic equipment for the volumetric inspection of flexible risers is described in detail. Currently, there exists no equipment that can perform reliable non-destructive inspection of subsea flexible risers. Robot performance has been experimentally validated and these results are presented here for the first time. The resulting crawling performance has been proved to be independent of its environment.

Keywords: Robotics, NDT, Underwater, Radiography, Flexirisers.

[RAM-096]

A NOVEL FLY OPTIMIZATION ALGORITHM FOR SWARMING APPLICATION

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This paper presents an initial development stage of Fly Optimization Algorithm which will be used for the path planning system of a swarm of autonomous surface vehicles. This algorithm was initially designed to be implemented for a swarm of robots which would be able to locate the deepest portion of lakes. The ability of the robots to reach the designated target points will therefore also be considered.

Keywords: Drosophila, Metaheuristics.

[RAM-160]

DESIGN CONSIDERATIONS FOR MICRO-AUTONOMOUS UNDERWATER VEHICLES (μAUVS)

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Mobile Underwater Sensor Networks provide an attractive solution to the problem of obtaining measurements from within liquid-based industrial processes. Most underwater vehicles are aimed at oceanographic applications and are therefore too large to be used in comparatively small processes. This paper sets out the design considerations for the development of a Micro-Autonomous Underwater Vehicle (μAUV) for use in a process environment.

Keywords: Autonomous underwater vehicles (AUVs), Underwater sensor networks, Nucelar storage ponds.

[RAM-175]

PROPULSION SYSTEMS FOR MICRO-AUTONOMOUS UNDERWATER VEHICLES (μAUVS)

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The development of small-scale sensor platforms for the internal monitoring of aqueous processes

creates a range of challenges in terms of the provision of mobility. De-coupled x-y plane and z-axis movement, the need for low power consumption and a minimum of 4 degrees of freedom means that the suitability of conventional propulsion systems needs to be investigated. This paper presents a brief summary and comparison of the available propulsion options. Propellers have been chosen as the best means of propulsion and a novel approach to modeling and selection of both motors and propellers is given. The thruster configuration and initial mechanical designs for a μAUV are also outlined.

Keywords: Autonomous underwater vehicles (AUVs), Underwater sensor networks, Propulsion, Buoyancy systems.

[RAM-170]

SEMI-AUTONOMOUS FLYING ROBOT FOR PHYSICAL INTERACTION WITH ENVIRONMENT

Albert Albers, Simon Trautmann, Thomas Howard, Trong Anh Nguyen, Markus Frietsch[a] and Christian Sauter

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This contribution presents the first results of the development of an unmanned aerial vehicle (UAV) which is capable of applying force to a wall while maintaining flight stability. This is a novel idea since UAVs are used so far only for tasks without physical contact to the surrounding objects. The basis for the work presented is a quadrotor system which is stabilized with an inertial measurement unit. As a new approach an additional actuator was added to generate forces in physical contact while the UAV stays horizontal. A control architecture based on ultrasonic distance sensors and a CMOS-camera is proposed. The performance of the system was proved by several flight tests. Potential applications of the system can be physical tasks at high places like cleaning windows or walls as well as rescue or maintenance tasks.

Keywords: Flying robot, UAV, Quadrotor, Helicopter, Physical interaction, Cleaning tasks.

[RAM-130]

FORMATION CONTROL FOR MULTIPLE MOBILE ROBOTS BASED ON THE SPIKING NEURAL NETWORK

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In this paper, a Spiking Neural Network (SNN) based controller is designed to fulfill the task of formation control of multiple mobile robots. The neural network contains three layers with different neuron model for different layer: the input layer encodes the inputs including sensor and task-related information by leaky integrate-and-fire (LIF) neurons, the hidden layer uses the approximate coincidence detection coding to fuse the information from the input layer and the spike response model (SRM model) is applied to the output layer to fire spikes to drive the motors. By the leader-follower strategy and the SNN controller, the multiple mobile robots system can realize the formation control. The validity of this controller is testified by the simulations.

Keywords: Spiking neural network, Multiple mobile robots, Formation control.

Session: TC1
Intelligent Transportation

Date:	Tuesday, 29 June 2010
Time:	16:00 – 18:00
Chair(s):	Roland Wischenewski and Yong Chia Tan
Venue:	Room 1

[RAM-105]

PARKING CONTROL OF A CENTER-ARTICULATED MOBILE ROBOT IN PRESENCE OF MEASUREMENT NOISE

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Articulated steering vehicles (with active joint) are preferable for navigation in narrow environments due to their high maneuverability. In order to achieve closed-loop control of a center-articulated mobile robot, feedback from the goal's position and orientation is needed. In practice, the measurement would be noisy. In this paper, we first investigate

a kinematic model for center-articulated mobile robots, and propose a method to control a parking maneuver. Then, using a beacon-based positioning system, we show the effectiveness of this method in the presence of measurement noise.

Keywords: Articulated steering, Parking control, Measurement noise.

[RAM-112]

MODIFIED TRAJECTORY SHAPING GUIDANCE FOR AUTONOMOUS PARALLEL PARKING

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This paper presents a novel and computationally inexpensive method for motion planning of autonomous parallel parking of four wheeled nonholonomic vehicles. The proposed method makes use of Trajectory Shaping Guidance, given in [1] and [2], which was originally developed for missiles to hit the target at a given angle. This paper uses a modified version of Trajectory Shaping Guidance (TSG) for path planning. The method computes a feasible path by inherently considering nonholonomic constraints of the vehicle. Detailed simulation results show the robustness, simplicity and efficiency of the proposed method.

Keywords: Path planning, Autonomous vehicles, Automated guided vehicles, Automotive control, Navigation systems, Trajectory planning.

[RAM-178]

OPERATING MANAGEMENT OF INTELLIGENT & AUTONOMOUS MIMO VEHICLES

Wissam Khalil[a], Rochdi Merzouki and Belkacem Ould-Bouamama

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In this work, a dynamic graphical model of operating modes of intelligent and autonomous multi inputs multi outputs (MIMO) vehicles is presented. This study shows the feasibility of improving the traffic management and decision inside confined space according to the operating situation of each involved vehicle. The proposed dynamic graphical model depends on the on-line monitoring outputs of the vehicles' actuators. These outputs correspond to the dynamic model based residuals of the actuators. Co-simulation using experimental data show the interest of the developed model.

Keywords: Dynamic graphical modeling, Intelligent autonomous vehicles, Monitoring, Fault detection and isolation.

[RAM-032]

A NEW HYBRID TIME-BASED / EVENT-BASED SIMULATION METHOD FOR TRANSPORT SYSTEMS CONSIDERING PHYSICAL EFFECTS

Roland Wischnewski[1] and Jürgen Roßmann[2]

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Current concepts for the simulation of transport systems within industrial production plants can be divided into two non-overlapping categories. Time-based concepts simulate physics for few carriers whereas event-based concepts handle many carriers at high abstraction level. We present a new hybrid hierarchical time-based/event-based method to combine the benefits of both concepts. New methods allow for 3-D simulation including physical effects without having to model carriers' masses. The simulation does not calculate forces and thus can be fast for more than a hundred carriers together with peripheral devices. We also describe some applications to prove the practical validity of the new methods.

Keywords: Simulation, Time-based, Event-based, Transport systems, Virtual production.

[RAM-085]

ROBOT PATH PLANNING BASED ON FOUR POINT-EGSOR ITERATIVE METHOD

Azali Saudi[a] and Jumat Sulaiman[b]

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This paper proposed a weighted block technique based on a block of four points known as 4 Point-EGSOR iterative method to solve path planning problem for mobile robot. It is based on the use of Laplace's equation to represent potential function in the configuration space of the robot. The experiment is carried out by applying finite-difference technique to produce smooth path that is free from local minima creation. The simulation results show that 4 Point-EGSOR method performs faster than

the previous method in generating path for mobile robot motion.

Keywords: Mobile robot path planning, Laplace's equation, Explicit group, Four Point-EGSOR iterative method, Harmonic functions.

[RAM-116]

AUTOMATED FOOD ORDERING SYSTEM WITH INTERACTIVE USER INTERFACE APPROACH

Yong Chai Tan[a], Kien Loong Lee, Zhi Chao Khor, Kae Vin Goh, Khim Leng Tan and Bent Fei Lew

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An Automated Food Ordering System using Interactive User Interface approach was created to improve the current food ordering system. A computer screen will be placed on each table for customers to make their order. Order will be sent to the server in the kitchen. Food will be delivered to customers using a robot controlled via wireless transmitter.

Keywords: Food ordering system, Interactive user interface.

Session: TC2
Dynamics and Motion Control;
Biologically-Inspired Robots and Systems

Date: Tuesday, 29 June 2010
Time: 16:00 – 18:00
Chair(s): Hamid Abdi and Zhao Liu
Venue: Room 2

[RAM-018]

A NEW CONTROL ALGORITHM FOR A PASSIVE TYPE DANCE PARTNER ROBOT

Zhao Liu[1,a], Chenglong Fu[1,b], Ken Chen[1,c], Yoshinori Koike[2,d], Yasuhisa Hirata[2,e] and Kazuhiro Kosuge[2,f]

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In this paper, the control algorithm of a female type dance partner robot called PDR was introduced to achieve dance between the robot and a male dancer with physical interaction. PDR is a passive type mobile robot and developed based on the concept of passive robotics. Firstly, the characteristics of servo brake were analyzed, according to the kinematic model and control constraint condition, the motion was divided into 8 states. Then the set of feasible brake torque was analyzed, which is a subset of whole brake torque, this makes the control of passive type robot more complicated than general mobile robots. When the desired force is within this set, the brake torque for each wheel can be derived by static equation, otherwise, the assistance force applied by male dancer is employed. Considering the passivity of PDR, non-time based path tracking control was proposed for dance step tracking, and a fast orthogonal projection algorithm was proposed to achieve non-time based control. Experimental results illustrated the validity of the proposed concept.

Keywords: Passive robot, Dance partner robot, Servo brake, Non-time based path tracking.

[RAM-059]

JOINT VELOCITY REDISTRIBUTION FOR FAULT TOLERANT MANIPULATORS

Hamid Abdi[a] and Saeid Nahavandi[b]

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If the end-effector of a robotic manipulator moves on a specified trajectory, then for the fault tolerant operation, it is required that the end-effector continues the trajectory with a minimum velocity jump when a fault occurs within a joint. This problem is addressed in the paper. A way to tolerate the fault is to find new joint velocities for the faulty manipulator in which results into the same end-effector velocity provided by the healthy manipulator. The aim of this study is to find a strategy which optimally redistributes the joint velocities for the remained healthy joints of the manipulators. The optimality is defined by the minimum end-effector velocity jump. A solution of the problem is presented and it is applied to a robotics manipulator. Then through a case study and a simulation study it is validated. The paper shows that if would be possible the joint velocity redistribution results into a zero velocity jump.

Keywords: Robotic manipulator, Fault tolerant, Optimal control, Actuator fault.

[RAM-108]

ENTRAINMENT PROPERTY ANALYSIS OF VAN DER POL OSCILLATOR DRIVING A SPRING-MASS SYSTEM FOR LARGE FORCE GENERATION BY AVERAGING METHOD

Jun Kobayashi

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This paper presents a mathematical proof of the entrainment property of Van der Pol (VDP) oscillator driving a spring-mass system for large force generation. The entrainment property enables the mechanical system to generate a large force despite smaller amount of driving torques. Although it has been already confirmed by simulations using a manipulator model that a method with the VDP oscillator is effective in efficient large force generation, any mathematical proof that supports the simulation results has not been provided yet. In this paper, using an averaging method, which is a technique for nonlinear system analysis, we derive an approximated model of a springmass system driven by the VDP oscillator, and then prove the entrainment property of the VDP oscillator that realizes efficient large force generation based on the model.

Keywords: Large force generation, Oscillatory motion, Van der Pol oscillator, Entrainment, Averaging method.

[RAM-033]

MOTION PLANNING ALGORITHM FOR A MOBILE ROBOT SUSPENDED BY SEVEN CABLES

A. Capua[1,a], A. Shapiro[1,b] and S. Shoval[2]

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In this paper we present a motion planning algorithm for a mobile robot, suspended by seven cables. We formulate the motion planning algorithm as a convex optimization problem. We analyze the robot's statics and kinematics in order to implement them into the motion planning. The robot consits of cable mechanisms and a central body. Each cable mechanism includes a thin cable with a simple gripper at the end, and a dispensing and rolling mechanism. The robot dispenses the cables towards possible grasping points in the surroundings, and then pulls the cables simultaneously in a coordinated manner.Depending on the geometry of the grasping points and the coordinated pulling, the robot can perform stable motion over curved surfaces or around and over obstacles. Simulations results are presented as well as experiments which are conducted on a novel underconstrained four cable suspended mobile robot.

Keywords: SpiderBot, Cable suspended robot, Underconstrained cable suspended robot.

[RAM-079]

A NEW BIONICALLY INSPIRED APPROACH TO INCREASE POSITIONING ACCURACY OF ROBOTIC SYSTEMS

Albert Albers, Simon Hörter and Markus Frietsch[a]

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In state of the art robotics, high positioning accuracy is achieved by using solid and stiff components as well as powerful drive units which have no backlash. In contrast, human beings are able to achieve remarkable high positioning accuracy despite of low mass, low power consumption and relatively simple mechanics. One approach to obtain this accuracy is to temporarily create additional supporting structures by interacting with the direct environment, e.g. supporting the heel of the hand on a table for writing. This article deals with the essential idea of applying this method correspondingly into the field of robotics. It points out advantages and disadvantages as well as possibilities to realize this method in different scenarios. With simplified conditions, the influence of propping up on the stiffness and hence on the positioning accuracy is examined using different simulation models. It turns out that blocking of even one degree of freedom in one direction, can lead to a significant improvement regarding stiffness and therefore positioning accuracy. This approach could be used in diverse applications e.g. deburring with an industrial robot or in a humanoid robot to increase the reliability of a process or to reduce cost of components.

Keywords: Robotics, Bionical, Kinematics, Dynamics, Positioning accuracy.

[RAM-036]

CAD-BASED OFF-LINE ROBOT PROGRAMMING

Pedro Neto[1,a], J. Norberto Pires[1,b] and A. Paulo Moreira[2]

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Traditional industrial robot programming, using the robot teach pendant, is a tedious and time-consuming task that requires technical expertise. Hence, new and more intuitive ways for people to interact with robots are required to make robot programming easier. The goal is to develop methodologies that help users to program a robot in an intuitive way, with a high-level of abstraction from the robot language. In this paper we present a CAD-based system to program a robot from a 3D CAD environment, allowing users with basic CAD skills to generate robot programs off-line, without stop robot production. This system works as a human-robot interface (HRI) where, through a relatively low cost and commercially available CAD package, the user is able to generate robot programs. The methods used to extract information from the CAD and techniques to treat/convert it into robot commands are presented. The effectiveness of the proposed method is proved through various experiments. The results showed that the system is easy to use and within minutes an untrained user can set up the system and generate a robot program for a specific task. Finally, the time spent in the robot programming task is compared with the time taken to perform the same task but using the robot teach pendant as interface.

Keywords: CAD, Robot programming, HRI, Intuitive programming, Industrial robot, Off-line programming.

Session: TC3
Computer and Robot Vision II

Date: Tuesday, 29 June 2010
Time: 16:00 – 18:00
Chair(s): Ray Jarvis and Mehmet Guzel
Venue: Room 3

[RAM-186]

SELF-LOCALIZATION OF HUMANOID ROBOTS WITH FISH-EYE LENS IN A SOCCER FIELD

Bo Tian, Chuen-Leong Ng and Chee-Meng Chew

Department of Mechanical Engineering, National University of Singapore, Singapore

The robot localization problem has been studied for decades and the particle filter algorithm has been successfully applied for the localization of wheel-based mobile robots. In this paper, we provide an implementation of the particle filter algorithm for the self-localization of our soccer playing humanoid robots, RO-PE (RObot for Personal Entertainment) VI, which participate in the Humanoid League (kid-size) of RoboCup in the past few years. The localization algorithm enables the robot to localize itself with respect to the soccer field. For our robot platform, there are a few challenges, such as the locomotion system has high variability in achieving the actual displacement; the vision system employs a fish-eye lens which has significant distortion and suffers from the oscillation caused by the locomotion; and limited computational power. In this paper, we propose a series of solutions for all these challenges and show their effectiveness by implementing the algorithm on the physical robots.

Keywords: Humanoid robot, Biped, Particle filter, Localization.

[RAM-029]

A NOVEL APPROACH FOR REAL TIME EYE STATE DETECTION IN FATIGUE AWARENESS SYSTEM

H. Wang, L. B. Zhou[a] and Y. Ying

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This paper proposes a novel eye state detection approach to construct an efficient real time driver fatigue awareness system with an ordinary webcam. Eye state detection has given big challenges to researchers as eye block takes only a small part of input image and can show at various appearances for its flexibility. Moreover, light illumination and viewpoint changes cause more confusions and difficulties for PC to robustly extract eye structure such

as contours and iris circles. We transfer this tough problem to a classification problem by combining a discriminative feature, namely Color Correlogram, with machine learning method (Standard Adaboost in this paper). The novelty of this work is that we can efficiently and robustly detect eye states in real time with a single ordinary webcam, even in somewhat harsh conditions such as certain lighting changes, head rotation and different objects. Experimental evidence supports this method well and human fatigue conditions are simultaneously measured based on eye states.

Keywords: Eye state detection, Color correlogram, Adaboost, Fatigue awareness.

[RAM-201]

ROBUST POSE ESTIMATION AND TRACKING SYSTEM FOR A MOBILE ROBOT USING A PANORAMIC CAMERA

Om K. Gupta[a] and Raymond A. Jarvis[b]

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A localisation system is an essential knowledge for a mobile robot to be able to freely navigate in its world. In this paper, pose estimation and tracking of a mobile robot is presented for an indoor cluttered environment using only an overhead panoramic vision system. The method presented is fast without requiring unwrapping of the panoramic view. It is assumed that the robot's workspace is 2D planer surface. A system combining mean-shift, Kalman Filter and Hough Transform based tracking is used to improve the result. Experiments show that the method is capable of robustly localising and tracking the robot in cluttered scenes even with variations of illumination and brief periods of occlusion.

Keywords: Pose estimation, Robot tracking, Robot localisation, Panoramic vision.

[RAM-020]

SCENE RETRIEVAL WITH COLOR MOMENT INVARIANT

Xiao Chen[1,a], Jianxun Li[1,b] and Jiayun Wu[2]

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[2] *Department of Mechanical Engineering, National University of Singapore, Singapore. E-mail: g0700814@nus.edu.sg*

In this paper, a novel scene retrieval method has been proposed. Under this framework, homogeneous color regions are detected and then described by color moment invariants. Different from most existing methods, color and spatial information are combined as the uniform descriptor to capture the image property. Moreover, the image descriptor in our method has alterable data structure, whose size is adaptive to the context of the image itself by a two-stage clustering technique. Experimental results show that this method has improved efficiency and robustness of color based image retrieval methods, without the cost of simplicity and compactness.

Keywords: Content based image retrieval, Color moment invariant.

[RAM-080]

OPTICAL FLOW BASED SYSTEM DESIGN FOR MOBILE ROBOTS

Mehmet Serdar Guzel[a] and Robert Bicker[b]

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This paper presents a new optical flow based navigation strategy, based on a multi-scale variational approach, for mobile robot navigation using a single Internet based camera as a primary sensor. Real experiments to guide a Pioneer 3-DX mobile robot in a cluttered environment are presented, and the analysis of the results allow us to validate the proposed behavior based navigation strategy Main contributions of this approach is that it proposes an alternative high performance navigation algorithm for the systems, consuming high computation time for image acquisition

Keywords: Optical flow, Variational approach, Mobile robot navigation, Behaviour, Obstacle avoidance, Time to contact.

[RAM-148]

DEVELOPMENT OF INTELLIGENT MASSAGE MANIPULATOR AND RECONSTRUCTION OF MASSAGE PROCESS PATH USING IMAGE PROCESSING TECHNIQUE

Chih-Cheng Peng[1], Thong-Shing Hwang[2,a], Chih-Jui Lin[3], Yao-Ting Wu[2], Ching-Yi Chang[2] and Jian-Bin Huang[2]

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[3] *Graduate Institute of Electrical Engineering, National Cheng Kung University, Taiwan, R.O.C.*

This paper develops a motor-driven massage artificial electro-mechanical manipulator system with intelligent biomedical sensing-monitoring capabilities and constructs the path of massage process by using

CCD image processing technique. In this paper, we integrate a versatile inter-digital electrocardiograph (ECG) into the manipulator system and construct a massage path by using twin CCD image processing technique with inverse engineering method. So, this electromechanical manipulator can automatically do the full massage process including pushing, pick-up and kneading actions to get the best therapy effect.

By capturing the variant signals of the cardiovascular physiological parameters from the versatile inter-digital electrocardiograph, we can understand and analyze the physiological reaction due to the massage action and then try further to improve the therapy effect of massage.

In the meantime, we have imitated a real human's palm with finger's action to design a human-like mechanical palm and accomplished the actions of massage including "pushing, pickingup, and kneading", the most decisive technique is lying on the design of the fingers.

Keywords: Massage manipulator, Image processing, Massage process, Biomedical sensing.

Session: TC4
Legged Robots

Date: Tuesday, 29 June 2010
Time: 16:00 – 18:00
Chair(s): Thanhtam Ho and Alberus Adiwahono
Venue: Room 4

[RAM-022]

AUTONOMOUS INFRARED (IR) THERMOGRAPHY BASED INSPECTION OF GLASS REINFORCED PLASTIC (GRP) WIND TURBINE BLADES (WTBS)

P. Chatzakos[1,a], N. Avdelidis[1], K. Hrissagis[1] and Tat-Hean Gan[2]

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In this paper, the development of an autonomous, novel and lightweight multi-axis scanning system, deploying insitu Infra Red Thermography (IRT) based Non Destructive Testing (NDT), on glass reinforced plastic (GRP) wind turbine blades (WTBs), is presented. The scanner incorporates an intrinsic multi-degree-of-freedom (DOF) end-effector able to comply and achieve successful adjustment on the complex contours of a WTB, automatically aligning at the same time, the IRT equipment in proper position for inspection. The scanning system has been developed to mimic the dexterity and Non-Destructive inspection operations performed by an expert human operator. For this reason the passive adjustment of the endeffector module has been achieved via the utilisation of a half Stewart platform. Simultaneous motion of a mechanically decoupled IRT equipment carrier is realised, that exhibits two degrees of freedom, enabling accurate self positioning, laterally to the target inspection area of the WTB and automatic retraction to home position upon system withdrawal from the inspection site.The overall philosophy inherent in the system's design and development is the maximisation of the blade area coverage in a single run, at a known sensitivity, with the utilisation of the minimum number of system degrees of freedom (DOFs) and the maximum repeatability as well as positional accuracy possible. The entire system, scanning modules and end-effector, are uniquely adapted to operate in remote locations, i.e. the 100 m blades utilised in offshore wind farms, as well as in the factory environment when used in a quality assurance capacity.

Keywords: Robotics, NDT, Composites, Thermography.

[RAM-038]

A PSO ALGORITHM FOR BIPED GAIT PLANNING USING SPLINE APPROXIMATION

Zhang Qizhi[1,a], Zhou Yali[1,b] and Ge Xinsheng[2]

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This paper discusses an optimal trajectory planning method for a compass gait biped robot. The biped robot is composed of a stance leg and a swing leg. Each step of walking locomotion is divided into two phases, i.e., the swing phase and toe collision phase. It is assumed that the toe collision is perfect plastic and occurs instantly. The motion of the swing and stance legs in swing phase is solved by the optimal trajectory planning based on the particle swarm optimization (PSO) and the spline approximation method. The performance index function is designed as the integral of weighted sum of input torque's square, each joint trajectory is approximated by a spline function. The optimal trajectory solutions are obtained by PSO method. The hip joint can be approximately passive by increasing the corresponding weighted factor, so that a smaller motor can be used at the hip joint to reduce the joint mass. Computer simulations are performed for the optimal trajectory planning method for a compass gait biped robot. Simulation results show that the proposed method is more energy-effective than the

virtual gravity method.

Keywords: Biped robot, Optimal trajectory planning, Particle swarm optimization, Spline approximation.

[RAM-040]

HUMANOID ROBOT PUSH RECOVERY THROUGH WALKING PHASE MODIFICATION

Albertus Hendrawan Adiwahono[a], Chee-Meng Chew[b], Weiwei Huang[c] and Van Huan au[d]

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Push recovery is an important capability that needs to be included while developing a robust humanoid robot walking scheme. In this paper we propose an overall control system and a push recovery controller for humanoid robot walking. When the robot is pushed, the algorithm will modify the walking phase to maintain walking, while considering the practical constraints. 3D simulation results of the walking phase modification approach are presented and its effectiveness for push recovery during walking is discussed.

[RAM-055]

PLANNING BIPEDAL WALKING GAIT USING AUGMENTED LINEAR INVERTED PENDULUM MODEL

Van-Huan Dau[a], Chee-Meng Chew[b] and Aun-Neow Poo[c]

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In this paper, we propose a new model called Augmented Linear Inverted Pendulum (ALIP) in which an augmented function *F* is added to the dynamic equation of the linear inverted pendulum. The purpose of adding the function *F* is to modify/adjust the inverted pendulum dynamics in such a way that disturbance caused by un-modeled dynamics (legs, arms, etc.) can be compensated or minimized. By changing the key parameters of the augmented function we can easily modify the inverted pendulum dynamics. The desired walking motion with maximized stability margin is achieved by optimizing the key parameters using genetic algorithm. The disturbance created by the un-modeled dynamics is minimized because full robot dynamics is considered in the optimization process. Simulations results show that the walking gait obtained using the proposed method is more stable than that obtained using the Linear Inverted Pendulum Mode (LIPM).

[RAM-098]

MOVING CONTROL OF QUADRUPED HOPPING ROBOT USING ADAPTIVE CPG NETWORKS

Anuar Bin Mohamed Kassim[1] and Takashi Yasuno[2]

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This paper describes the moving control using the adaptive Central Pattern Generators (CPGs) including motor dynamic models for our developed quadruped hopping robot. The CPGs of each leg is interconnected with each other and by setting their coupling parameters can act as the flexible oscillators of each leg and adjust the hopping height of each leg to require stable hopping motion. The formation of the CPG networks are suitable not only to generate the continuous jumping motion but also can generate the moving motion in two-dimensional, respectively. We also propose the reference height control system which including the maximum hopping height detector and Proportional Integral (PI) controller to achieve the reference jumping height. By using the proposed method, the hopping height of each leg can be control independently in order to make the posture of robot's body incline ahead and move forward. We create MATLAB/Simulink model to conduct various types of experiments and confirmed the effectiveness of our proposed CPG model including the reference height control system to generate the stable moving performance while jumping continuously.

Keywords: Quadruped hopping robot, CPG networks, Two-dimensional moving control.

[RAM-150]

DESIGN OF AN SMA-ACTUATED JUMPING ROBOT

Thanhtam Ho[a] and Sangyoon Lee[b]

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High locomotion speed and energy efficiency are the most attractive characteristics of the jumping gait for small mobile robots. In this paper, the design and simulation of a lightweight jumping robot is described. We propose the use of shape memory alloy (SMA) for actuating the jumping mechanism. We also report that the robot design is inspired by vertebrates' lower musculoskeletal system, in particular the structure of legs and the functions of muscles. SMA wires are used as artificial muscles to realize the jumping motion. A parametric dynamics simulation study is conducted to develop a suitable pattern of muscle activation. The simulation results show that the robot can jump up half of its height and move forward by about 25% of its length.

Keywords: Jumping gait, Mobile robot, Shape memory alloy, Biomimetic robot.

Author Index

Program-At-A-Glance

Time	Monday, 28 June 2010			
08:50 – 09:00	**Welcome by the CIS-RAM General Chair**			
09:00 – 10:00	**Plenary Speech-1: Lower Extremity Exoskeleton Systems for Medical Applications** by *H. Kazerooni* **Chair***: Wang Han,* **Room:** *Waterfront Ballroom I*			
	Room 1	**Room 2**	**Room 3**	**Room 4**
	Session 1			
10:30 – 12:30	**MA1: Systems Biology & Biomedical Engineering** Chair(s): Jianxin Xu and Xianming Qing	**MA2: Artificial Intelligence & Computational Optimization** Chair(s): Chu Kiong Loo and TongYuen Chai	**MA3: Wearable sensors and haptic devices for healthcare and biomechanics applications** Chair(s): *I-Ming Cheng, Zhiqiang Luo and Chee Kian Lim*	**MA4: Design & Performance Evaluation** Chair(s): *Kyung-Soo Kim and Wang Liping*
	Session 2			
13:30 – 15:30	**MB1: Computer Vision** Chair(s): *Marco Paleari and Biao Wang*	**MB2: Computational Intelligence** Chair(s): *Luis Paulo Reis and Wee Chiat Alan Tan*	**MB3: Medical Robots and Systems** Chair(s): *Louis Phee and Yi Xiang*	**MB4: Dynamics and Motion Control** Chair(s): *Pauline Hamon and Boyang Hu*
	Session 3			
16:00 – 18:00	**MC1: Image Processing,** Chair(s): *Chin-Wei Bong and Raymond Jarvis*	**MC2: Intelligent Control,** Chair(s): *Insu Song and M. Shawkat Ali*	**MC3: Wheeled Mobile Robots,** Chair(s): *Luis Paulo Reis and Ming Yang*	**MC4: Sensors and Mixed Topics** Chair(s): *Chu Kiong Loo and Y. S. Wong*

Time	Tuesday, 29 June 2010			
09:00 – 10:00	**Plenary Speech-2: Cybercars: the New Market for Robotics?** by *Michel Paren* **Chair***: Lin Hai,* **Room:** *Waterfront Ballroom I*			
	Room 1	**Room 2**	**Room 3**	**Room 4**
	Session 1			
10:30 – 12:30	**TA1: Networked Dynamical Systems** Chair(s): *Dwight Deugo and Panida Jirutitijaroen*	**TA2: Modeling, Planning and Control I** Chair(s): *Yu-Sheng Lu and Jun Xu*	**TA3: Advances in Social Humanoid Robotics** Chair(s): *Carlos Acosta and Zhou Changjiu*	**TA4: Robotics and Automation Applications** Chair(s): *ChingSeong Tan and Hamid Abdi*
	Session 2			
13:30 – 15:30	**TB1: Methodologies for Robotics and Automation** Chair(s): *Alireza Partovi and Hai Lin*	**TB2: Modeling, Planning and Control II** Chair(s): *Brigida Monica Faria and Jian Xu*	**TB3: Computer and Robot Vision I** Chair(s): *Evangelow Georgiou and Chingseong Tan*	**TB4: Underwater & Flying Robots** Chair(s): *Simon Watson and Albert Albers*
	Session 3			
16:00 – 18:00	**TC1: Intelligent Transportation** Chair(s): *Roland Wischenewski and Yong Chia Tan*	**TC2: Dynamics and Motion Control; Biologically-Inspired Robots and Systems** Chair(s): *Hamid Abdi and Zhao Liu*	**TC3: Computer and Robot Vision II** *Chair(s): Ray Jarvis and Mehmet Guzel*	**TC4: Legged Robots** Chair(s): *Thanhtam Ho and Alberus Adiwahono*

NOTE: ***Session Information***

All chairpersons and speakers are requested to be in their respective session room atleast 10 minutes prior to the commencement of each session.

20 minutes has been allocated for each oral presentation, including time for questions. Session chair-persons will strictly enforce this limit. Presenters are requested to keep their presentation within the stated time limits.

For presentations, a video projector will be made available. No slide projector will be provided.

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