4th International Conference on Autonomous Robots and Agents (ICARA 2009)

Program

Day	Time	Chancellor 1	Chancellor 2	Chancellor 3	Chancellor 4
Tue 10/02/2009	08:00 AM-09:00 AM	Registration (Level 16 Foyer)			
	09:00 AM-09:30 AM	**S0**: *Inaugural Session*			
	09:30 AM-10:30 AM	**S1**: *Keynote Address #1* *(p 30)*			
	10:30 AM-11:00 AM	*Morning Coffee Break (Level 16 Foyer)*			
	11:00 AM-12:00 PM	**S2**: *Keynote Address #2* *(p 31)*			
	12:00 PM-01:00 PM	*Lunch Break (Level 17 Whitbys Restaurant)*			
	01:00 PM-03:00 PM		**S3A**: *Autonomous Robots and Agents* *(Page 3)*	**S3B**: *Special Session on "Biorobotics and Biomechatronics"* *(Page 4)*	**S3C**: *Multi-Agent Systems* *(Page 5)*
	03:00 PM-03:30 PM	*Afternoon Coffee Break (Level 16 Foyer)*			
	03:30 PM-05:30 PM		**S4A**: *Special Session on "Computational Intelligence: Algori_ thms and Applications" – I* *(Page 7)*	**S4B**: *Special Session on "Vision-based Measurement and Localization" – I* *(Page 8)*	**S4C**: *Advanced Algorithms in Robotic Systems – I* *(Page 9)*
Wed 11/02/2009	08:00 AM-09:30 AM	Registration (Level 16 Foyer)			
	09:30 AM-10:30 AM	**S5**: *Keynote Address #3* *(p 32)*			
	10:30 AM-11:00 AM	*Morning Coffee Break (Level 16 Foyer)*			
	11:00 AM-12:00 PM	**S6**: *Keynote Address #4* *(p 33)*			

	12:00 PM-01:00 PM	*Lunch Break (Level 17 Whitbys Restaurant)*			
	01:00 PM-03:00 PM		**S7A**: *Advanced Algorithms in Robotic Systems – II* *(Page 11)*	**S7B**: *Image Processing for Robotics* *(Page 12)*	**S7C**: *Navigation, Positioning and Sensing* *(Page 14)*
	03:00 PM-03:30 PM	*Afternoon Coffee Break (Level 16 Foyer)*			
	03:30 PM-05:30 PM		**S8A**: *Special Session on "Vision-based Measurement and Localization" – II* *(Page 15)*	**S8B**: *Special Session on "Embodied Artificial Intelligence"* *(Page 16)*	**S8C**: *Unmanned Vehicle and Vehicle Tracking"* *(Page 17)*
	06:00 PM-10:00 PM	*Banquet at The Wellesley Country Park (Buses will leave from James Cook Hotel at 6 pm)*			
Thu 12/02/2009	09:00 AM-10:20 AM		**S9A**: *Vision Applications in Robotics* *(Page 19)*	**S9B**: *Humanoid Robots* *(Page 20)*	**S9C**:*Special Session on Intelligent Data Processing for Autonomous Applications"* *(Page 20)*
	10:20 AM-10:50 AM	*Morning Coffee Break (Level 16 Foyer)*			
	10:50 AM-12:10 PM		**S10A**: *Smart Robots* *(Page 21)*	**S10B**: *Special Session on "Computational Intelligence: Algorithms and Applications" - II* *(Page 22)*	**S10C**: *Sensors in Robotic Applications* *(Page 23)*
	12:10 PM-01:10 PM	*Lunch Break (Level 17 Whitbys Restaurant)*			
	01:10 PM-03:10 PM		**S11A**: *GA, AI and Adaptive Control in Robotics* *(Page 24)*	**S11B**: *Mobile Robots* *(Page 25)*	**S11C**: *Modelling, Simulation and Control in Robotics* *(Page 26)*
	03:10 PM-03:40 PM	*Afternoon Coffee Break (Level 16 Foyer)*			
	03:40 PM-05:20 PM		**S12A**: *Intelligent and Adaptive Control in Robotics* *(Page 27)*	**S12B**: *Special Session on "Passive Dynamic Walking Robots"* *(Page 28)*	**S12C**: *Path Planning* *(Page 29)*
	05:20 PM-05:40 PM		**S13**: *Closing Session*		

Tuesday, Feb 10

9:00 AM - 9:30 AM → S0: Inaugural Session

Room: Chancellor 1
Chair: Serge Demidenko (Massey University, New Zealand)

9:30 AM - 10:30 AM → S1: Keynote Address #1

Room: Chancellor 1
Chair: Serge Demidenko (Massey University, New Zealand)

What is Quantum Computing, and Does It Have Any Future in Robotics?
Prof. Mel Siegel (Carnegie Mellon University, USA)

11:00 AM - 12:00 PM → S2: Keynote Address #2

Room: Chancellor 1
Chair: Gourab Sen Gupta (Massey University, New Zealand)

A scheme for an Embodied Artificial Intelligence
Dr Rory Flemmer (Massey University, New Zealand)

1:00 PM - 3:00 PM

S3A: Autonomous Robots and Agents

Room: Chancellor 2
Chair: Raymond Jarvis (Monash University, Australia)

13:00 ***Design and Development of an Automated Band Wrapper Robot for Grapevine Pest Control***
Todd Lee (Washington State University, USA); Scott Hudson (Washington State University, USA); Jen-Yuan (James) Chang (Massey University, New Zealand)

With a view toward enhancing pest control and achieving organic requirements in wine industry, development of a prototypical autonomous vehicle that automatically applies a band barrier on grapevine is detailed in this paper. A novel band wrapper mechanism is proposed in this work. The band wrapper serving as the carrier for pest control is applied by the vehicle's six-degree-of-freedom articulator real-time controlled through classical inverse kinematics. It is found in the laboratory that the automated band wrapper robot can successfully detect a rod-like object and optimally place the band wrapper on the desired location for pest control.

13:20 ***Recognition of Lawn Information for Mowing Robots***

Kensuke Tsubata (Future University Hakodate, Japan); Keiji Suzuki (Hokkaido University, Japan); Ei-ichi Osawa (Future University Hakodate, Japan); Sadayoshi Mikami (Future University - Hakodate, Japan)

In this paper, the method for recognition of lawn information in mowing robots (Robomower) is proposed. The Robomower is a small and low-power mowing robot.It is necessary to collect surrounding information adequately by using the robot of the low-output. Robomower did not have the means to recognize turf for the mowing task. We need to recognize the lawn to complete mowing. We succeeded in recognizing turf with a simple, cheap sensor. The method is to presume the amount of turf by using transmission type's Photointerrupter. The effectiveness of the sensor was confirmed by experimenting with the sensor.

13:40 ***An Integrated Approach for Automatic Farm Monitoring System***

Ibrahim Al-Bahadly (Massey University, New Zealand); Michael Lusby (Massey University, New Zealand)

Monitoring systems are commonplace in many areas of industry; however farms as a general rule are a minority for this statistic. This paper introduces a new architecture for integration of a monitoring system into farming environments. Farms consist of various elements which are constantly changing state; for example opening and closing gates, water trough levels, feed levels etc. Monitoring the status of these elements automatically reduces the workload of a typical farmer, as well as providing benefits such as real-time monitoring, alerts and statistical analysis.

14:00 ***On the implementation of a robotic SWARM testbed***

Xiaolei Hou (The Australian National University, Australia); Changbin Yu (The Australian National University, Australia)

This paper presents the development of a robotic testbed for investigating the formation control algorithms. The design of this testbed aims for enhancing the sensing capability of the robotic agents, overcoming the constraints led by lack of communication among robots and accustoming itself to various formation control simulations. The proposed design schema utilizes an overhead camera to localize the agents which are 3 E-puck robots, one computer as the simulation platform and console to generate commands for controlling the robots and recording the experimental data.

14:20 ***A Semi-Autonomous Walk-Chair***

Raymond Jarvis (Monash University, Australia)

Frail, aged, or disabled people often need assistance in getting about but deserve maximum freedom and control within their ability yet also within an envelope of safety. This paper introduces a new apparatus for providing such freedom with safety, using robotic sensors and technology applied to a mechanism which combines the advantages of both a powered walking frame and a wheelchair to accommodate the user's needs with flexibility and convenience.

14:40 ***Robotic Automation System for Steel Beam Assembly in Building Construction***

Baeksuk Chu (Korea University, Korea)

In building construction, steel beam assembly has been considered as one of the most dangerous manual operations. In this paper, applying robotic technologies to the steel beam assembly task is discussed. The automated robotic assembly system presented in the paper consists of robotic bolting device performing actual bolting operation, robotic mobile mechanism transporting the robotic assembly system to target position, and bolting control system which plays a role of safely and efficiently operating the robotic assembly system. This paper includes major components of the entire robot system that have been built and future plans to integrate them.

S3B: Special Session on "Biorobotics and Biomechatronics"

Room: Chancellor 3

Chair: Wenhui Wang (University of Canterbury, New Zealand)

13:00 ***Simulation of Swimming Nanorobots in Biological Fluids***

Rwitajit Majumdar (BITS Pilani, India); Jitendra Rathore (BITS, Pilani, India); Niti Nipun Sharma (University, India)

Nanotechnology is an emerging area with very useful applications in medicine. Study of flagellar propulsion in micro-organisms gives us an idea of how to design swimming Nanorobots. Resistive Force Theory gives good results for small amplitudes of bending waves. Resistive Force Theory based modeling of swimming nanorobots with small amplitude and an inert head is done. The nature of change of efficiency and velocity fraction with other non-dimensional parameters are simulated and analyzed. The expression for the total thrust force on the moving robot is also derived.

13:20 ***Modelling of Hybrid Bio-Mechanical Mechanism for Nanorobotic Propulsion***

Chhavi Adtani (Birla Institute of Technology and Science, Pilani, India); Adwitya Das (Birla Institute of Technology and Science, Pilani, India); Niti Nipun Sharma (University, India)

In the present work the thrust force obtained from the unzipping of a dsDNA has been calculated. Utilizing the force hysteresis pattern obtained during unzipping and rezipping of a dsDNA and the calculated thrust force, a feasible DNA based hybrid bio-mechanical actuator model has been proposed which is considered for usage for locomotion of nanorobots in a liquid medium.

13:40 ***A modular robot climbing on pipe-like structures***

Jörg Mämpel (Ilmenau University of Technology, Germany); Kurt Gerlach (Ilmenau University of Technology, Germany); Cornelius Schilling (Ilmenau University of Technology, Germany); Hartmut Witte (Technische Universität Ilmenau, Germany)

"Raupi" is a prototype of climbing robot. The robot is designed modularly by only two different types of modules. It is able to climb on pipe-like substrates. Research on biological climbers shows us, locomotion is driven by the trunk, not only by the limbs. So a trunk-driven concept is chosen as a base for the design process. The request by the climbing locomotion to the mechanics of the system is very strong. The substrate contact has to be established and broken actively. A sensor concept was developed allowing to determinate relevant sensor ranges depending on the desired type of control.

14:00 ***Cell Image Recognition and Visual Servo Control for Automated Cell Injection***

Ali Ghanbari (University of Canterbury, New Zealand); Wenhui Wang (University of Canterbury, New Zealand); Christopher Hann (University of Canterbury, New Zealand); Geoff Chase (Univ of Canterbury, New Zealand); XiaoQi Chen (University of Canterbury, New Zealand)

This paper presents a micro-robotic bio-manipulation system for automated cell injection, addressing two key challenges. First, this paper reports a human interference-free determination of material deposition destinations based on image processing of the cell structures. Recognition of the nucleoli boundary brings us basic cell structure information, which consequently provides high flexibility to determine the deposition destinations. Second, it presents a visual servo control design which moves the micropipette tip to the targeted position and deposits foreign materials to that point autonomously. The visual servo control allows the motion settle time within 0.5 sec., with an accuracy of one pixel.

14:20 ***Landing Posture Control via Trajectory Planning for a Generalized Twin-body System***

Yi-Ling Yang (National Tsing Hua University, Taiwan); Paul C.-P. Chao (National Chiao Tung University, Taiwan); Cheng-Kuo Sung (National Tsing Hua University, Taiwan)

For the purpose of preventing a free-falling object from damage, this study is devoted to the landing posture control via trajectory planning for a twin-body system. The system is the simplified model of a free-falling cellular phone with two rotational DOFs. The governing equations of the system are first established based on the Lagrange-Euler formulation. PD and sliding controllers are designed to achieve the desired landing posture, and the trajectory planning is adopted to reduce the input energy. The performance of the controller is validated by MATLAB simulations, and the relations between input energy, trajectory-function, and falling height are discussed.

14:40 ***A Mathematical Model for Mapping EMG Signal to Joint Torque for the Human Elbow Joint using Non-linear Regression***

Khalil Ullah (Myongji University South Korea, Korea); Jung Kim (Assistant Professor, Korea)

In this study we apply some pre-processing techniques on EMG signal and get a linear envelope of the EMG signal and use that linear envelope to estimate the joint torque. We propose a new mathematical model. This model has some unknown adjustable parameters, which can be adjusted using non-linear regression. Predictions made by our model are well correlated with experimental data with R-square and MSE 0.998 and 0.056Nm respectively. This model may be helpful in the control systems for recognition systems, robot manipulators, exoskeletons, EMG prosthesis and electric stimulators.

S3C: Multi-Agent Systems

Room: Chancellor 4

Chair: Hiroshi Furukawa (University of Tsukuba, Japan)

13:00 ***Distributed Computations and Control in Multi-Agent Systems***

Justin Rice (Delft University of Technology, The Netherlands); Michel Verhaegen (Delft University of Technology, The Netherlands)

For large scale multi-agent systems, the design of optimal or robust distributed control laws has been both a theoretical and computational challenge. Recently, computationally efficient techniques based on special matrix structure preserving algorithms have been developed that allow arbitrarily nonconservative optimal control synthesis for heterogeneous systems arranged on a line. In this paper, we show how such design methods can equivalently be performed on distributed processors with distributed memory, connected in the same structure as the original system; an important step in the development of intelligent and adaptive distributed systems.

13:20 ***A Method for Cooperative Robot Actions through Multi-stage Construction of Action Intelligence***

Masakazu Suzuki (Tokai University, Japan); Yuki Igarashi (Tokai University, Japan)

In this article presented is a method for cooperative robot actions through multi-stage construction of action intelligence. According to the Intelligent Composite Motion Control, a complex action is gradually realized from fundamental motions. The action intelligence is then constructed through multi-stage optimization. For optimization Multi-stage Genetic Algorithm, MGA, is used. The MGA solves a large-scale optimization problem with complicated constraints as multi-stage combinatorial optimization problems with simple constraints. The method is successfully applied to optimal realization of cooperative robot soccer actions. And it is shown that the resultant action intelligence has large applicability.

13:40 ***Cooperative multi-agent mapping and exploration in Webots***

Adele Scott (Australian National University, Australia); Changbin Yu (The Australian National University, Australia)

This paper addresses the problem of mapping and exploration of an unknown space by cooperative multi-agent systems. The exploration problem is extended to jointly covering an area n times. Agents are localised and can communicate with other agents. A probability based mapping algorithm is developed. Based upon this, a potential field based exploration algorithm is proposed, with three sample charge profiles that can be used for different mission requirements. Simulation results in Webots confirms the scalability and the effectiveness of these algorithms. This research justifies and prepares for a full trial in a multi-robot testbed.

14:00 ***Market-based Approach for Multi-Team Robot Cooperation***

Cheng Siong Lim (Universiti Teknologi Malaysia, Malaysia)

The scalability of market-based approaches in multi-robot system (MRS) coordination enables an assigned task to be decomposed into subcomponents achievable by individuals or subteams within the team. However, in some potential MRS applications, particularly search and rescue operations, it can involve deployment of multiple teams of MRS from different parties to work side by side. Each team of MRS is independently managed by its operator. A loose collaboration among MRS is needed to increase the efficiency of a task completion. This paper address the method of coordination among MRSs and is verified on a physical mobile robot platform.

14:20 ***Multi-Objective Multi-Robot Surveillance***

Francesco Delle Fave (University of Rome, Sapienza, Italy); Vittorio Ziparo (Università degli studi di Roma "Sapienza", Italy); Stefano Canu (University of Rome, Sapienza, Italy); Daniele Nardi (Università di Roma, Italy); Luca Iocchi (University of Rome, Sapienza, Italy)

In many surveillance applications, there are different properties of the environment to check. It is very hard to characterize the solution of this problem in terms of a unique utility function. In this paper, we present an approach to address such issues. In particular, we define the multi-robot multi-objective surveillance problem and show how it can be solved in terms of multi-objective heuristic search. The approach has been experimented based on an off-line planner including simulated and real robot plan execution results.

14:40 ***Usage of Different Levels of Functional Information in Multiple Robot Operation***

Hiroshi Furukawa (University of Tsukuba, Japan)

A main goal of this study is development of a design concept based on Ecological Interface Design (EID) for human supervision of a robot team. This paper describes an experimental study conducted to discuss a method of information selection for the proposed concept. An experimental test-bed simulation was used in this study. Usage and importance of functional indications with different levels of abstraction were analyzed under two typical tasks in which the goals and cognitive workloads were different. The results demonstrate that the usage and importance of functional indications depend on tasks and strategies used by operators.

3:30 PM - 5:30 PM

S4A: Special Session on "Computational Intelligence: Algorithms and Applications" - I

Room: Chancellor 2
Chair: Roelof Brouwer (Thompson Rivers University, Canada)

15:30 ***Planning based on Dynamic Bayesian Network algorithm Using Dynamic Programming and Variable Elimination***
Gyubok Moon (Sogang University, Korea)

In this paper, plan inference for aimed goal is modeled by calculating with probability what task system performs through the observed behavior. Dynamic Bayesian Network (DBN) uses the probabilistic inference to reveal the relation of data varying according to time. Machine Repository Pioneer data of UCI has proved that accuracy and efficiency of inference is higher than the existing DBN by lowering useless calculation applying the variable elimination method and the concept of dynamic programming for DBN algorithm.

15:50 ***Fixed Point Relational Fuzzy Clustering***
Roelof Brouwer (Thompson Rivers University, Canada)

The proposed relational fuzzy clustering method called FRFP (fuzzy relational fixed point) is not based on minimizing an objective function, as in traditional methods, but rather on determining a fixed point of a function of the desired membership matrix with the proximity matrix as parameter. The proposed method is compared to other relational clustering methods including NERFCM, Rouben's method and Windhams AP method. A clustering quality index is calculated for doing the comparison. using various proximity matrices as input. Simulations show the method to be very effective and less computationally expensive than other fuzzy relational data clustering methods.

16:10 ***Modified GA-based Optimizer for Multi-objective Product Family Design***
Yoke-San Wong (National University of Singapore, Singapore)

Successful product family design often relies on properly resolving the inherent tradeoff between commonality across the family and performance loss compared to individual design. In this paper, a modified genetic algorithm using dynamic weighted aggregation is proposed to optimize a scale-based product family design while making the two-objective (performance-and-commonality) optimization tractable and efficient. The proposed method not only overcomes the drawbacks of conventionally fixed weight aggregation for product family design, but is also computationally more economical. An example of designing a family of planetary gear trains is presented to demonstrate the proposed method.

16:30 ***Spacecraft Attitude Estimation with the Aid of Locally Linear Neurofuzzy Models and Multi Sensor Data Fusion Approaches***
Masoud Mirmomeni (University of Tehran, Iran); Karim Rahmani (Iranian Research Organization for Science and Technology, Iran); Caro Lucas (Tehran University, Iran)

This paper Locally Linear Neurofuzzy (LLNF) models with data fusion approach are uses to solve the spacecraft attitude estimation problem. LLNF with locally linear model tree algorithm have been used as a well-known method for nonlinear system identification and estimation. The efficiency of the LLNF estimator is verified through numerical simulation of a fully actuated rigid body with three sun sensors and three-axis-magnetometers. For comparison, Kalman filter, MLP and RBF neural networks are used to evaluate the performance of LLNF. Results clearly demonstrate that the LLNF is superior to other methods in coping with the nonlinear model.

16:50 ***A Four Step Design Procedure for an Improved Fuzzy Crane Control***
Akbar Assa (Amirkabir University of Technology, Iran); Abolghasem Raie (Amirkabir University, Iran); Anahid Attar Kashani (Amirkabir University of Technology, Iran); Siavash Gorji (Amirkabir University of Technology, Iran); Mahyar Naraghi (Amirkabir University of Technology, Iran)

Fast transporting of the loads without unintentional load sway has become a regular problem with cranes. Any improvement in the time of load transportation leads to higher rate of load accommodation and thus lower costs. In this paper a four step process is taken to design an optimized fuzzy controller that is independent and free of any large and expensive computer help. The controller can suppress the load sway faster comparing to previous reported results of fuzzy crane control. The proficiency of this controller is confirmed with experimental results.

17:10 ***Localization of a High-speed Mobile Robot using Global Features***

Seung-Keun Cho (Pusan National University, Korea); Jang-Myung Lee (Pusan National University, Korea); MunGyu Choi (Pusan National University, Korea); Tae Kyung Yang (Pusan National University, Korea)

This paper proposes a new localization algorithm for a fast-moving mobile robot, which utilizes only one beacon and the global features of the differential-driving mobile robot. It takes a relatively long time to localize a mobile robot with active beacon sensors, since the distance to the beacon is measured by the freight time of the ultrasonic signal. This new approach resolves the high localization error caused by the speed of the mobile robot. The performance of the new localization algorithm has been verified in an experiment with a high-speed mobile robot.

S4B: Special Session on "Vision-based Measurement and Localization" - I

Room: Chancellor 3

Chair: Chen-Chien Hsu (Tamkang University, Taiwan)

15:30 ***Real-time 3-D robot vision employing novel color fringe projection***

Liang-Chia Chen (National Taipei University of Technology, Taiwan); Xuan-Loc Nguyen (National Taipei University of Technology, Taiwan)

This article presents a novel 3-D image acquisition technique using color fringe projection with encoded triangular fringes for high-speed 3-D machine vision. In the developed method, three-step phase shifting operation can be performed simultaneously by encoding and analyzing RGB color components on single structured fringe patterns. From the preliminary experimental result analysis, it was demonstrated that the speed of the 3D image acquisition can be achieved up to 60 frames per second (fps) or higher. The maximum measurement errors can be controlled within 2.8% of the overall detection range.

15:50 ***2-Dimenional Localization Based on Tilt Photographing of a Single CCD Camera***

Ming-Yu Cheng (TamKang University, Taiwan); Chen-Chien Hsu (Tamkang University, Taiwan)

This paper provides an image-based localization method based on tilt photographing of a single CCD camera. Image captured by the CCD camera is pre-processing to locate the target object in the picture in terms of pixel count deviation from the CCD camera. By using an established formula based on relationship between tilt angle of the CCD camera and distance, coordinate of the target object can be calculated. Experiment results have demonstrated that the feasibility of the proposed approach with satisfactory accuracy in determining the position of the target object.

16:10 ***Three-Dimensional Measurement of a Remote Object with a Single CCD camera***

Ti-Ho Wang (St. John's University, Taiwan)

A novel method by regulating the height of a CCD camera to measure the width and height of a targeted object in this paper. That is, three-dimensional measurement can be obtained with the use of a single CCD camera. To facilitate the measurement using various kinds of CCD cameras, parameters pertinent to the cameras can be established via a proposed mechanism in this paper. As a result, any kinds of CCD cameras can be used to perform three dimensional measurement of a targeted object via software implementation of the proposed measuring method.

16:30 ***Image-Based Detection and Obstacle Avoidance for Mobile Robots***

Cheng-Chuan Chen (St. John's University, Taiwan); Ming-Chih Lu (St. John's University, Taiwan); Pei-Chun Chang (St. John"s University, Taiwan); Cheng-Pei Tsai (St. John's University, Taiwan); Tien-Yu Tang (St. John's University, Taiwan)

In this paper, we use two visible laser points as the measuring ruler for automatically adjusting measurement. The measuring principle is to produce two bright projection spots on the measuring surface with two parallel lasers projectors. As a result, the pixel value between the spots will change in accordance with the shooting distance. As long as the pixel value between the two bright spots in the image frame can be identified, distance measurement can be obtained for detection and obstacle avoidance for mobile robots by using a single camera image.

16:50 ***A Novel Calibration Method for 3D Optoelectronic Motion Tracking System***

Ming Tsai (National Cheng-Kung University, Taiwan); Hsin-Cheng Chen (National Cheng Kung University, Taiwan); Zong-Han Lyu (National Cheng-Kung University, Taiwan); Hsui-Yong Lung (National Cheng-Kung University, Taiwan)

This study proposed an automatic calibration processes including lens distortion correction and 3D positioning parameters optimization calibration of a 3D optoelectronic motion tracking system. The system consists of three line CCD sensor sets to sense the light of the IrLED markers attached on the moving object. Plücker Coordinate is employed to represent the lines in the system calibration and 3D position calculation process. This method, comparing to the point based method, improves the precision of the system. This motion tracker system is a versatile and a low cost 3D capturing system.

S4C: Advanced Algorithms in Robotic Systems - I

Room: Chancellor 4

Chair: Johnny Koh (Universiti Tenaga Nasional, Malaysia)

15:30 ***ELA+: Goal-oriented Navigation with Obstacle Avoidance for Rescue Robots***

Haekwan Jeong (KAIST, Korea)

This paper describes development and demonstration of obstacle avoidance algorithm named ELA+ adaptable to rescue robots.In the ELA+, autonomous navigation based on the ELA(Emergency Level Around) proceeds until a goal is occurred, and then goal-oriented navigation with the ELA is followed. We assume some scenario similar to real disaster situation, and drive the ELA+ to avoid obstacles located on 2D virtual space. Simulation results show that the ELA+ is helpful to guide a robot to the goal by use of bearing information only even though distance to the goal and localization are not prepared.

15:50 ***Satellite selection algorithm for combined GPS-Galileo navigation receiver***

Xu Bo (Najing university of aeronautics and astronautics, P.R. China)

For space robots, integrated GPS-Galileo Navigation Satellite System will provide high accuracy and real-time navigation service. Using a reasonable and fast algorithm to select satellites would have a favor to precise and real-time navigation. In this paper, we choose the Weighted Geometric Dilution of Precision (WGDOP) as the optimal satellite selection criteria and propose the new satellite selection criteria-WGDOP minimum algorithm for the combined GPS-Galileo navigation receiver. The algorithm makes full use of available information to select the optimal satellites for navigation solution. The results show that the WGDOP minimum criteria can more accurately reflect the performance of combined constellation.

16:10 ***A Method of Accelerating Convergence for Genetic Algorithms Evolving Morphological and Control Parameters for a Biomimetic Robot***

Frank Saunders (Tufts University, USA); John Rieffel (Tufts University, USA); Jason Rife (Tufts University, USA)

In generating efficient gaits for biomimetic robots, control command and robot morphology are closely coupled, particularly for soft bodied robots with complex internal dynamics. Achieving optimal robot energy consumption is only possible if robot control parameters and morphology are tuned simultaneously. In this application genetic algorithms converge slowly because of the form of the fitness landscape. To accelerate GA convergence for design applications involving biomimetic robots, a new physics-based preprocessing methodology is proposed. This preprocessing strategy was applied to develop gaits for a biomimetic caterpillar robot.

16:30 ***Algorithm for Swarm Robot Flocking Behavior***

Xiang Li (Singapore Polytechnic, Singapore); Fikret Ercan (Singapore Polytechnic, Singapore)

This paper presents a decentralized control algorithm based on geometric approach for swarm of robots. Our focus is to build rapidly deployable, scalable, adaptive swarm with distributed control of robots. The control algorithm which is executed by all the members of swarm is presented in detail and our simulation results show that group behaviors such as aggregation, obstacle avoidance and flocking are achieved successfully.

16:50 ***An Automated Gravimetric & PWM based Fluid Dispensing System with GA Parameter Fine Tuning***

Edwin Sim (Universiti Tenaga Nasional, Malaysia); Johnny Koh (Universiti Tenaga Nasional, Malaysia); Sieh Kiong Tiong (UNITEN, Malaysia); BoonKar Yap (Universiti Tenaga Nasional, Malaysia)

In this paper we present a gravimetric and Pulse Width Modulation based fluid dispensing technique with Genetic Algorithm Parameter Fine Tuning technique. The system is able to dispense up to 50 samples with an accuracy of +/- 2g with the dispensing speed varies between 50 to 60 seconds for a 5.2kg batch. This fast and accurate system is able to handle different fluids with varying viscosity and overcome limitations of the volumetric dispensing and manual parameter tuning presently applied in the coatings industry. The working principles of the system and experimental results are presented.

17:10 ***Swarm Robots Task Allocation Based on Response Threshold Model***

Yang Yongming (College of Communication Engineering, Jilin University, China, P.R. China); Changjiu Zhou (Singapore Polytechnic, P.R. China); Yantao Tian (Jilin University, P.R. China)

A task allocation algorithm is proposed for foraging mission of swarm robotic system. The goal of foraging mission is to collect foods timely so that food consumption at home can be satisfied. This algorithm is based on response threshold model which can account for the regulation of division of labor in insect societies. This algorithm is scalable and distributed, and no communication strategy is utilized. Simulation experiments are carried out to study the effect of response threshold on the performance of foraging. Simulation experiments verified this algorithm can respond properly to the change of food density and consumption rate.

Wednesday, Feb 11

9:30 AM - 10:30 AM → S5: Keynote Address #3

Room: Chancellor 1
Chair: Subhas Mukhopadhyay (Massey University, New Zealand)

Recent Advances in Memetic Algorithms for Evolutionary Optimization
Prof. K. C. Tan, NUS, Singapore

11:00 AM - 12:00 PM → S6: Keynote Address #4

Room: Chancellor 1
Chair: Subhas Mukhopadhyay (Massey University, New Zealand)

Powering Nanorobots: An Engineering Challenge
Prof. R. K. Mittal, BITS, Pilani, India

1:00 PM - 3:00 PM

S7A: Advanced Algorithms in Robotic Systems - II

Room: Chancellor 2
Chair: Christopher Messom (Massey University, New Zealand)

13:00 ***Drivable Road Region Detection based on Homography Estimation with Road Appearance and Driving State Models***
Chunzhao Guo (Toyota Technological Institute, Japan); Seiichi Mita (Central Research Laboratory, Hitachi, Ltd.,, Japan)

In this paper, we present a drivable road region detection method based on homography estimation with road appearance and driving state models, in which, the planar road region is detected and objects inside the region are localized through a 2D projective transformation between the stereo image pair by computing the homography induced by the road plane dynamically. This method is composed of three modules: preliminary classification module, feature-based detection module, and area-based detection module. The combination of these modules uses both image evidence and temporal information. Therefore, more accurate as well as robust drivable road region detection can be expected.

13:20 ***Control of Inverted Pendulum System Using a Neural Extended Kalman Filter***
Adrian Lyons (University of San Diego, USA); Andrew Gerry (University of San Diego, USA); Stephen Stubberud (Rockwell Collins, USA); Kathleen Kramer (University of San Diego, USA)

The neural extended Kalman filter (NEKF) is an adaptive state estimation technique. The NEKF identifies mismodeled dynamics using online learning to improve state estimation by learning the differences between the previous model and the measurements that it observes. The prediction from the NEKF can then be used for target tracking or different kinds of interceptions. Experimental results of the NEKF control system on an inverted-pendulum system are used to evaluate the method.

13:40 ***Swarm Ant Robotics for a Dynamic Cleaning Problem - Analytic Lower Bounds and Impossibility Results***

Yaniv Altshuler (Ben Gurion University, Israel); Alfred Bruckstein (Technion, Israel); Israel Wagner (IBM Haifa Research Labs, Israel); Vladimir Yanovski (Technion - Israel Institute of Technology, Israel)

Recent works considered multi agent robotics in static environments. This work examines ways of operating in dynamic environments, in which changes take place independently of the agents' activity. The work focuses on the dynamic cooperative cleaners problem, in which a grid of "dirty" tiles is available. along which several agents move, each having the ability to "clean" its current location. The dynamic variant of the problem involves a deterministic expansion of this dirt, simulating a spreading of contamination, or fire. Several impossibility results are shown. A cleaning protocol is presented, as well as an analytic lower bound on its performance.

14:00 ***Interaural Time Difference Estimation Using Cross-power Spectrum Phase with Zero-crossings***

Byoung-gi Lee (Korea Institute of Science and Technology, Korea); Jongsuk Choi (Korea Institute of Science and Technology, Korea); Munsang Kim (Korea Institute of Science and Technology, Korea)

ITD (Interaural Time Difference) estimation is an important part of the auditory signal process such as sound source localization. CPSP (Cross-power spectrum phase) is a popular ITD estimation method but requires FFT and IFFT that are involved with much computation. To reduce the amount of computation of CPSP, we propose an approximation method of CPSP using zero-crossing process and call it CPSP-ZC. The CPSP-ZC is structurally based on ZCTD which is a computationally efficient ITD estimation method using zero-crossing process. We believe that CPSP-ZC will be a good alternative of CPSP when only little computation is allowed.

14:20 ***Swarm Ant Robotics for a Dynamic Cleaning Problem - Upper Bounds***

Yaniv Altshuler (Ben Gurion University, Israel); Alfred Bruckstein (Technion, Israel); Israel Wagner (IBM Haifa Research Labs, Israel); Vladimir Yanovski (Technion - Israel Institute of Technology, Israel)

Recent works considered multi agent robotics in static environments. This work examines ways of operating in dynamic environments, in which changes take place independently of the agents' activity. The work focuses on a the dynamic cooperative cleaners problem. This problem assumes a grid, having "dirty" tiles, that form a connected region. Several agents move in this dirty region, each having the ability to "clean" its current location. The dynamic variant of the problem involves a deterministic expansion of dirt in the environment, simulating spreading contamination, or fire. A cleaning protocol is presented, as well as analytic bounds on its performance.

14:40 ***Stream Processing of Moment Invariants for Real-time Classifiers***

Christopher Messom (Massey University, New Zealand)

This paper introduces a general purpose graphics processing unit (GPGPU) stream processing implementation of moment invariants using a summed area table approach. Summed area tables have been used to help attain real-time performance for some classifier systems, however due to the computational complexity of moment invariants, a high throughput computational platform is required to obtain real-time processing. The stream programming algorithm is presented and its performance is evaluated and compared with alternate CPU based approaches. The significant performance gains means that moment invariant classifiers can be implemented for real-time performance on GPGPUs that would not be possible on current CPUs.

S7B: Image Processing for Robotics

Room: Chancellor 3

Chair: Amal Punchihewa (Massey University, New Zealand)

13:00 ***Real-time 3-D Object Recognition by Using Scale Invariant Feature Transform and Stereo Vision***

Gee-Sern Hsu (National Taiwan University of Science and Technology, Taiwan); Chyi-Yeu Lin (Naitional Taiwan University of Science and Technology, Taiwan); Jia-Shan Wu (Naitional Taiwan University of Science and Technology, Taiwan)

3-D object recognition and stereovision is an important work in the computer vision field. In this paper, we use the Scale Invariant Feature Transform (SIFT) to find the features of an object. Due to the excellent rotating invariance, scale-invariance, and background noise resistance of SIFT, our detector could achieve rotating invariance and allow simultaneous detection of objects of different sizes. In this paper, the stereovision theory is used to judge the distance between 3-D object and the camera. Use the information of object to control robot arm to point at it.

13:20 ***Autonomous Mobile Robot Self-Localization Based on Environmental Visual Features***

Fairul Azni Jafar (Utsunomiya University, Japan); Yasunori Suzuki (Utsunomiya University, Japan); Kazutaka Yokota (Utsunomiya University, Japan); Takeshi Matsuoka (Utsunomiya University, Japan)

This paper presents a robust robot self-localization method where robot will identify its own position based on visual appearance features in the environment. Many research studies have been conducted on the navigation method for the autonomous mobile robot, and introduced precise and accurate robot self-localization methods. However, we believe that in some situation, it is not necessary for a robot to precisely and accurately identify and measure its own position. In our proposed method, the robot does not have to measure its own position precisely but depends only on the visual features which could be extracted from the environment.

13:40 ***Visualization of Clusters in Very Large Rectangular Dissimilarity Data***

Laurence Park (The University of Melbourne, Australia); Jim Bezdek (University of West Florida, USA); Christopher Leckie (The University of Melbourne, Australia)

*A matrix D, of pairwise dissimilarities between m row objects and n column objects, can be clustered: amongst row objects or column objects; amongst the union of row and column objects; and amongst the union of row and column objects containing at least one object of each type (co-clusters). The coVAT algorithm, which builds images for visual assessment of clustering tendency for these problems, is limited to mn≈O(10^4*10^4). We develop a scalable version of coVAT that approximates coVAT images when D is very large. Two examples are given to illustrate and evaluate the new method.*

14:00 ***A Simple and Accurate Method for Lens Calibration***

Claire Flemmer (Massey University, New Zealand); Rory Flemmer (Massey University, New Zealand)

A simple method for lens calibration is presented. The method uses a fiducial disc and straightedge which are placed imprecisely within the field of view. An inexpensive 6mm lens and CCD camera were used to validate the method. It is fast and accurate to a variance of less than half a pixel, which makes it a useful tool for computer vision.

14:20 ***Vision Based Game Controller Interface***

Amal Punchihewa (Massey University, New Zealand); Chandratilak Liyanage (Massey University, New Zealand)

This research presents a design of a game controller interface based on visual processing. Mechanical and electrical interfaces of a video game can be replaced with a camera input. Tests were performed for a car simulation game. The game player operates a mock wheel with coloured markings on it to the camera. The controller software identifies the markings using colour recognition techniques and translates the mock wheel movements into commands for the car simulation game. Simulations were carried out successfully to interface wheel to the game controller

14:40 ***Cognitive Map Approach for Mobility Path Optimization using Multiple Objectives Genetic Algorithm***

Prajindra Sankar Krishnan (University Tenaga Nasional, Malaysia); Sieh Kiong Tiong (UNITEN, Malaysia); Johnny Koh (Universiti Tenaga Nasional, Malaysia)

This paper describes an evolutionary planning strategy for mobile robot to move along streamlined collision-free paths in a known static environment. The Cognitive Map method is combined with genetic algorithm to derive the mobile robot optimal moving path towards its goal point. In this study, multi-objectives genetic algorithm (MOGA) is utilized due to there are more than one objective need to be achieved while planning for the robot moving path. The simulation results has shown that the hybrid Cognitive Map approach with MOGA demonstrated good performance in planning and navigating a robot situated among stationary obstacles towards its goal.

S7C: Navigation, Positioning and Sensing

Room: Chancellor 4
Chair: Luiz Martins-Filho (Universidade Federal do ABC, Brazil)

13:00 ***Intelligent Navigation of Unmanned Land Vehicle by using GPS & One ABS Sensor***

Syed Riaz un Nabi Jafri (NED University of Engineering and Technology, Pakistan); Syed Minhaj un Nabi Jafri (SUPARCO, Pakistan); Syed Zeeshan Shakeel (University of Illinois, Chicago, USA)

Navigation for unmanned vehicles always required correct positions during the movement of vehicle. Normally GPS is considered a valuable tool for the purpose of navigation and surveillance. Any obstruction in the area of GPS antenna can cause very significant reduction in accuracy. Therefore, GPS-INS based solution is utilized to improve accuracy. In case of small vehicles, hardware integration of such module is a very difficult and expensive task. So to give a better approach, GPS is integrated in the design with a simple opto coupler based ABS sensor. IR modules are used to detect obstacles in front of vehicle.

13:20 ***Error Compensation of GPS using Sensor Fusion in Intelligent Vehicle***

Byeong-Mook Chung (Yeungnam University, Korea)

In the development of intelligent vehicles, path tracking of unmanned vehicle is a basis of autonomous driving and automatic navigation. It is very important to find the exact position of a vehicle for the path tracking, and it is possible to get the position information from GPS. However, the information of GPS is not the current position but the past position because a vehicle is moving and GPS has a time delay. In this paper, the moving distance of a vehicle is estimated using a direction sensor and a velocity sensor to compensate the position error of GPS.

13:40 ***Development of an Amphibious Robotic Propulsor Based on Electroactive Polymers***

Laos Hirano (Federal University of Ouro Preto, Brazil); Luiz Martins-Filho (Universidade Federal do ABC, Brazil); Ricardo Duarte (Federal University of Ouro Preto, Brazil); José Paiva (Federal University of Ouro Preto, Brazil)

This paper presents the project of a robotic device for propulsion in aquatic environment. The propulsor is a biologically inspired system characterized by efficiency and flexibility for locomotion: the legs of anuran amphibious. These animals are exceptionally adapted to locomotion in water and land. This type of locomotion requires specific features that are hardly provided by traditional solutions based on standard electric motors. The proposed approach is based on ionomeric polymers-metal composites drives. The paper presents the the locomotion modeling, a description of the electroactive polymers, experimental production procedures and results, and discusses constructive aspects of a first device prototype.

14:00 ***Development of a low cost Optical Tilt sensor***

Amir Abul_Al_Aish (University Sains Malaysia, Malaysia); Mahfoozur Rehman (University Sains Malaysia, Malaysia)

The paper deals with the theory, design, fabrication and test results of a Fiber optic tilt sensor. The sensor is based upon the modulation of light intensity with the change in the level of Mercury (Hg) surface. 650 nm light-emitting diode (LED) is used as light source and the reflected light is detected by light dependant resistor (LDR). The output of the receiver circuit is directly proportional to the tilt angle. The sensitivity of the sensor is 0.014 V mrad-1 and the maximum range covered is 26.7 mrad. The sources of error and their minimization have been discussed.

14:20 ***Measurement Accuracy on Indoor Positioning System Using Spread Spectrum Ultrasonic Waves***

Akimasa Suzuki (Soka University, Japan)

This paper describes significant factors on spatial error distribution measured in a given indoor space with a local positioning system which utilizes spread spectrum ultrasonic waves generated by narrow directional ultrasonic transmitters. The positioning error has been discussed from the viewpoints of the dilution of precision (DOP) and the ranging error due to the transmitter directional characteristic, mainly. They suggest that it has to be considered from the viewpoints of not only the ranging error, which could be yielded by the distance measurement, but also the DOP, which is obtained by a geometrical arrangement relative to the transmitters and receiver.

14:40 ***An Improved View-Based Navigation by Adjustable Position Resolution***

Yoshinobu Hagiwara (Soka University, Japan)

In existing view-based navigations, their position resolution is defined depending on the change of scenery around robots. However, when applying the view-based navigation in actual environments, requirements for the position resolution are different in accordance with the environments given and the tasks assigned to a robot. Thus, in this paper we suggest an improved view-based navigation that is applicable to the changes of scenery by easily adjusting the position resolution. We also could confirm through the experiments that the improved navigation method is able to flexibly respond to the change of surroundings and tasks of a robot.

3:30 PM - 5:30 PM

S8A: Special Session on "Vision-based Measurement and Localization" - II

Room: Chancellor 2

Chair: Chen-Chien Hsu (Tamkang University, Taiwan)

15:30 ***Height Measuring System via Slant Photography***

Ming-Chih Lu (St. John's University, Taiwan); Wei-Yen Wabg (National Taiwan Normal University, Taiwan); Jen-Chi Cheng (Fu-Jen Catholic University, Taiwan); Cheng-Pei Tsai (St. John's University, Taiwan); Yin-Yu Lu (National Central University, Taiwan)

In this paper, a novel distance measuring method to measure the height of a building is proposed. Traditionally, distance measuring using CCD is based on stereo parallax. This paper puts forward a method of measuring the width and height of a building regardless of the distance of the camera or the angle between optical axis and ground. By using two parallel laser spots, the distance from the camera to the building and the height, the width of the building, and the area of special region can be determined in a single photo session and with a single picture.

15:50 ***Programmable Logical Circuit Architecture for Edge Detection in Color Images***

Shyang-Lih Chang (St. John's University, Taiwan); Chung-Ju Yeh (National Taiwan Normal University, Taiwan); Shen Cherng (Cheng Shiu University, Taiwan); Sei-Wang Chen (National Taiwan Normal University, P.R. China)

In this paper, a technique capable of detecting specific color edges in an image is proposed. Instead of developing an efficient algorithm for detecting edges caused by specific colors, we prefer a process that can be effectively implemented in hardware. The proposed process first calculates the differences of the individual color components of each pixel. Next, the colors causing the differences are identified by analyzing the calculated differences of color components. An architecture realizing the process using an FPGA-based SOPC is proposed in this paper, which allows users to specify the colors that form the edges to be located.

16:10 ***Optical Linear Scales of Image Area Measurement transformation System***

Chin-Tun Chuang (St. John's University, Taiwan); Ming-Chih Lu (St. John's University, Taiwan); Min-Hsiang Huang (Ta Hwa Institute of Technology, Taiwan); Chih Hung Chuang (University, Taiwan); Yin-Yu Lu (National Central University, Taiwan)

Optical Linear Scales have been used on various types of manufacturing machines. The fixed structure was reserved before assemble machine structure. It was complex in design and production by a manufacturing machine. This research provides a new approach for non-contact image-based distance measurement by only fixing a circle plate of given dimensions without changing the machine structure. As a result, maximal image contour of an unknown working table displacement picture can be obtained so as to achieve measuring results with highest resolution at each time.

16:30 ***Lane Detection System Based on Software and Hardware Codesign***

Ming-Jer Jeng (Chang Gung University, Taiwan)

In this paper, we present a lane detection system (LDS) based on software and hardware codesign. In combining both hardware and software designs, it can achieve a real time lane detection within a processing time of less than 50ms. The hardware implemented by FPGA chip captures the lane image from CCD camera within a time less 10ms. The lane departure warning algorithm detects the vehicle whether in traffic lane and judges whether sends out the warning. Experimental results demonstrate a quite good accuracy in lane detection whether at day or night condition.

16:50 ***Distance Measurement Based on Pixel Variation of CCD Images***

Ke-Wei Chin (Tamkang, Taiwan); Chen-Chien Hsu (Tamkang University, Taiwan)

This paper presents a distance measurement method based on pixel number variation of images for digital cameras by referencing to two arbitrarily designated points in image frames. Based on an established relationship between the displacement of the camera movement along the photographing direction and the difference in pixel counts between reference points in the images, distance from an object can be calculated via the proposed method. To integrate the measuring functions into digital cameras, circuit design implementing the proposed measuring system is proposed in this paper.

S8B: Special Session on "Embodied Artificial Intelligence"

Room: Chancellor 3

Chair: Rory Flemmer (Massey University, New Zealand)

15:30 ***Generalised Object Recognition***

Rory Flemmer (Massey University, New Zealand); Huub Bakker (Massey University, New Zealand)

Object recognition from machine vision is a complex task that has, to date, no formal method of solution. The use of brightness contours instead of edges and the corresponding contour profile diagram, or fingerprint, can provide mathematically non-intensive comparisons that can be efficiently performed in a database. More than that, this method provides a formalism which claims to be appropriate for all machine vision. This, the first of two papers, outlines the general problem, the current solution and provides preliminary results. The second deals with data mining a library of known objects and confirmation or rejection of the object.

15:50 ***Data Mining for Generalised Object Recognition***

Huub Bakker (Massey University, New Zealand); Rory Flemmer (Massey University, New Zealand)

Object recognition from machine vision is a complex task that can involve the comparison of image data with hundreds of thousands of templates. The use of brightness contours instead of edges and the corresponding contour profile diagram, or fingerprint, can provide mathematically non-intensive comparisons that can be efficiently performed in a database. This, the second of two papers, deals with data mining a library of known objects for matches and the final confirmation or rejection of the object identity. The first paper[1] outlines the general problem, the current solution and provides preliminary results.

16:10 ***Feature-based Object Recognition***

John Howarth (Massey University, New Zealand); Huub Bakker (Massey University, New Zealand); Rory Flemmer (Massey University, New Zealand)

The use of grey-scale contours, and fingerprints derived from this, has recently been used to analyse images for object recognition. The processing of these data can take a number of different forms. This paper describes a method for using characteristic aspects of the fingerprint, and geometrical relationships between them, to reduce an image to a set of simple geometric features. These features allow for compact storage in a database and very fast scanning to create a short list of candidate matching objects.

16:30 ***Development of an Autonomous Kiwifruit Picking Robot***

Alistair Scarfe (Massey University, New Zealand); Rory Flemmer (Massey University, New Zealand); Huub Bakker (Massey University, New Zealand); Claire Flemmer (Massey University, New Zealand)

The design concept and development status of an autonomous kiwifruit picking robot is presented. The robot has an intelligent vision system which ensures that only "good" fruit is picked. The robot receives instruction by radio link and operates autonomously as it navigates through the orchard, picking fruit, unloading full bins of fruit, fetching empty bins and protecting the picked fruit from rain. The robot has four picking arms, each of which will pick one fruit per second. To extend the useful annual work period of the robot, it is envisaged that it will also be used to pollinate kiwifruit flowers.

16:50 ***A Review of Artificial Intelligence***

Emma Brunette (Massey University, New Zealand); Rory Flemmer (Massey University, New Zealand); Claire Flemmer (Massey University, New Zealand)

This paper reviews the field of artificial intelligence focusing on embodied artificial intelligence. It also considers models of artificial consciousness, agent-based artificial intelligence and the philosophical commentary on artificial intelligence. It concludes that there is almost no consensus nor formalism in the field and that the achievements of the field are meagre.

17:10 ***Automatic meal planning using artificial intelligence algorithms in computer aided diabetes therapy***

Jaroslaw Bulka (AGH University of Science and Technology, Poland); Andrzej Izworski (AGH University of Science and Technology, Poland); Joanna Koleszynska (AGH University of Science and Technology, Poland); Jerzy Lis (AGH University of Science and Technology, Poland); Ireneusz Wochlik (AGH University of Science and Technology, Poland)

Paper presents the review of the computer aided diabetes therapy introducing GIGISim (Glucose-Insulin and Glycemic Index Web Simulator) e-learning tool based on the glucose and insulin plasma levels simulation models and genetic algorithms optimization. Artificial intelligence is applied in GIGISim tools to improve patients' management and health awareness. Interactive, diabetes-dedicated simulators, supported with genetic algorithms (GA) have a great deal of educational potential for patients. It is generally believed that evolutionary algorithms, which GA are a particular class of, perform consistently well across all types of optimization problems, in this case the optimization of the diabetes meal plan.

S8C: Unmanned Vehicle and Vehicle Tracking

Room: Chancellor 4

Chair: Rini Akmeliawati (International Islamic University, Malaysia)

15:30 ***Feature Correspondence Finding with Vertical Cylinder and Epipolar Geometry for Indoor Environments***

Yu Fu (National Taiwan University of Science and Technology, Taiwan); Tien-Ruey Hsiang (National Taiwan University of Science and Technology, Taiwan); Sheng-Luen Chung (National Taiwan University of Science and Technology, Taiwan)

We introduce an improved approach - FCVC, that finds matches from two images of indoor environments. Our method first finds accurate matches in vertical cylinders based on three consistenies: (1) altitudinal order; (2) composition of features for each vertical cylinder; and (3) horizontal order of all vertical cylinders. Once some accurate matches are acquired, the epipolar geometry is recovered to retrieve matches. Experiments reveal at comparable accuracy, FCVC spends at most 6% of time required by RANSAC and achieve at least 71% in number of matches obtained by RANSAC.

15:50 ***Pedestrian Inertial Navigation with Gait Phase Detection Assisted Zero Velocity Updating***

Young Soo Suh (University of Ulsan, Korea); Sangkyung Park (University of Ulsan, Korea)

An inertial navigation system for pedestrian position tracking is proposed, where the position is computed using inertial and magnetic sensors on shoes. Using the fact that there is a zero velocity interval in each stride, estimation errors are reduced. When implementing this zero velocity updating algorithm, it is important to know when is the zero velocity interval. The gait states are modeled as a Markov process and gait state is estimated using the hidden Markov model filter. With this gait estimation, the zero velocity interval is more accurately estimated, which helps to reduce the position estimation error.

16:10 ***Path Tracking Control for Underactuated AUVs Based on Resolved Motion Acceleration Control***

YoungShik Kim (Chungnam National University of KOREA, Korea); Jihong Lee (Chungnam National University of KOREA, Korea)

Autonomous underwater vehicles should find a proper trajectory, control to follow the trajectory, avoid static or moving obstacles, and home safely to their mother ship or launching device by themselves. As a consequence, lots of newly introduced problems have to be solved compared to man-operating underwater vehicle case. In these works we focus on path following control problems. Most AUVs are usually designed to be under-actuated or non-holonomic constrained system. In this paper, we propose a method of resolved motion and acceleration control (RMAC) to solve the path following control problems of an underactuated AUV.

16:30 ***Effects of camera calibration errors on RLS Trajectory Estimation of a Spinning Flying Object***

Rafael Herrejon (Tohoku University, Japan); Shingo Kagami (Tohoku University, Japan); Koichi Hashimoto (Tohoku University, Japan)

Effects of camera calibration errors are investigated in static-eye configuration. The effect of the error in the extrinsic parameters of the camera to extract and predict the position of a flying object in a 3D environment using Recursive Least Squares (RLS) is analyzed. Simulations have been carried in order to minimize the error of the position predicted in the global reference frame modifying the camera position

16:50 ***To Add With Caution - Decreasing a Swarm Robotics' Efficiency by Imprudently Enhancing the Robots' Capabilities***

Yaniv Altshuler (Ben Gurion University, Israel); Alfred Bruckstein (Technion, Israel); Israel Wagner (IBM Haifa Research Labs, Israel)

This work discusses the common opinion among robotic systems' designers, speculating that given a robotic system designed for efficiently handling a given assignment, enhancing this system by increasing the physical capabilities of the robots may only result in an improvement in the overall performance of the system. This work argues that this assumption is incorrect and should be avoided. An example concerning the problem of multi-robots exploration of a graph is given, in which adding communication features to the robots causes the entire system's performance to drop significantly.

17:10 ***Autonomous Flying Vehicle***

Mikaere Henderson (Massey University, New Zealand); Liqiong Tang (Massey University, New Zealand); Subhas Mukhopadhyay (Massey University, New Zealand)

Autonomous flying vehicles are being used more widely in a range of applications. This paper outlines the development of an autonomous flying vehicle which is to be used as a platform to mount different sensors. By doing this the vehicle will be able to perform a range of activities depending on the equipment and sensors it is mounted with. The focus of the project was on control of a small autonomous craft which was naturally unstable. Through this project more will be known about the aerodynamics and control of unstable craft and further developments can be made in the future.

Thursday, Feb 12

9:00 AM - 10:20 AM

S9A: Vision Applications in Robotics

Room: Chancellor 2
Chair: Donald Bailey (Massey University, New Zealand)

9:00 ***Enhancement of Infrared-based Image Identification System for Security Robots by Image Decomposition***
Khairul Hamimah Abas (Meiji University, Japan)

In this paper, a new infrared-based face identification system based on an input image decomposition is presented. The proposed image decomposition is a novel approach to transform an infrared image into a multilayer infrared image based on energy levels. The proposed approach is able to identify correct images from manifold poses by using frontal view of the infrared images and its decomposition layers as training images. The application of this finding is substantial, for security and rescue robots, for example, where a single image is acquired and should be critically identified.

9:20 ***Static Hand Sign Recognition using Linear Projection Methods***
Ye Chow Kuang (Monash University Malaysia, Malaysia); Nuwan Gamage (Monash University, Malaysia); Rini Akmeliawati (International Islamic University, Malaysia)

Shape matching is one of the more significant research topics in the fields of Computer Vision, Pattern Recognition and Machine Learning. Successful shape matching algorithms/ methods has a high potential for a wide variety of practical applications. In this paper, we present our effort on using linear projection methods for static hand sign recognition in Malaysian Sign Language. PCA and LPP methods have been used with a database of 240 hand shapes.

9:40 ***Novel Encoding and Fiducial Techniques for Visual Positioning Beacons***
Andrew Finlay (Victoria University, Australia); Aladin Zayegh (Victoria University, Australia)

A novel beacon system has been developed that allows for accurate positioning using machine vision techniques. A novel barcode and fiducial is applied to a positioning beacon and includes features that allow for fine position resolution, variable sized code spaces & rotation and translation invariant detection. Beacon position is found using standard machine vision techniques.

10:00 ***Tracking Performance of a Foveated Vision System***
Donald Bailey (Massey University, New Zealand); Christos-Savvas Bouganis (Imperial College London, United Kingdom)

Foveal images have variable spatial resolution, enabling a significant reduction in image size and data volume. This paper examines the performance of a new system for tracking a single target. It demonstrates that in the case of static targets, the fovea is able to be positioned within 1 pixel of the true target location within two frames. In the case of dynamic targets, it is demonstrated that there is a significant improvement over using a uniform low resolution image, where using a foveated image gives only a slight increase in error compared with using a high resolution image.

S9B: Humanoid Robots

Room: Chancellor 3
Chair: Peijie Zhang (Jilin University, P.R. China)

9:00 ***An Experimental Iterative Learning Strategy for a Biped Performing Semi-Active Walking***
Ting-Ying Wu (National Tsing Hua University, Taiwan); Ting-Jen Yeh (National Tsing Hua University, Taiwan)

In this paper, an iterative learning strategy is proposed for a biped which performs semi-active walking in the way that during the single support phase, only joints in the support leg are actuated and others are unactuated. This strategy provides experimental tuning on the actuated joint trajectories computed by a optimization procedure. The strategy iteratively modifies the hip trajectory to minimize foot scuffing and keep the associated foot clearance to within a small limit. The learning strategy experimentally leads to a convergent hip trajectory for the biped to demonstrates a good balance between power efficiency and robustness to ground conditions.

9:20 ***Two Legged Robot Design , Simulation and Realization***
Niravkumar Patel (Nirma University of Science and Technology, India)

This paper introduces a systematic approach to design and realize a two-legged robot.Development process of the robot has been divided in to three phases, (1) Design (2) Verification and (3) Realization, while robot's architecture consists of three subsystems, (1) Mechanical subsystem (2) Electronics subsystem and (3) Software subsystem. Stepper motors are used to reduce the Robot complexity while 8051 micro controller is used to control all the stepper motors.Along with this complete software has been developed to give commands to 8051 micro controller.

9:40 ***Behavior Based Water Depth Estimation for Diver Type Small Humanoid Robot***
Hitoe Oya (Future University - HAKODATE, Japan); Keiji Suzuki (Hokkaido University, Japan)

In this paper, for the purpose of extending application area of a humanoid robot, we study the method of water depth estimation. To estimating the water depth, we utilize the robot has to adjust the basic motion of standing up depending on depth of water. Therefore we use two motions of standing up and their output waveforms of the acceleration sensor. As the result, it is able to estimate the depth of the water when the robot is standing up with stable. Furthermore it is useful to change the motion in water.

10:00 ***False Alarm Demand: A New Metric for Measuring Robot Performance in Human Robot Teams***
Mohan Rajesh Elara (Singapore Polytechnic, Singapore); Sardha Wijesoma (NTU, Singapore); Acosta Calderon Carlos Antonio (Singapore Polytechnic, Singapore); Changjiu Zhou (Singapore Polytechnic, P.R. China)

Traditionally adopted Crandall's model for robot performance measurement in human robot teams assume ideal conditions ignoring any false alarms due to erroneous interactions. In this paper, we present the false alarm demand, a new metric for measuring effects of false alarms on human robot team performance and extend the Crandall's model to situations in which false positives and false negatives are prevalent. Experiments were performed with real and virtual humanoid soccer robots across tele-operated, and point to point modes of autonomy to validate the proposed extended Crandall's model and adequate results were obtained.

S9C: Special Session on "Intelligent Data Processing for Autonomous Applications"

Room: Chancellor 4
Chair: Annamaria Varkonyi-Koczy (Budapest University of Technology and Economics, Hungary)

9:00 ***Double-agent Convoying Scenario Changeable by an Emergent Trigger***
Makoto Katoh (Osaka Institute of Technology, Japan); Natsuki Imura (Osaka Institute of Technology, Japan)

This paper presents double-agent convoying scenario based simulation which is changeable by an emergent trigger (ET). They use an easy collaborative control (ECC) with reduced gains of the simple robust normalized IP control (SIRONOIPC) and a case base taking scenes technique (CBTST).

9:20 ***CSE+: Path Planning amid Circles***

Sven Ronnback (Umea University, Sweden); Simon Westerberg (Umeå University, Sweden); Kalle Prorok (Umea University, Sweden)

This paper describes a way of generating a collision free path in an environment populated by circular obstacles.

9:40 ***Representation of the Perceived Environment and Acquisition of Behavior Rule for Multi-Agent Systems by Q-Learning***

Mengchun Xie (Wakayama National College of Technology, Japan)

In the present study, we focused on the problem of "trash collection", in which multiple agents collect all trash as quickly as possible. The goal is for multiple agents to learn to accomplish a task by interacting with the environment and acquiring cooperative behavior rules. Therefore, for a multi-agent system, we discuss how to acquire the rules of cooperative action to solve problems effectively.

10:00 ***Universal Autonomous Robot Navigation Using Quasi Optimal Path Generation***

Aron Laszka (Budapest University of Technology and Economics, Hungary); Annamaria Varkonyi-Koczy (Budapest University of Technology and Economics, Hungary); Gabor Pek (Budapest University of Technology and Economics, Hungary); Peter Varlaki (Szechenyi Istvan University, Hungary)

Autonomous robot navigation is an important research field because these robots can solve problems where the human presence is impossible, dangerous, expensive, or uncomfortable. In this paper, a new hybrid autonomous navigation method is introduced. The algorithm is composed of visible/shortest path global navigation and simple potential field based local navigation parts. It applies a new automated graph generation method which may become necessary if, because of the observed new obstacles, a new path should be generated. The presented technique offers a quasi-optimal universal navigation technique which can successfully be used in all, known, unknown, and dynamically changing environments.

10:50 AM - 12:10 PM

S10A: Smart Robots

Room: Chancellor 2

Chair: Claire Flemmer (Massey University, New Zealand)

10:50 ***Design of Multi-joint Tracked Robot for Adaptive Uneven Terrain Driving***

Koh Doo Yeol (Korea Advanced Institute of Science and Technology, Korea); Hyun Kyung Hak (Korea Advanced Institute of Science and Technology, Korea); Kim Soo Hyun (Korea Advanced Institute of Science and Technology, Korea)

Single tracked mechanism can be in trouble when the body gets caught with high projections. A transformable tracked mechanism is proposed to cope with this problem. The mechanism is designed with several articulations surrounded by tracks, used to generate an attack angle when the robot comes near obstacles. The stair climbing ability of proposed robot was analyzed since stairs are one of the most difficult obstacles in USAR mission. Stair climbing process is divided into four separate static analysis phases. The proposed mechanism was produced from optimized design parameters, and demonstrated in artificially constructed uneven environment and the actual stairway.

11:10 ***How Taxel-based displaying devices can help blind people to navigate safely***

Ryad Chellali (Italian Institute of Technology, Italy)

This paper reports on the studies we are conducting concerning the development of a new device emulating haptic pictures. This device is a part of the system we are builting (DIGEYE ®) to help impaired people to navigate safely. We present here some results showing how a single taxel-based display can participate to acquire geometrical information dealing with low level navigation.

11:30 ***New Variable Focal Liquid Lens System Using antagonistic type SMA actuator***

Hyung-Min Son (Kyungpook National University, Korea); Yun-Jung Lee (Kyungpook National University, Korea)

This paper presents a new variable focal liquid lens system using SMA actuator. The conventional liquid lens systems are not easy to make small and light since they have a large and heavy actuator to distribute the liquid in a lens. And its focus control is difficult because of nonlinear focal variation with respect to linear actuation. To solve problems, we propose a new actuation system of liquid lens using SMA wire and rotating piston mechanism in which the cylindrical cam structure is adopted to make the linear relationship between the radius of curvature of lens and actuator's displacement.

11:50 ***Viewing Comics on Robots***

Hang-Bong Kang (Catholic University of Korea, Korea); Myung-Ho Ju (Catholic University of KOrea, Korea)

People can see and hear fairy tales, comics and songs from mobile robots. Traditional displaying methods of these contents on robots are usually linear and fixed. For providing flexibility in viewing contents, it is desirable for user to manipulate contents in his own style. In this paper, we present human robot interaction techniques using face pose, facial expression and hand gesture for viewing comics on the robot. The user's face pose is used to control viewing order of panels and his facial expression is used to re-coloring comics. Hand gesture is used to manipulate the objects.

S10B: Special Session on "Computational Intelligence: Algorithms and Applications" - II

Room: Chancellor 3

Chair: Kay Chen Tan (National University of Singapore, Singapore)

10:50 ***A New Hybrid Algorithm Based on Collaborative Line Search and Particle Swarm Optimization***

Xiang Li (Singapore Polytechnic, Singapore); Fikret Ercan (Singapore Polytechnic, Singapore)

Recently Particle Swarm Optimization (PSO) algorithm gained popularity and was employed in many engineering applications because of its simplicity and efficiency. The performance of the PSO algorithm can further be improved by using hybrid techniques. In this paper, we propose a cooperative line search particle swarm optimization (CLS-PSO) algorithm by integrating local line search technique and basic PSO (B-PSO). The performance of the proposed hybrid algorithm, examined through four typically nonlinear optimization problems, is reported. Our experimental results show that CLS-PSO outperforms basic PSO.

11:10 ***Constrained optimal control for wheeled cars***

Bing-Min Shiu (National Chung Hsing University, Taiwan); Chun-Liang Lin (National Chung Hsing University, Taiwan)

This paper considers the optimal control problem for a wheeled car (robot) subject to inequality constraints which are induced by hardware. Before solving the optimal control problem, we propose an equality constraint to substitute the inequality constraints with a new technique, which is developed to design an optimal controller for tracking while characterizing the reasonable input torque. It is shown that the problem of optimal control design with equality constraints imposing feasible range of input torque is easily solvable by applying the proposed technique.

11:30 ***Autonomous vehicle parking using artificial intelligent approach***

Chen-Kui Lee (National Chung Hsing University, Taiwan); Chun-Liang Lin (National Chung Hsing University, Taiwan); Bing-Min Shiu (National Chung Hsing University, Taiwan)

This paper devotes to the design and implementation of a hybrid artificial intelligent control scheme for a car-like vehicle through the performance optimization of the task of car parking. The genetic algorithm is used to determine the feasible parking locations. The Petri-net is used to replace the traditional system flow chart and most importantly, to plan alternative parking routes especially in a global space. A fuzzy controller is utilized to drive the car along the optimal parking route.

11:50 ***Path Control of Dexterous Robotic Hand Using Genetic Algorithm***

Albert Fong (Universiti Tenaga Nasional, Malaysia); Johnny Koh (Universiti Tenaga Nasional, Malaysia); Phing Chen Chai (UNITEN, Malaysia); Loo Chu Kiong (Multimedia University, Malaysia); Sieh Kiong Tiong (UNITEN, Malaysia)

This paper would presents the path control of a dexterous robotic hand finger reaching in a given search space. The proposed system would adopt the advantages of Genetic Algorithm (GA) to optimize the system performance in terms of path control, speed and accuracy. The system would search for a valid path and optimal velocity. A new genetic operator, namely Real Coded Dynamic Multilayer Chromosome Crossover (RC_DMCC) has been introduced and incorporated in the system. The simulation results of the proposed technique are presented.

S10C: Sensors in Robotic Applications

Room: Chancellor 4
Chair: Subhas Mukhopadhyay (Massey University, New Zealand)

10:50 ***Integrated Relative Navigation using a Low Cost INS/Vision Sensor for a Autonomous Aerial Vehicle***
S Sung (Konkuk University, Korea); Sukchang Yun (Konkuk University, Korea)

Despite precise relative positioning performance of a GPS based navigation system, it may require the reference station in close boundaries and can be affected by satellite observation environments. Thus, this paper presents an INS and vision sensor integrated system, which uses a combination of feature points and the landmark whose position is already known in order to overcome the limitation of GPS-only system. The proposed system has the advantage of implementing three-dimensional navigation using the geometry of landmark images. The simulation verifies the performance of integrated navigation system.

11:10 ***Trajectory optimization by cooperative maneuver with different types of sensors***
Wonsuk Lee (KAIST, Korea); Hyochoong Bang (KAIST, Korea)

Using Fisher Information Matrix(FIM), the optimal trajectory which is generated in order to localize the speci□c target is obtained as optimal problem. However, it is more effective to use more vehicles with various sensor in order to gather information about target. So, since we just check how multi vehicles with various sensors by cooperative maneuver affect the trajectory in this paper. Analytical solution is obtained from the above formulation and then the solution is verified through several simulations.

11:30 ***Development of the dexterous manipulator and the force sensor for Minimally Invasive Surgery***
Jungju Lee (Korea Advanced Institute of Science and Technology, Korea); Hoseok Song (Korea Advanced Institute of Science and Technology, Korea)

This paper describes the design and the performance results of a dexterous manipulator for Minimally Invasive Surgery. The design of the loadcell to measure the force of its tool-tip and its method are also presented for including a force-feedback loop in the future.

11:50 ***Underwater short range free space optical communication for a robotic swarm***
Fikret Ercan (Singapore Polytechnic, Singapore)

Communication mechanism is a major design concern for a robotic swarm, as data exchange is frequent between the robots in order to achieve a collective behavior. In this paper, we discuss the implementation of a short-range communication mechanism based on free space optics for a swarm of robot operating underwater. To increase the communication throughput, a multi-channel design is adopted, therefore, a robot can broadcast data to its peers simultaneously and this is based on a processor that supports parallel computing. Our experiments show that using a 50mW semiconductor laser, a transfer rate of 110Kbps or higher can be achieved.

1:10 PM - 3:10 PM

S11A: GA, AI and Adaptive Control in Robotics

Room: Chancellor 2
Chair: Ibrahim Al-Bahadly (Massey University, New Zealand)

13:10 ***Control and Measurement Device for Under Water Tidal Flow Power Generation***
Ibrahim Al-Bahadly (Massey University, New Zealand)

This paper introduces a measurement and control device for an under water tidal flow power generator. There are a number of designs for under water tidal flow turbine. One concept being considered is to have a vertical axis turbine with funnels of both sides to direct and concentrate the flow of water onto the turbine. To test this concept we are building a test device that varies the angle on one funnel and measures the power to find the angle that maximises the power.

13:30 ***Feedback Error Learning Control for Underactuated Acrobat Robot with Radial Basis Function Based FIR Filter***
Norsinnira Zainul Azlan (Tokyo Institute of Technology, Japan, Japan)

This paper presents a new Feedback Error Learning (FEL) scheme with the application of Radial Basis Function Network (RBFN) based FIR filter to control underactuated systems. This method provides a stable feedback controller, derived from sequential backstepping procedure. Besides, it also gives a simple approach for FEL feedforward controller by employing the plant's inverse dynamic model with physical parameters. The RBF based FIR filter is used for accurate state estimation to produce ideal control input. Simulation result on a two link acrobat robot with nonzero initial angular momentum is provided to show the validity of the proposed algorithm.

13:50 ***Modeling and Control of Dynamic Yoyo with Pulling Back Motion***
Shingo Kojima (Tokyo Denki University, Japan)

In this paper, we treat a dynamic model of yoyo. It is a challenging task for robotic control to control a yoyo by robot. It treats for a two-degree-of-freedom model of a yoyo in the beginning. A yoyo loses energy by friction. It is controlling by many researches using a simple model, without taking an axis and a string into consideration. However, when controlling by considering energy, there is the problem that a model cannot control correctly with it being simple. In this research, a twodegree-of-freedom model of yoyo is modeled and the controlling method which observed energy is proposed.

14:10 ***Using AI approach to solve a supplier-buyer deteriorating inventory model under price decrease***
Muh-Lin Tsai (Takming University of Science and Technology, Taiwan); Jonas Chao-pen Yu (Takming University of Science and Technology, Taiwan)

This study drives a two-echelon deteriorating inventory model where buyer is a price-leader. The rate of deterioration is assumed constant and demand increases with price decrease. We consider a varying rate of deterioration with a Weibull distribution and apply the compensation policy. The objective of the study is to maximize total supplier's profit. A genetic algorithm(GA) is developed to obtain the optimal lifecycle time. Numerical examples are given to validate the analysis of the models.

14:30 ***Optimisation of the Gas-Exchange System of Combustion Engines by Genetic Algorithm***
Colin Rose (Massey University, New Zealand); Stephen Marsland (Massey University, New Zealand); Donald Law (Massey University, New Zealand)

Current techniques for the optimisation of combustion engine gas-exchange systems still predominantly use trial and error. This paper proposes a new method for the optimisation of these systems through the use of modified Genetic Algorithm techniques, principally a variable length chromosome encoding. Promising initial results are presented and discussed.

S11B: Mobile Robots

Room: Chancellor 3
Chair: Dale Carnegie (Victoria University of Wellington, New Zealand)

13:10 ***Space Robot Formation Flying Control***

Xu Bo (Najing university of aeronautics and astronautics, P.R. China)

A control method for space robot formation flying is proposed. A neural network based on Radial Basis Function is used to modify the parameters of exponent reaching law of sliding mode control in order to get an optimal balance between convergence speed of the sliding quantity and fuel consumption; Exponent reaching law with saturation function is adopted to weaken the chatting which is actuated by unmodeled dynamics and the high frequency switch control. The results of the simulation prove the effectiveness of the proposed neural network-based sliding mode control method for space robot formation flying.

13:30 ***Exerting Human Control Over Decentralized Robot Swarms***

Mitchell Potter (U.S. Naval Research Laboratory, USA); Zsolt Kira (Georgia Institute of Technology, USA)

Robot swarms are capable of performing tasks with robustness and flexibility using only local interactions between the agents. Such a system can lead to emergent behavior that is often desirable, but difficult for a human operator to manipulate post-design. In this paper we propose two possible forms of control: top-down control of global swarm characteristics and bottom-up control by influencing a subset of the swarm members. We present and analyze learning methods to address each of these. Finally, we show how they can be used by a human operator to dynamically control a swarm in real time.

13:50 ***Odometry Correction with Localization Based on Landmarkless Magnetic Map for Navigation System of Indoor Mobile Robot***

Sam Ann Rahok (Utsunomiya University, Japan); Ozaki Koichi (Utsunomiya University, Japan)

The paper proposes a method of correcting odometry with localization based on DC magnetic field occurred in the environment. In this work, we apply a magnetic sensor to detect this magnetic field to build a magnetic map. The robot localizes by matching sensor readings against the DC magnetic field stored in magnetic map. The experimental results indicate, by applying the proposed method, the robot is possible to accurately localize and by applying the localization result to compensate to odometry, the cumulative error can be eliminated.

14:10 ***Position Probability Grids for Mobile Robots Obtained by Convolution***

Felix Hackbarth (Hamburg University of Technology, Germany)

We present an approach to use relative sensor information in an absolute position probability grid. Here relatively measuring sensors are the odometry and nine narrow beam infrared sensors with nonlinear characteristics of a mobile robot. An inaccurate indoorGPS sensor is available for absolute position data. For best position estimating all these sensors must be considered. Data fusion can only be done with comparable data. Therefore, the relative sensor information is transformed into absolute position information by convolution and represented as individual position probability grids. To determine the resulting position of one robot these grids are combined according to Bayes Theorem.

14:30 ***Local Wheeled Mobile Robot Navigation with Monocular Data***

LLuis Pacheco (University of Girona, Spain); Ningsu Luo (University of Girona, Spain); Xavier Cufi (University of Girona, Spain); Javier Cobos (University of Girona, Spain)

This paper presents recent WMR (wheeled mobile robot) navigation experiences using local perception knowledge provided by monocular and odometer systems. A local narrow perception horizon is used to plan safety trajectories towards the objective. Therefore, monocular data are proposed as a way to obtain real time local information by building two dimensional occupancy grids through a time integration of the frames. The path planning is accomplished by using attraction potential fields, while the trajectory tracking is performed by using model predictive control techniques. The results are faced to indoor situations by using the lab available platform.

14:50 ***Enhancement Approaches of Covering Process for Robot Behaviors***

Saeed Baneamoon (University Sains Malaysia, Malaysia); Rosalina Abd. Salam (Universiti Sains Malaysia, Malaysia)

In this paper a simulated control system for robot is designed by using distributed classifier system to perform complex behaviors. A set of enhanced solutions of cover detectors problem is suggested and compared with each other in order to make the simulated robot more effective in choosing the appropriate behavior (action).

S11C: Modeling, Simulation and Control in Robotics

Room: Chancellor 4

Chair: Huub Bakker (Massey University, New Zealand)

13:10 ***Web Navigation Analysis and Simulation using Ant Colony Optimization***

Ekachai Jinhirunkul (Chulalongkorn University, Thailand); Peraphon Sophatsathit (Chulalongkorn University, Thailand)

This paper utilizes the Ant Colony Optimization algorithm to explore an unknown web site, mapping its structure and navigation routing so that accessibility and performance information can be attained. The investigation will also unveil changing structure of the web site adaptively. As a consequence, coverage of all reachable nodes within the designated web site can be obtained, along with essential performance statistics to reflect near optimal accessible paths to any given node in the web site. By virtue of the simplicity of the Ant Colony Optimization, some straightforward mapping techniques were employed to entail opportunistic commercialization of the proposed algorithm.

13:30 ***Unsupervised Approach to Acquire Robot Joint Attention***

P. Ravindra S. De Silva (Computer Aided Design Lab, Toyota Technological Institute, Japan); Katsunori Tadano (Toyota Technological Institute, Japan); Susantha Herath (St. Cloud State University, USA); Masatake Higashi (Toyota Technological Institute, Japan)

Recent inclination of robotic researches interested to develop robot joint attention models for having skill of social learning toward to engage of natural interaction with humans. Recent approaches in robotic address the simulated looking or simple coordinated behaviors (caregiver) to obtained skill of joint attention. Our proposed framework uses Mixture Gaussian based unsupervised cluster to detect the caregiver attention at each of the time segmentation (segmenting the eye gaze data) without uses any train data. Experimental results proven that when objects distance is 20cm, proposed approach can accurately recognized 80\% of caregiver interested objects and result was quite impressive.

13:50 ***Adaptive Embodied Entrainment Control based on Communication Activity Measurement - A Challenge for A Robotic Introducer Agent -***

Kenzaburo Miyawaki (Osaka Institute of Technology, Japan); Mutsuo Sano (Osaka Institute of Technology, Japan)

In this paper, we propose an adaptive control of robotic embodied entrainment to multi communication participants. That is based on communication activity measurement, and uses an interaction timing learning which depends on nonverbal communication channels. The mechanism selects an appropriate embodied robotic behavior, and increases the communication activity by changes of speaker and listener. For this, we focus on a gaze lead, gaze distribution and synchronizing nod. The actions and timing are controlled by a decision-tree. We applied our proposal to a robotic introducer agent and experimented. As the result, the agent could control communication situations similarly to a human.

14:10 ***Fast Vertical-Pose-Invariant Face Recognition Module for Intelligent Robot Guard***

Chian C. Ho (National Yunlin University of Science and Technology, Taiwan)

Based on semi-3D cuboid face model, this paper proposes a simple but practical preprocessing method to recover the vertical pose variation for the face recognition module of the intelligent robot guard. The proposed Fast Semi-3D Vertical Pose Recovery method evaluates the angle of the vertical pose variation simply from a single 2D image view and thereby recovers the vertical-rotated face to the nearly frontal view. The experimental results show the proposed method can significantly raise both recognition accuracy and recognition confidence of the face recognition module under various vertical pose conditions.

14:30 ***Control method for a robot based on the adaptive attractor selection model***

Ippei Fukuyori (Osaka University, Japan)

Recent biological studies reveals that animals utilize (or exploit) biological fluctuation to achieve flexibility and robustness against environmental disturbances. In this paper, we propose a simple but flexible control mechanism inspired by biological adaptation mechanism. Experimental results show that our proposed method can be applied to the control of a robot without prior knowledge about the robot.

14:50 ***Robotics Competitions in Engineering Education***

Moi Tin Chew (Massey University, New Zealand); Serge Demidenko (Massey University, New Zealand); Christopher Messom (Massey University, New Zealand); Gourab Sen Gupta (Massey University, New Zealand)

Internationally engineering education has had to become more pro-active in attracting students with technical knowledge, skills and motivation enabling them to excel in four or more years of study with the ultimate goal of addressing the ever-growing demand for qualified engineers from the industry. General public perceptions that engineering is a difficult career field while offering inadequate financial rewards as compared to alternative fields have resulted in significant reduction in student numbers. This paper presents the experience of using robotic competition events to motivate school students and help them appreciate what is involved in an engineering design and development fields.

3:40 PM - 5:20 PM

S12A: Intelligent and Adaptive Control in Robotics

Room: Chancellor 2

Chair: Gourab Sen Gupta (Massey University, New Zealand)

15:40 ***Application of a Communication Interface between Agents and the Low Level Control***

Munir Merdan (Vienna University of Technology, Austria); Wilfried Lepuschitz (Vienna University of Technology, Austria); Ingo Hegny (Vienna University of Technology, Austria); Gottfried Koppensteiner (Vienna University of Technology, Austria)

Increasing complexity in the transport domain requires flexible and reconfigurable control architectures. In this paper we present the deployment of an agent-based system in this domain splitting the manufacturing control into two layers: a high level control based on agents and a low level control based on the standard IEC 61499. A further focus is laid on the design of a generic communication interface between the control layers and a graphical representation of the target system that allows the simulation of failure scenarios.

16:00 ***Neural-Adaptive Control of Robotic Manipulators Using a Supervisory Inertia Matrix***

Dean Richert (University of Calgary, Canada); Chris Macnab (University of Calgary, Canada)

This paper utilizes a novel neural-adaptive method for controlling a two-link robotic manipulator. We do not need to resort to estimating the inverse dynamics. Our control utilizes the full dynamic model estimate including an inertia matrix estimate, referred to as a forward dynamics approach. Our novel contribution is to use an inertia matrix estimate to supervise the training of the neural networks. The proposed method greatly improves performance over the forward dynamics approach, verified in experiment. The method is robust to significant changes in payload.

16:20 ***A System Architecture for Intelligent Building Guide Robot PHOPE***

SeungSub Oh (PIRO (Pohang Institute of Intelligent Robotics), Korea); Young-Ho Choi (PIRO, Korea); SungYong Yun (PIRO, Korea); Bongjin Jun (Postech, Korea); Choengjae Lee (POSTECH, Korea); Hyukjoon Jang (POSTECH, Korea); Jaiyoon Song (POSTECH, Korea); Jeong-Gwan Kang (POSTECH, Korea); Choi Won-Seok (POSTECH, Korea); Su-Yong An (POSTECH, Korea)

A number of intelligent service robots have been developed to guide a building for visitors. The robot named PHOPE to be presented is also made for guidance at indoor environment. All software components including face recognition, voice communication, navigation, touch-pad based GUI, database and TTS systems are integrated into one guide system based on PIRO Service Mobile Robot (PSMR) using TCP/IP communication. And hardware components including sensors, actuators, micro-processors and power-supply system are also integrated into PHOPE.

16:40 ***Cluster Position Control of Brownian Movement Factors using Boundary Push Method***

Chiyen Kim (Pusan National University, Korea); Min Cheol Lee (Pusan National University, Korea)

This paper has interest in the way to gather many random moving objects and to take all of them to target position area. To find one of solution to do cluster position control, this paper proposes boundary push method which clusters plural Brownian moving factors and migrates them to target area as shepherding sheep in pasture. In this paper, there are cluster dynamic modeling to simulate the proposed method, explanation of algorithm and the result of computer simulation before experiment using micro robots.

17:00 ***Emotional Control of Inverted Pendulum System, A soft switching from Imitative to emotional learning***

Mehrsan Javan Roshtkhari (University of Tehran, Iran); Arash Arami (University of Tehran, Iran); Caro Lucas (University of Tehran, Iran)

Model-free control of unidentified systems with unstable equilibriums results in serious problems. In order to surmount these difficulties, firstly an existing model-based controller is used as a mentor for emotional-learning controller. This learning phase prepares the controller to behave like the mentor, while prevents any instability. Next, the controller is softly switched from model based to emotional one, using a FIS. Also the emotional stress is softly switched from the mentor-imitator output difference to the combination of objectives generated by a FIS which attentionally modulated stresses. For evaluating the proposed model free controller, a laboratorial inverted pendulum is employed.

S12B: Special Session on "Passive Dynamic Walking Robots"

Room: Chancellor 3

Chair: Peijie Zhang (Jilin University, P.R. China)

15:40 ***Semi-Passive Dynamic Walking for Humanoid Robot Using Controllable Spring Stiffness on the Ankle Joint***

Aiman Omer (Waseda University, Japan); Reza Ghorbani (University of Hawaii, USA); Hun-ok Lim (Kanagawa University, Japan); Atsuo Takanishi (Waseda University, Japan)

The bipedal humanoid robot WABIAN-2R is developed to simulate human locomotion. Performing a walking motion requires a high torque at the ankle joint. WABIAN-2R consists of harmonic gears in its driveline system which increases the weight of each leg and respectively decreases the energy economy. Therefore, a new idea is proposed and developed through computer simulation to modify the design of the ankle joint by adding a spring mechanism. The spring stiffness could be controlled by twisting the joint to set the required torque. This helps reduce the energy consumed while walking by storing and returning part of the energy.

16:00 ***Finite-time Robust Trajectory Tracking Control for the Underactuated Biped Robot Based on Poincaré-like-alter-cell-to-cell Mapping Method***

Limei Liu (Jilin University, P.R. China); Yantao Tian (JiLin University, P.R. China); Zhen Sui (JiLin University, P.R. China); Xiaoliang Huang (JiLin University, P.R. China)

Poincaré-like-alter-cell-to-cell mapping method is proposed to search for the target point. The finite-time robust trajectory tracking control strategy is designed to make the states of the system reach the target point in finite time. And this strategy can make the error be bounded in terminal value under the condition of external uncertain disturbance. Experiments show that the finite-time robust trajectory tracking controller is effective. The stable gait of the underactuated biped robots generates easily with the control strategy proposed in this paper. The stability and robustness of the gaits can be improved.

16:20 ***Bisection Method for Evaluation of Attraction Region of Passive Dynamic Walking***

Peijie Zhang (Jilin University, P.R. China); Yantao Tian (school of communication engineering,Jilin university, P.R. China); Zhenze Liu (Jilin University, P.R. China)

A new numeric method for the calculation of limit cycle in passive dynamic walking are proposed in the paper. The new method called bisection method is presented to determine the basin of attraction approximately by searching for its edge. Compared to the usually used cell mapping method, the presented method can locate the attraction region with a much higher accuracy and yet need much less of calculation amount. Using the proposed bisection method, the basins of attraction are calculated for passive dynamic walker with and without knees, and the result is compared with the cell-to-cell mapping method.

16:40 ***Stable Neural Control of a Flexible-Joint Manipulator Subjected to Sinusoidal Disturbance***

Chris Macnab (University of Calgary, Canada)

The proposed method aims at halting weight drift when using multilayer perceptions in direct adaptive control schemes, without sacrificing performance or requiring large control gains. Unchecked weight drift can lead to a chattering control signal and cause bursting. Previously proposed robust weight update methods, including e-modification and dead-zone, will sacrifice significant performance. A Lyapunov analysis proves the semi-global uniform ultimate boundedness of all signals for the proposed method. Experiments with a two-link flexible-joint robot demonstrate the improvement in performance compared to e-modification and dead-zone.

S12C: Path Planning

Room: Chancellor 4
Chair: Simon Thompson (AIST, Japan)

15:40 ***Smooth Path Planning with Pedestrian Avoidance for Wheels Robots: Implementation and Evaluation***
Yumiko Suzuki (NARA Institute Science and Technology, Japan); Simon Thompson (AIST, Japan); Kagami Satoshi (AIST, Japan)
We extended our method of smooth path planning in the presence of moving obstacles and we implemented our planner on a real wheels robot.

16:00 ***A Probabilistic Model of Human Motion and Navigation Intent for Mobile Robot Path Planning***
Simon Thompson (AIST, Japan)
In order to plan paths in environments inhabited by humans, robots must predict human motion. Human navigation intent is determined by the function and structure of the environment. Manually assigned functional places are combined with automatically extracted navigation way-points to define a number of likely navigation targets within the environment. A probabilistic model of human motion, using motion probability grids, predict motion to navigation goals. The models of human navigation intent and motion are integrated with an autonomous mobile robot system, and experiments in human prediction and robot path planning carried out.

16:20 ***Distributed Optimal Control Based on Internal Average Kinetic Energy for Multi-robot System***
Mao Yang (school of communication engineering Jilin university, P.R. China); Yantao Tian (school of communication engineering,Jilin university, P.R. China); Xianghua Yin (school of communication engineering,Jilin university, P.R. China)
In this paper, an M-member continuous-time energetic swarm problem is studied. A new control strategy is developed for the multi-robot system which exist velocity damping. The control strategy has two separated layers. The lower layer is a distributed optimum control such that the swarm center can arrive at the goal which is given previously with the least time under present restrict. The upper layer is based on internal average kinetic energy. The proposed control algorithm can be used effectively for multi-robot coverage path planning problem. The proof of convergence is presented. Numerical simulations are given to illustrate the theoretic results.

16:40 ***Closed form Dynamic Model of the PUMA 560 Robot Arm***
Alirzea Izadbakhsh (Islamic Azad University- Garmsar Branch, Iran)
This paper investigates an explicit dynamic model of the PUMA 560 robot manipulators, based on standard Denavit-Hartenberg approach and without any mathematical simplifications. The presented model obviates the existing shortcomings in reference model in MATLAB robotic toolbox and so could be an appropriate substitution for robotic toolbox. A numerical comparison, employing different inputs, is utilized to illustrate the accuracy of the mentioned model.

Keynote address #1

Professor Mel Siegel

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INTERESTS and ACTIVITIES

- Sensing, sensors and instruments, measurement science, system modelling
- AI methods for data fusion, analysis, presentation, and system control
- Sensor fusion for context aware computing / human computer interaction
- 3D-stereoscopic display system concepts, optics, coding, and psychophysics
- Robots and sensors for remote explosives and drug detection, and aircraft inspection
- High-fidelity tele-operation for remote and space–based science
- Innovative sensors and sensor fusion methods for future vehicles and driver safety
- Large networks of small sensors, e.g., to initialize global-scale weather models
- Teaching outreach and program innovation; Technology Peace Corps

RESEARCH MILESTONES

- Negative ion structures (laser photo detachment photoelectron spectrometry)
- Ion-atom/molecule collisions (double differential cross-section measurements)
- Atomic hyperfine structure (magnetic resonance in hex pole-focused beams)
- Space, analytical, process, and isotopic mass spectrometry (high pressure ionizers)
- Biotechnology process control (rule-based characterization and decision)
- Piezoelectric and optical tactile sensors (identification and manipulation by robots)
- Solid state gas sensor characterization and mixture analysis (neural networks)
- Analytical and numerical modelling of optical devices and instruments (photons, ions)
- Mobile robots for remote and automated skin inspection of aging aircraft
- Zoneless 3D-autostereoscopic display system

PROFESSIONAL SERVICE

IEEE: Instrumentation and Measurement Society Administrative Committee and Treasurer, IMTC Program Committee, VIMS Program Committee and General Chair, Transactions on Instrumentation and Measurement Associate Editor, chair of Technical Committees in Instrumentation and Measurements Society and Robotics and Automation Society, Senior Member Advancement Panel.

AWARDS

Fellow of the IEEE, cited for contributions to the field of sensors, measurement and robotics. IR-100 awards for “100 most significant inventions of the year” for inventions in mass spectrometry (2 awards), particle detection, and semiconductor-based gas sensors. Best paper of the year award, Robotic Assistants for Aircraft Inspectors, IndustrialRobot (MCB University Press).

What is Quantum Computing, and Does It Have Any Future in Robotics?

The field of quantum mechanics has its roots in the early 1900s, its fundamental aspects were well-developed by the 1920s, and spectacularly accurate results were routine by the 1930s. But the relevance of quantum mechanics to computing was not appreciated until the 1980s, and until very recently work in quantum computing – and in the closely-related quantum information and quantum communication fields – has been entirely theoretical. Now promising proof-of-principle experimental results are being published with increasing frequency, and several companies are advertising – though it is not clear that they can actually deliver product – quantum communication devices for tamper-proof and eavesdrop-proof transfer of cryptographic keys. Almost all of this work has been done in the physics community rather than the computer science community, partly perhaps because quantum mechanics can be a mind-boggling topic that requires many years of immersion for it to be internalized, and partly perhaps because the computer science community has plenty of interesting things they can do with rapid successive generations of more and more capable commercial CMOS devices.

The aim of my talk is to introduce the robotics community to what quantum mechanics is and why it seems to be important for the future of computing, and to suggest some problem areas in robotics where new computing opportunities might offer answers where there are now none. My underlying aim is to get my colleagues in robotics – you – thinking about the possibilities for applications in your own research areas. Your first challenge is to understand the premises and formalism, and internalize the actual correctness, of quantum mechanics. What is so hard about it? It is that the rules of quantum mechanics, the laws of physics before which we could not correctly describe and predict the structure, behavior, and interaction of atoms, electrons, and photons – dictate that these objects, and systems made of them, act in unintuitive ways. Quantum mechanical behaviors are so different from everyday experience with macroscopic – called “classical” – objects and systems that we find them illogical. But that is just the way it really is: no theory in any field at any time in history has ever predicted reality – the outcome of actual experiments – with precision that comes anywhere near quantum mechanics.

So who can argue with success like that? Most notably Einstein, who famously said – in German, so translations vary and the speaker's actual intent is possibly subject to speculation – “god doesn't play dice with the universe” and “god is subtle but not malicious” arguing against the correctness of quantum mechanics based on correct – according to quantum mechanics – but objectionable – according to Einstein – conclusions that can be drawn from it. For example, that the outcome of a simple measurement on a system initialized as completely as nature will allow can be predicted no better than to say the result will be one several discrete values whose probabilities the formalism shows how to calculate. Or that the act of making such a measurement on a system here can instantaneously affect the probabilities of the allowed outcomes of a measurement on a similar system on Mars.

What does all this physics have to do with information, computation, and communications? Classical computing is based on classical bits, idealizations of physical objects that can *exist* in either of two distinct states that we conveniently label 0 and 1; quantum computing is based on quantum bits, idealizations of physical objects that can *be observed* in either of two distinct states that we conveniently label 0 and 1. But in the absence of actually making said observation they can *exist* in a mixed state such that when actually observed at a later time there will be predictable probabilities that 0 vs. 1 will be seen. Sufficiently clever arrangements of several quantum bits thus provide the possibility of massively parallel computing by very small systems – small in size and small in number of quantum bits – as well as powerful new concepts for efficient and secure communication. In my talk I will try to explain the “thus” in the previous sentence, and connect it to prospects for future robot intelligence.

Keynote address #2

Dr. Rory C. Flemmer

Rory Flemmer is a Senior Lecturer in the School of Engineering and Advanced Technology (SEAT) at Massey University, Palmerston North, New Zealand. He received a Masters degree in Mechanical Engineering in 1975 and a PhD in Chemical Engineering in 1978 from the University of Natal in South Africa. As an Associate Professor at that university, his research areas included hypersonic flow with mixing and chemical reaction, ultrafiltration, reactors, fluidization, two-phase flow, fractal analysis, high temperature gas heating and artificial intelligence/ artificial vision. He then spent three years as Professor in the department of Mechanical and Aerospace Engineering at the University of West Virginia where he continued his research into artificial intelligence/ artificial vision, fluidization and electrostatic field mechanisms in pneumoconiosis.

From 1989 to 2004, Rory developed an American automation company specializing in robotic and artificial vision systems for Fortune 500 companies such as Corning, Sony, Bausch and Lomb, Union Carbide, Briggs and Stratton, General Motors and Siemens. Projects included the automated high-speed packing of hardwood flooring, precision laser cutting of television tubes, automation of processes for PCB inspection, lumber mills, eyewear, glass and ceramic processes. He acted as Bausch and Lomb's international technical consultant for their facilities in the USA (New York, Maryland and Texas), Ireland, Hong Kong, Brazil and India. He developed the Nimbl line of innovative robots.

In 2005 Rory moved to New Zealand. His current research areas are artificial intelligence, artificial vision, automated fruit picking and packing, data sonification and development of a novel wheel chair. He supervises five PhD students and 2 Masters students. He has published 54 papers and holds 7 patents with 3 patents pending.

A scheme for an Embodied Artificial Intelligence

This address discusses the question of building artificial intelligence into a humanoid robot. The approach is rather that of machine builders than analysts and presents a fuzzy blueprint of what is intended to be done over the next two years to produce a humanoid robot which is capable of learning and manipulating in a general environment.

The literature on embedded artificial intelligence is voluminous and all the important questions have been perceived and discussed for 50 years. However the exemplars reported are, on the spectrum of achievement, closer to a fridge light rather than to R2D2 or Terminator III.

The paradigm which is laid out is nothing if not grandiose (though unkind persons might use the word preposterous).

- The keynote address reports on the development of a technique in artificial vision which allows general objects to be learned, recognized and oriented in six space. (x, y, z, φ1, φ2, φ3). This will be fleshed out and validated by experimental data in papers in the special session on "Embodied Artificial Intelligence".
- The presenter argues, on the basis of paleontological evidence, that intelligence and vision have developed simultaneously over evolutionary time and, further, that intelligence and vision are fundamentally concerned with objects. Any sentence in any language is also concerned with objects and the use of language as a paradigm for intelligence follows naturally.
- Once this paradigm is enunciated, the presentation will go into the details of the following questions:
    - Instinct
    - Memory
    - Logic
    - Teleological planning
    - Play
    - Volition and behaviour
    - "Is there something out there?"
    - Emotion
    - Consciousness
- The presentation takes the form of a how-to-do discussion of each of these aspects with the notion that only those schemes are proposed which can be implemented and will work.

Keynote address #3

Dr Kay Chen Tan

Kay Chen TAN is currently an Associate Professor in the Department of Electrical and Computer Engineering at the National University of Singapore, Singapore. He is actively pursuing research in computational and artificial intelligence, with applications to multi-objective optimization, scheduling, automation, data mining, and games.

Dr Tan has published over 80 journal papers, 100 papers in conference proceedings, co-authored 5 books including Multiobjective Evolutionary Algorithms and Applications (Springer-Verlag, 2005), Modern Industrial Automation Software Design (John Wiley, 2006; Chinese Edition, 2008), Evolutionary Robotics: From Algorithms to Implementations (World Scientific, 2006), Neural Networks: Computational Models and Applications (Springer-Verlag, 2007), and Evolutionary Multi-objective Optimization in Uncertain Environments: Issues and Algorithms (Springer-Verlag, expected in 2009), co-edited 4 books including Recent Advances in Simulated Evolution and Learning (World Scientific, 2004), Evolutionary Scheduling (Springer-Verlag, 2007), Multiobjective Memetic Algorithms (Springer-Verlag, expected in 2009), and Design and Control of Intelligent Robotic Systems (Springer-Verlag, expected in 2009).

Dr Tan has been invited to be a keynote/invited speaker for many international conferences. He served in the international program committee for over 80 conferences and involved in the organizing committee for over 20 international conferences, including the General Co-Chair for IEEE Congress on Evolutionary Computation 2007 in Singapore and the General Co-Chair for IEEE Symposium on Computational Intelligence in Scheduling 2009 in Tennessee, USA. Dr Tan is currently the Chairman of Evolutionary Computation Technical Committee in IEEE Computational Intelligence Society and a member of Board of Directors in Evolutionary Programming Society. Dr Tan currently serves as an Associate Editor / Editorial Board member of 10 international journals, such as IEEE Transactions on Evolutionary Computation, IEEE Transactions on Computational Intelligence and AI in Games, European Journal of Operational Research, Journal of Scheduling, and International Journal of Systems Science.

Dr Tan received the Recognition Award (2008) from the International Network for Engineering Education & Research (iNEER) for outstanding contributions to engineering education and research. He was also a winner of the NUS Outstanding Educator Awards (2004), the Engineering Educator Awards (2002, 2003, 2005), the Annual Teaching Excellence Awards (2002, 2003, 2004, 2005, 2006), and the Honour Roll Awards (2007).

Recent Advances in Memetic Algorithms for Evolutionary Optimization

Memetic algorithms (MAs), the synergy of evolutionary or any population-based approaches with separate individual learning or local improvement procedures, represent one of the recent growing areas of research in computational intelligence. In the literature, MAs are also referred to as hybrid evolutionary algorithms (EAs), Baldwinian EAs, Lamarckian EAs, cultural algorithms, or genetic local search. With the help of local improvement procedures or synergy between different computational frameworks, MAs are reported to be capable of obtaining high quality solutions more efficiently than conventional EAs across a wide range of application domains. In this talk, issues and recent advances of memetic algorithms for evolutionary optimization will be discussed. The application of these algorithms to a few practical problems will also be presented, such as solving the NP-hard multi-objective routing and scheduling problems, which often involve different competing specifications in a large and highly constrained search space.

Keynote address #4

Prof. R. K. Mittal

R.K.Mittal is Deputy Director (Administration) and Professor of Mechanical Engineering and Computer Science at Birla Institute of Technology and Science, Pilani (BITS Pilani), India, which is an all-India Institute for higher education to provide the highest quality technical education, at three tiers to students from all over India. He began his academic career at BITS in 1975, moving from lecturer to professor in 1995, as well as serving as Unit Chief, Dean and member/chair of several academic and administrative committees. R.K.Mittal's career at BITS Pilani is spanned over 33 years now, with executive responsibilities in Engineering, Finance, and Information Technology. During this period he participated and led the team in stream of disruptive computing technologies – from punch cards to the Web – to cater to the in-house administrative computing needs of the university. He has pioneered introduction of several new courses in emerging and interdisciplinary areas.

R. K. Mittal received B. E. (Hons.) Mechanical Engineering, M. E. Mechanical Engineering (with Practice School) and Ph.D. (Software Engineering) degrees from the Birla Institute of Technology and Science, (BITS), Pilani, India, in 1973, 1975, and 1992, respectively. He obtained the highest rank in order of merit in M.E. and was awarded the Institute's Gold Medal. He has been teaching undergraduate and postgraduate courses, has guided several M. E. Dissertations and five Ph.D. students in Robotics and Software Engineering areas. Three students have completed Ph.D. His research interests includes robust robot designs, two-/three-dimensional robot-path planning, microelectromechanical systems (MEMS), microrobots and nanorobots, nanotechnology, software engineering, and software testing. He is the founding member of the Centre for Robotics and Intelligent Systems (CRIS) created from scratch in 1992 and was its Coordinator until 2000. A team of students have developed the first humanoid in India, named AcYut, which participated in World RoboGames 2008 held at San Francisco, California, USA.

He is also the Dean, Academic Registration and Counselling Division since 1995 and was the first Unit Chief of Computer Assisted Housekeeping Unit (CAHU), from 1987 until 2006. Dr. Mittal is member of IEEE and is the Branch Counselor for the IEEE Students Branch, BITS. He was instrumental in establishing BITS Alumni Association (BITSAA) in 1989 and is the President of the BITSAA.

He has coauthored two textbooks: *Robotics & Control* (New Delhi, India: McGraw-Hill, 2003) and *Elements of Manufacturing Processes* (New Delhi, India: Prentice-Hall, 2003); editor of two conference proceedings: EMTM2N-2007 (Research Publishing, Chennai, India) and ISSS-MEMS-2007 (CD Proceedings); numerous in-house course notes, lab manuals and monographs. He has authored or co-authored over 35 papers in international and national peer reviewed journals and conferences. He was Programme Chair of a highly successful International Conference on Emerging Mechanical technology-Macro to Nano, EMTM2N-2007, 16-18 February 2007, BITS Pilani and was joint organizer for 2nd ISSS National Conference on MEMS, Microsensors, Smart Materials, Structures and Systems, ISSS-MEMS2007, November 16-17, 2007, CEERI Pilani.

Powering Nanorobots: An Engineering Challenge

Nanorobotics is a fast emerging field of engineering concerned with creating miniaturized robots of the size of few hundred nanometers and below consisting of components of nanoscale or molecular size and with functionalities of their macro-counterparts. There is an all around development in nanotechnology towards realization of nanorobots in the last two decades. Nanorobots will work either in vacuum or in a fluid as flying or swimming machines. Propulsion of nanometer sized robot through a fluid, where friction dominates and motion invariably is overdamped, calls for design strategies very different from the macroscopic world.

Propulsion requires expenditure of energy, transduction of energy and transmission of energy. For nanorobots, the small size and complexity of issues like energy storage and utilization of energy in efficient manner is challenging to engineers. The issues in propulsion have been addressed by scientists and engineers since the advent of research on nanorobotics. The queue has been taken from nature where biology has come up with a large number of concepts ranging from active polymerization of gel network, molecular motors moving on tracks formed by protein filaments, to rotating and beating flagellar mechanisms.

Energetics in the assay of nanorobot propulsion presents hitherto impregnable situation but the continuing attempts by scientists and engineers towards realization of nanorobots are conclusive indications of a solution imminent in near future. Various energy storage possibilities (Gravitational, Mechanical, Chemical, Electrical, Magnetic and Nuclear) and compatible transducing mechanisms to mechanical motion have been explored and are available in literature. For nanorobots, onboard volume is a precious and limited commodity. Energy stored per unit volume (joules/m3) is an appropriate figure of merit for nanoscale energy storage devices. Most of the experimental investigations on energy usage by a nanorobot are done through external excitations and technology for on-board power device is still a challenge to engineers. The continuity of power supply is another issue in energetics of nanorobots as refueling is beyond practical proposition. The key to nanorobot power supply is the efficient conversion of energy from one form to another. Biologicals in nano-domains obtain the continuous power supply from surrounding medium through ATP reduction. The thermal energy content of environment of a nanorobot is abundant and presents a plausible source but its utilization is denied by second law of thermodynamics in ordinary equilibrium processes. Theory does predict that at non-equilibrium fluctuations, thermal content of surrounding medium manifesting as Brownian motion of environmental molecules may be tapped for rectified motion of nanorobots. In a nanorobot, a mechanomechanical transducer needs to be developed to convert environmental Brownian motion into mechanical energy for internal storage or immediate utilization.