



## Technical Program Details & Paper Abstracts

### Monday, 17 December

PS I

Plenary Session I

RM#206 + 207

Chair: Jun Jo, Griffith University, Australia

8:50-9:40

#### Computational Red Teaming for Air Traffic Management

Prof. Hussein A. Abbass, University of New South Wales - Canberra, Australia

M1A

Genetic Intelligence

RM#202

09:50-11:05

Chair: Kamran Shafi, University of New South Wales, Australia

M1A-1

09:50-10:05

#### Experimental Study of Grouser's Effect for Planetary Rovers Based on Terramechanics

Yuto Nakane<sup>1</sup>, Kojiro Iizuka<sup>1</sup>, Takashi Kubota<sup>2</sup>

<sup>1</sup>Shinshu University, Japan, <sup>2</sup>Japan Aerospace Exploration Agency, Japan

In the future, the planetary exploration missions, planetary robots are required to traverse over very rough terrain. On the lunar surface and Mars surface, there are covered with loose soil, namely • • Regolith • • The reason why the wheel is easy to occur the poor condition during traverse on loose soil is not yet clear in detail. We use Terramechanics model for analyzing the mechanism of slipping and sinking behavior. Terramechanics model which is widely used as locomotion model for some lunar rovers is applicable to only circular wheel. So, it is not easy to apply to wheel with grousers. Therefore, firstly, we simulated the conventional model to confirm the difference between the wheel without grousers and with grousers. Secondly, we carry out the running experiments using the rigid circular wheel (with and without grousers) to compare with simulation results. From these results, we consider the difference between the conventional model and the real wheel's model.

M1A-2

10:05-10:20

#### Evolving Story Narrative using Surrogate Models of Human Judgement

Kun Wang<sup>1</sup>, Vinh Bui<sup>1</sup>, Eleni Petraki<sup>2</sup> and Hussein A. Abbass<sup>1</sup>

<sup>1</sup>School of Engineering and IT, Australia, <sup>2</sup>University of Canberra, Australia

Communication has been an active field of research in Robotics.

However, less work has been done in the ability of robots to negotiate meanings of the world through storytelling. In this paper, we address this gap from the perspective of evolving stories. By approximating human evaluation of stories to guide the evolution, we can automate the story evolutionary process without interacting with humans. First, a multi-objective story evolution approach is applied where the approximated human story evaluation model automatically evaluates the subjective story metrics such as coherence, novelty and interestingness. We then use humans again to validate the stories narrated by the machine. Results show that for each of the human subjects, the stories collected after story evolution are regarded as better stories compared to the initial stories. Some interesting relationships are revealed and discussed in details.

M1A-3

10:20-10:35

## **A Homogeneous Distributed Computing Framework for Multi-Objective Evolutionary Algorithm**

Ki-Baek Lee and Jong-Hwan Kim

*KAIST, Korea*

This paper proposes a homogeneous distributed computing (HDC) framework for multi-objective evolutionary algorithm (MOEA). In this framework, multiple processors divide a work into several pieces and carry them out in parallel. Every processor does its task in a homogeneous way so that the overall procedure becomes not only faster but also fault-tolerant and independent to the number of processors.

To implement this framework into an evolutionary algorithm, the evolutionary process of multi-objective particle swarm optimization (MOPSO) is employed. The effectiveness of the proposed framework is demonstrated by empirical comparisons between the results with the different numbers of processors, one and four. Seven DTLZ functions are used as benchmark functions and hypervolume, diversity, and evaluation time are used as comparison metrics. The results indicate that the evaluation time is significantly reduced by the proposed framework without any loss of overall solution quality and diversity.

M1A-4

10:35-10:50

## **Neuro-evolution of Escape Behaviour under High Level of Deception and Noise**

Shir Li Wang, Kamran Shafi, Chris Lokan and Hussein A. Abbass

*University of New South Wales, Australia*

Red teaming is an approach to studying a task by anticipating the actions of an adversary ("red") who wishes to affect the achievement (by "blue") of that task. Computational red teaming is a recent approach that extends in red teaming concept in cyber space and benefits from replacing the physical *red* and *blue* with simulated entities. In this study, we focus on the use of multiple strategies in computational red teaming and the factors that influence the selection of strategy. The reason for the use of multiple strategies is to simulate variability observed in human choice. The use of multiple strategies are demonstrated by the generation of diversified solutions by evolutionary robotics while the factors that influence the preferences of strategies are perception and deception. This paper presents an attempt at exploring and modeling the effect of red through the evolutionary method in a synthetic red teaming game environment.

M1A-5

10:50-11:05

## **Distributed Multiobjective Quantum-inspired Evolutionary Algorithm (DMQEA)**

Si-Jung Ryu and Jong-Hwan Kim

*KAIST, Korea*

Most of the multiobjective evolutionary algorithm inherently has heavy computational burden, so it takes a long processing time. For this reason, many researches for reducing computational time have been carried out, in particular by using distributed computing such as multi-thread coding, GPU coding, etc. In this paper, multi-thread coding is used to reduce computational time and applied to multiobjective quantum-inspired evolutionary algorithm (MQEA). In MQEA, nondominated sorting and crowding distance assignment which take a long time are carried out in each subpopulation. By multi-thread coding, the processes in each subpopulation can be performed simultaneously. To demonstrate the effectiveness of the proposed distributed MQEA (DMQEA), comparisons with single-thread and multi-thread are carried out for seven DTLZ functions.

M1B

Behavioral Intelligence I

RM#203

09:50-11:05

Chair: Kojiro Iizuka, Shinshu University, Japan  
Chair: Victor Raskin, Purdue University, USA

M1B-1

09:50-10:05

### Curvature Path Planning with High Resolution Graph for Unmanned Surface Vehicle

Hanguen Kim, Byeolteo Park and Hyun Myung  
*KAIST, Korea*

In this paper, we propose a curvature path planning algorithm for unmanned surface vehicles (USVs). To control the USV automatically, various robot navigation techniques can be applied and numerous researchers are working on a grid map-based path planning algorithms. However, the most grid map-based path planning methods for the USVs consider only two-dimensional (x, y) plane without considering vehicle's maximum curvature. Since the most of the USVs are typically highly under-actuated, the ship tends to result in failure and sometimes induces hazardous collision situation when the ship follows the resultant path generated by the two-dimensional path planning algorithm. To solve this problem, we construct a non-uniform grid map which can reflect the geometric cost. Next we extend the dimension to reflect the kinematic constraint of the USV. Finally, to consider the vehicle's dynamic constraint, we propose a new cost function. The result of the proposed algorithm has been demonstrated through the simulation on the real map and the results show that the proposed algorithm generates the most plausible and efficient path.

M1B-2

10:05-10:20

### Development of Crawler Robot with Pile Units to traverse Loose Soil with Steep Slope

Kojiro Iizuka<sup>1</sup>, Hirofumi Komatsu<sup>1</sup> and Takashi Kubota<sup>2</sup>

<sup>1</sup>International Young Researcher Empowerment Center, Japan, <sup>2</sup>Japan Aerospace Exploration Agency, Japan

Rovers are the most important devices for planetary exploration. Rovers are required to traverse many situation of ground, on various form's stones, loose soil, steep slope etc. There are some technologies that large obstacles such as stones can be avoided by using cameras or lasers. However, it is extremely difficult for rovers to traverse loose soil, especially "loose soil with steep slope" If the area being traversed is sloped, these rovers might not work. During a lunar exploration mission, rovers must be able to traverse slopes. Lunar surfaces are mainly characterized by loose soil called regolith, and the ground is very steep around craters. We developed a crawler robot to adapt such condition. Proposed rover has an ability to traverse loose soil with steep slope. It is to use the shearing strength of soil. This means that we use characteristic of soil that the shearing strength of deeply soil areas was very strong compared with surface of ground. If the rovers can make use of the deep area of loose soil, they may be able to support their weight on slopes with loose soil. Therefore, we employ piles to penetrate into the deep area of loose soil. We combined the crawler robot and piles units. The experimental results are shown the high performance of the proposed crawler robot with piles units on uneven ground and loose soil.

M1B-3

10:20-10:35

### Robo-Teacher: A Computational Simulation Based Educational System to Improve Cyber Security

Bin Zhang, Kamran Shafi and Hussein A. Abbass

*UNSW Canberra, Australia*

Various threats and security issues exist in the cyber environ-ment. For information assurance, we need to fully understand the concept of Cyber Intelligence (CI) which includes the identification, track-ing, analysis and countering of security threats in cyberspace. In order to achieve this, we focus on educating and training CI for organizations and individuals via effective smart systems design and implementation using artificial intelligence (AI) techniques to build an interactive and adaptive learning environment. Based on investigation of basic theories and CI concepts, a simulation model is proposed. Interaction and adap-tation are then integrated or designed upon simulation. Such a learning environment aims to impart a thorough and comprehensive understand-ing of cyber intelligence and provide enhanced learning experience. Keywords: Cyber Intelligence, Education, Training, Simulation, Optimization

M1B-4

10:35-10:50

## Automatic Take-off and Landing Control for Small Unmanned Helicopter

Satoshi Suzuki

*Shinshu University, Japan*

In this study, a control scheme and controller design for automatic take off and landing of a small unmanned helicopter are proposed. First, acceleration feedback controller is designed for stabilizing horizontal motion of the helicopter. In acceleration feedback controller, horizontal acceleration is estimated by using Kalman filter, and desired attitude to cancel out horizontal acceleration is generated by using estimated acceleration. Second, altitude controller by using ultrasonic sensor is designed to stabilize altitude of the helicopter near ground. Finally, each control system is verified by flight experiment, and automatic landing experiment is also carried out.

M1B-5

10:35-10:50

## Comparative Analysis of Arm Control Performance Using Computational Intelligence

Cesar H. Valencia, Marley M. B. R. Vellasco and Karla T. Figueiredo

*PUC-Rio, Brasil*

Several models of computational intelligence have been proven to be useful in robotic devices control. This work evaluates three models to solve the inverse kinematics problem of a robotic manipulator with two degrees of freedom, which is used to position objects in conjunction with the CoroBot platform. They were initially developed the direct and inverse kinematic models using the homogeneous transformation matrices, extracting from these, the training, testing and validation data used in the three models. This paper takes advantage of the great potential of artificial neural networks, in order to determine the feasibility and response of the experiments performed, keeping in focus the possible applications and modification of design and training parameters. The models used are Feedforward Neural Networks, Neuro-Fuzzy Systems and finally Echo State Networks.

M1C

Cognitive Intelligence I

RM#204

09:50-11:05

Chair: Katsunari Shibata, Oita University, Japan

M1C-1

09:50-10:05

## Slip Compensation of Mobile Robots Using SVM and IMM

Jongdae Jung<sup>1</sup>, Hyoung-Ki Lee<sup>2</sup> and Hyun Myung<sup>1</sup>

*<sup>1</sup>KAIST, Korea, <sup>2</sup>Samsung Advanced Institute of Technology, Korea*

Improvement of dead reckoning accuracy is essential for robotic localization system and has been intensively studied. However, existing solutions cannot provide accurate positioning when a robot suffers from changing dynamics such as wheel slip. In this paper, we propose a interacting multiple model (IMM) framework to detect and compensate for wheel slip. Firstly, two different types of extended Kalman filter (EKF) are designed to consider both no-slip and slip dynamics of mobile robots. Then a support vector machine (SVM) for slip estimation is constructed using real world training data. The trained model is utilized along with the two EKFs in the IMM framework. The approach is evaluated with experiments and the results show that the proposed approach improves positioning and slip compensation compared to the conventional approach.

M1C-2

10:05-10:20

## Emergence of Discrete and Abstract State Representation through Reinforcement Learning in a Continuous Input Task

Yoshito Sawatsubashiy<sup>1</sup> and Mohamad Faizal bin Samusudin<sup>2</sup>, and Katsunari Shibata<sup>1</sup>

*<sup>1</sup>Oita University, Japan, <sup>2</sup>Universiti Malaysia Perlis, Malaysia*

"Concept" is a kind of discrete and abstract state representation, and is considered useful for efficient action planning. However, it is supposed to emerge in our brain as a parallel processing and learning system through learning based on a variety of experiences, and so it is difficult to be developed by hand-coding. In this paper, as a previous step of the "concept formation", it is investigated whether the discrete and abstract state representation is formed or not through learning in a task with multi-step state transitions using Actor-Q learning method and a recurrent neural network. After learning, an agent repeated a sequence two times, in which it pushed a

button to open a door and moved to the next room, and finally arrived at the third room to get a reward. In two hidden neurons, discrete and abstract state representation not depending on the door opening pattern was observed. The result of another learning with two recurrent neural networks that are for Q-values and for Actors suggested that the state representation emerged to generate appropriate Q-values.

M1C-3

10:20-10:35

### Ensembles of Gradient Based Descriptors with Derivative Filters for Visual Object Categorization

Enas A. A. Eqlouss, Azizi Abdullah, Siti Norul Huda Sheikh Abdullah

*Universiti Kebangsaan Malaysia, Malaysia*

This paper describes several ensemble methods that combine multiple edge and orientation based histograms with support vector machine classifiers. The aim is to enhance learning speed and accuracy performance by using the chosen classical primitive filters on different edge and orientation descriptors. For efficiently describe images using these descriptors, the combination of a few basis features or edge filters are used. The stronger filter operator responds to edge-like structures, the more sensitive it to orientation. Thus, using more than one edge filter allows to capture more edge information to completely describe the structure of image content. One problem in combining these different descriptors is that the input vector becomes very large dimensionality, which can increase problems of overfitting and hinder generalization performance. The intuitively designed ensemble methods namely product, mean and majority are then used to combine support vector machines classifiers derived from the multiple orientations of edge operators. The results indicate that the ensemble methods outperform the single and naive classifiers.

M1C-4

10:35-10:50

### Transdisciplinary way of Knowledge Representation in Intelligent Autonomous Systems with Neural Networks

B.A. Kalashankar<sup>1</sup> and N.N.S.S.R.K. Prasad<sup>2</sup>

*<sup>1</sup>IT Consultant, India, <sup>2</sup>Group Director (Electromagnetic & Optical Systems), India*

Learning is the highly complex and ongoing process in each and every stage of life to enrich our thought processes, in the same way our thought process is involved in the course of acquiring auxiliary knowledge with an existing knowledge. In this perspective human stands ahead on every stage of life, an important difference between intelligent autonomous applications and human intelligence is our ability to exploit common sense knowledge attained from a lifetime of learning and experiences to inform our decision-making and behavior. This allows humans to adapt easily to novel situations where intelligent autonomous systems fail in some cases due to lack of situation-specific rules and generalization capabilities.

In the ongoing research and development, most of the intelligent autonomous systems can do the task as expected, but still fails in the process of acquiring additional knowledge apart from the acquired knowledge. This is due to our way of learning methodologies, domain experience, and way of thought processes where we involved as a disciplinary, multidisciplinary, interdisciplinary and transdisciplinary approach of learning. In order for intelligent autonomous systems to exploit common sense knowledge in reasoning as humans do, understand domain specific basics, then, we need to provide them with human-like reasoning strategies.

In complex situation, in particular, representation of multiple domain knowledge to resolve the problem based on the situation. The domain knowledge should be adapted at multidimensional way or parallel or dynamic way of adapting the knowledge. This leads intelligent autonomous systems to use an alternative when it fails at the particular point of solving the problem, so for better result knowledge should be organized in the better way. Knowledge is dominantly organized in disciplines, as multidisciplinary and interdisciplinary research is developing at the boundaries of the scientific disciplines [8]. In this paper we compare transdisciplinary, interdisciplinary, multidisciplinary and non-disciplinary forms of knowledge representations and adopt transdisciplinary approach for intelligent autonomous systems with neural networks.

M1C-5

10:50-11:05

### Obstacle Detection Using Fuzzy Integral-Based Gaze Control for Mobile Robot

Seung-Beom Han, Jeong-Ki Yoo and Jong-Hwan Kim

*KAIST, Korea*

Obstacle detection is one of key issues in robotics because robots should avoid obstacles not to collide with or use them to obtain some

information in the environment. Decision making for a proper gaze direction to get more information is also an important issue when there are many obstacles, in particular, dynamic obstacles. To deal with these issues, this paper proposes fuzzy integral-based gaze control for obstacle detection of mobile robots. The fuzzy measures are calculated with the preference degree for five criteria about obstacle detection and the fuzzy integral decides a final gaze direction using the fuzzy measure values and partial evaluation values with respect to the five criteria. Computer simulation demonstrates the effectiveness of the proposed algorithm.

M2A

Social Intelligence

RM#202

11:20-12:35

Chair: Takashi Kubota, The University of Tokyo, Japan

Chair: John Gallagher, Wright State University, USA

M2A-1

11:20-11:35

### Multimodal Human-Robot Interface with Gesture-based Virtual Collaboration

Young Eun Song, Mihoko Niitsuma, Takashi Kubota, Hideki Hashimoto and Hyoung Il Son

*Univ. of Tokyo, Japan*

This paper proposes an intuitive teleoperation scheme by using human gesture in conjunction with multimodal human-robot interface. Further, in order to deal with the complication of dynamic daily environment, the authors apply haptic point cloud rendering and the virtual collaboration to the system. All these functions are achieved by a portable hardware that is proposed by authors newly, which is called "the mobile iSpace". First, a surrounding environment of a teleoperated robot is captured and reconstructed as the 3D point cloud using a depth camera. Virtual world is then generated from the 3D point cloud, which a virtual teleoperated robot model is placed in. Operators use their own whole-body gesture to teleoperate the humanoid robot. The Gesture is captured in real time using the depth camera that was placed on operator side. The operator receives both the visual and the vibrotactile feedback at the same time by using a head mounted display and a vibrotactile glove. All these system components, the human operator, the teleoperated robot and the feedback devices, are connected with the Internet-based virtual collaboration system for a flexible accessibility. This paper showcases the effectiveness of the proposed scheme with experiment that were done to show how the operators can access the remotely placed robot in anytime and place.

M2A-2

11:35-11:50

### A Simultaneous Generation Method for Gaze Behaviors and Facial Expressions of a Robotic Head

Bum-Soo Yoo and Jong-Hwan Kim

*KAIST, Korea*

Human robot interaction (HRI) is one of emerging areas in robotics. When robots communicate with people, non-verbal communication including facial expressions, gestures and gaze plays an important role to express their emotion and intention effectively. Thus, many researches are carried out to generate proper non-verbal communications that would make robots to be considered as social agents. This paper proposes a method of generating facial expressions and gaze directions simultaneously. When external environment is perceived, robot's emotion is changed either instantly or gradually. The emotion is used to generate facial expressions using the fuzzy measures and fuzzy integral.

At the same time, a fuzzifier is applied to the perceived information to produce useful human information. The human information includes the number of faces and the size of faces, which can be used to approximate distances from the robot to faces. The human information is used to select a gaze behavior among four candidate behaviors. Through the proposed method, robots can generate proper facial expressions and gaze behaviors at the same time. The effectiveness of the proposed method is demonstrated through the simulation and the experiments with a robotic head, developed in the RIT Laboratory, KAIST.

M2A-3

11:50-12:05

### Three-Layered Architecture for Tele-operator and Its System Test

Koshi Hoshino and Yasuharu Kunii

*Chuo University, Japan*

In this paper, we discuss an intelligent system architecture for teleoperators (e.g., planetary exploration rovers). This architecture

offers advanced flexibility (variability), efficiency, scalability, and transparency. The architecture is composed of two software layers (first and second) and one hardware layer (third). The software layer is divided into two layers to achieve both efficient task construction by the users and management of software modules by the system. To maintain a variable structure and improve accessibility to information, we connect modularized software and hardware via a network. Moreover, to achieve high-speed data communication between software modules, we use a shared memory. Through the proposed architecture we can efficiently perform repairs and consequently enhance the functionality of teleoperator systems. Therefore, our proposed architecture can provide significant contributions to the development and operation of teleoperators.

M2A-4

12:05-12:20

**Analysis of Physiological Signals for Emotion Recognition based on Support Vector Machine**

Makara Vanny, Seung-Min Park, Kwang-Eun Ko, and Kwee-Bo Sim

*Chung-Ang University, Korea*

Emotion recognition is one of the important part to develop in human-human and human-computer interaction. In this paper, we focused on the experimental paradigm and feature extraction to extract features from the physiological signals. The experimental paradigm for data acquisition used MULTI module equipment of biofeedback 2000 x-pert which combined multi-sensor such as skin conductance, skin temperature, and blood volume pulse to collect physiological signals from the subject's fingertip of the non-dominant hand. And an approach for the emotions recognition based on physiological signals such as fear, disgust, joy, and neutrality that international affective picture system (IAPS) was used to elicit emotion. These were selected to extract the characteristic parameters, which will be used for classifying emotions. Support vector machine (SVM) is a popular technique for classifying emotion recognition and perform high accuracy for classification. The experiment results showed that the methodology by using experimental paradigm, feature extraction and especially multi-class support vector machine (MSVM) provided significant improvement in accuracy for classification emotion recognition states.

M2A-5

12:20-12:35

**Human Intention Reading by Fuzzy Cognitive Map: A Human-Robot Cooperative Object Carrying Task**

Ji-Hyeong Han and Jong-Hwan Kim

*KAIST, Korea*

Considering the symbiosis between humans and robots in coming years, robots should be able to infer the implicit human intention for the efficient humanrobot interaction. This paper focuses on the human-robot cooperation problem among the various fields of human-robot interaction. The human intention reading method using fuzzy cognitive map for the efficient human-robot cooperation is proposed along with the algorithm which decides the appropriate behavior of a robot with the recognized human intention. The effectiveness of the proposed method is demonstrated through computer simulation on human-robot cooperative object carrying task.

M2B

Behavioral Intelligence II

RM#203

11:20-12:35

Chair: Satoshi Suzuki, Shinshu University, Japan

Chair: Azizi Abdullah, National University of Malaysia, Malaysia

M2B-1

11:20-11:35

**Advanced Sampling Scheme Based on Environmental Stifnes for a Smart Manipulator**

Taku Shimizu<sup>1</sup> and Takashi Kubota<sup>2</sup>

<sup>1</sup>The University of Tokyo, Japan, <sup>2</sup>ISAS/JXAX, Japan

Extraction of rock samples using robotic arms is an essential technique for planetary exploration. By sampling and analyzing the rocks, we can gain knowledge, not only about the planetaly body itself but also about other bodies and the space environment as a whole. In conventional missions, images of the surface are captured and sent to Earth so that the human operator can deside a sampling strategy. However, in such missions, communication delays with Earth are inevitable, and a large number of scientists and engineers are involved in the decisions, which makes the procedure time-consuming, expensive and limited in efficiency. For these reasons, automated extraction processes are required to increase the scientific return. In this study, a novel intelligent manipulator system

which samples the rocks semi-automatically by measuring environmental stiffness is proposed. To make such a system autonomous in an unknown environment, vision-based approaches are usually preferred. However, information obtained from cameras is difficult to process. In this paper, another technique based on measuring applied forces is presented, and we demonstrate its effectiveness for the detection of buried rocks.

M2B-2

11:35-11:50

### **Walking Pattern Generation on Inclined and Uneven Terrains for Humanoid Robots**

Young-Dae Hong and Jong-Hwan Kim

*KAIST, Korea*

This paper introduces a walking pattern generation method on an inclined terrain in both pitch and roll directions, and uneven terrain. The walking pattern generation method is based on a modifiable walking pattern generator (MWPG) which allows a zero moment point (ZMP) variation in real-time. As a navigational command set, a 3-D command state (CS) is defined, which consists of single and double support times, sagittal and lateral step lengths, and foot height of the swing leg. In the single support phase, the primary dynamics of the humanoid robot on the inclined terrain is modeled as a 3-D linear inverted pendulum model (LIPM) with constant center of mass (CoM) height, and the dynamic equation of the 3-D LIPM is derived to obtain the sagittal and lateral CoM motions. Using the sagittal and lateral CoM motions, the sagittal and lateral CoM trajectories are generated to satisfy the sagittal and lateral step lengths of the swing leg. The foot trajectories of the swing leg are generated according to the commanded sagittal and lateral step lengths, and foot height. In the double support phase, the vertical CoM trajectory is generated to satisfy the foot height of the swing leg from the single support phase. The walking pattern generation method is implemented on a simulation model of the small-sized humanoid robot, HanSaRam-IX (HSR-IX) and the effectiveness is demonstrated through computer simulations.

M2B-3

11:50-12:05

### **Optimal EEG Channel Selection for Motor Imagery BCI System using BPSO and GA**

Jun-Yeup Kim, Seung-Min Park, Kwang-Eun Ko, and Kwee-Bo Sim

*Chung-Ang University, Korea*

A motor imagery brain-computer interface system is used to translate a subject's intention into a control command of machine, such as electrical wheelchair, robot manipulator, and so on. The overall process of classification of the motor imagery EEG signals is based on the acquisition of raw data from multiple channel of scalp when the subject tries to imagine the movement of limbs. So far, we have been concentrated which channel are activated by the imagination of the movement of limbs. Therefore, we have expected that the more channels are selected, the better results can be acquired. However, the problem is that using many channels causes other problems. When applying a common spatial pattern (CSP), which is a spatial feature extraction, many channels cause an overfitting problem, in addition there is difficulty using this technique for medical analysis. To overcome these problems, we suggest a binary particle swarm optimization (BPSO) as an optimal channel selection method. This paper examines selecting optimal channels and their combination, and comparing accuracy and the number of selected channels obtained from BPSO and simple genetic algorithm.

M2B-4

12:05-12:20

### **Trigonometry Technique for Ball Prediction in Robot Soccer**

Muhammad Nuruddin Sudin, Siti Norul Huda Sheikh Abdullah, Mohammad Faidzul Nasrudin and Shahnorbanun Sahran

*National University of Malaysia, Malaysia*

The main challenge in a robot soccer competition is to estimate the best robot's position according to two aspects: the ball and other robots positions given by visualize system and the game strategies. The ultimate aim is that to assign the right robot to the right position at the right time to win the ball for attacking or defending. Most of the time, the movements of the robots are determined by the position of the ball. The paper presents a ball position prediction technique based on trigonometry. We demonstrate the precision of the predicted ball position from the proposed technique and compare the precision result with those obtained from several existing techniques.

M2B-5

12:20-12:35

## Stable Modifiable Walking Pattern Algorithm with Constrained Optimized Central Pattern Generator

Chang-Soo Park and Jong-Hwan Kim

*KAIST, Korea*

In this paper, stable modifiable walking pattern algorithm is proposed using evolutionary optimized central pattern generator (CPG). Sensory feedback pathways in CPG are proposed, which use force sensing resistor (FSR) signals. For the optimization of CPG parameters, two-phase evolutionary programming (TPEP) is employed. Modifiable walking pattern generator (MWPG) generates position trajectory of center of mass (COM) of humanoid robot and CPG generates sagittal swing foot position trajectory. The effectiveness of the proposed scheme is demonstrated by simulations using aWebots dynamic simulator for a small sized humanoid robot, HSR-IX, developed in the Robot Intelligence Technology (RIT) Lab, KAIST.

M2C

Cognitive Intelligence II

RM#204

11:20-12:35

Chair: Pitoyo Hartono, Chukyo University, Japan

M2C-1

11:20-11:35

## Behavior Selection Method for Entertainment Robots Using Intelligence Operating Architecture

Woo-Ri Ko and Jong-Hwan Kim

*KAIST, Korea*

To get and hold a user's attention, entertainment robots should be able to think and behave like a human being to show various responses in a certain situation. For this purpose, this paper proposes a behavior selection method for entertainment robots using intelligence operating architecture (iOA). The iOA consists of five parts and 15 modules to implement the robot intelligence, which is motivated by the key functions of human brain. In the internal state part, the strengths of the robot's internal states, i.e. motivation, homeostasis, and emotion, are updated. The sensory information is converted to contexts in the context module. Considering both the internal states and contexts, a behavior which is composed of four expressions, i.e. facial expression, gesture, movement, and voice expression, is selected in the problem solving module. To show the effectiveness of the proposed method, a software entertainment robot is implemented for simulations. The simulation results show that entertainment robots with different characteristics can be created and they can generate various behaviors by the proposed behavior selection method.

M2C-2

11:35-11:50

## A Quality Control Model for Trustworthy Crowdsourcing in Collaborative Learning

Jun Jo, Ann Stevens and Clarence Tan

*Griffith University, Australia*

Crowdsourcing is getting more popular in various on-line communities. This method allows many people to share and learn knowledge through collaborations. However, fraud or inaccurate information often causes crucial problems and the quality and accuracy of the knowledge became a major issue. This paper investigates the effects of crowdsourcing in education. Inquiry-based learning will be employed as an educational technology. This paper will then introduce a quality control model that integrates trustworthy crowdsourcing into collaborative learning. A new method for credit rating will be introduced.

M2C-3

11:50-12:05

## Improving Learning Performance through Formative Certainty-based Assessment and Feedback

Manuela Carmona and Jun H. Jo

*Griffith University, Australia*

The purpose of this paper is to present a system enhancement to improve the performance of the Learner Behaviour Tracker (LBT) system through the addition of certainty-based formative assessment. The LBT system was designed around a constructivist approach that used a tracker system and a database to investigate the effects of learner control in an e-learning environment. Analysis of the LBT implementation results was encouraging. The unrestricted learner control group overall achieved 6% higher marks than the educator controlled group and they also showed higher knowledge retention rates in a post-test, especially the members of the

younger age group. This group was also more actively involved in the learning process and used most of the system facilities. However, it was identified that neither group made great use of the feedback links provided in quizzes and online tests. The inclusion of the certainty-based formative assessment module is intended to improve this shortcoming. The aim is to ensure that feedback is provided instantly and that it addresses the specific knowledge status of the learner. Certainty-based assessment is well suited for this task as it requires learners to indicate their certainty level for each question, thus, engaging them in the learning process. It is expected that this engagement encourages higher order thinking processes.

**M2C-4**

**12:05-12:20**

**Differential Trace in Learning of Value Function with a Neural Network**

Katsunari Shibata and Shuji Enoki

*Oita University, JAPAN*

Reinforcement learning has a fatal problem of slow learning. To solve this problem, Eligibility-trace has been widely used. However, since the trace throws away old information and takes the present information constantly not depending on the information is important or not, long-term learning and short-term learning are incompatible. In this paper, a novel approach called "Differential trace" is proposed, in which the trace is not updated constantly, but according to the change of each neuron's output in a neural network. In other words, the time axis is subjectively adjusted in each neuron. The characteristics of the Differential trace could be observed in the learning of state value in a simple task where one-dimensional continuous environment is divided into 100 states. The learning performance is better in total than the case of Eligibility trace with either of two decay rates.

**M2C-5**

**12:20-12:35**

**Episodic Memory Design for Predicting the User's Intention**

Seung-Hwan Choi, Woo-Ri Ko, and Jong-Hwan Kim

*KAIST, Korea*

These days, people can easily access various services through IT devices. However, in most cases, the user has to spend much time in configuring the right options to get the exact desired service. To solve this problem, this paper proposes a service system with the episodic memory for predicting the user's intention. The interaction module is the main module which is developed for seamless and interactive service, and it contains the episodic memory and the service information. The episodic memory records the history of the user's pattern when the user utilizes the service agent. The service information is a set of essential data for providing services. Also, the reliability of the episode memory is proposed for predicting user's intention. The effectiveness and applicability of the proposed system are demonstrated through the experiments.

**PS II**

**Plenary Session II**

**RM#206 + 207**

Chair: Eric Matson, Purdue University, USA

**14:00-14:50**

**Service Robot Platform for Open Robotics Community**

Dr. Kyung Chul Shin, President of Yujin Robot Co.,Ltd, Korea

**M3A**

**Ambient Intelligence I**

**RM#202**

**15:00-16:15**

Chair: Khaled Al-Wahedi, The Petroleum Institute, UAE

Chair: Seon-Woo Lee, Hallym University, Korea

**M3A-1**

**15:00-15:15**

**Experimental Tests of Autonomous Jellyfish Removal Robot System JEROS**

Donghoon Kim, Jae-uk Shin, Hyongjin Kim, Donghwa Lee, Seung-Mok Lee, and Hyun Myung

*KAIST, Korea*

Recently, the increase in population of jellyfish is becoming a great menace to the oceans ecosystem, which leads to drastic damage to the fishery industries. To overcome this problem, a jellyfish removal system with trawl boats equipped with the jellyfish removal net has

been suggested by NFRDI. However, the system needs large ships which need to be operated by a lot of human operators. Thus, this paper represents the design and implementation of an autonomous jellyfish removal robot system, called JEROS. The JEROS consists of an autonomous surface vehicle (ASV), a grid for jellyfish removal, and an autonomous navigation system. Once jellyfish are detected using a camera, the jellyfish removal scenario is started with generating efficient path to remove the jellyfish. Finally, the jellyfish is sliced up with the grid installed underneath the JEROS by following the generated path. The prototype of the system was implemented, and its feasibility was demonstrated through outdoor experiments and field tests.

M3A-2

15:15-15:30

**An Examination of Feature Detection for Real-time Visual Odometry in Untextured Natural Terrain**Kyohei Otsu<sup>1</sup>, Masatsugu Otsuki<sup>2</sup>, Genya Ishigami<sup>2</sup>, and Takashi Kubota<sup>2</sup><sup>1</sup>The University of Tokyo, Japan, <sup>2</sup>ISAS/JAXA, Japan

Estimating the position of a robot is an essential requirement for autonomous mobile robots. Visual Odometry is a promising localization method in slippery natural terrain, which drastically degrades the accuracy of Wheel Odometry, while relying neither on other infrastructure nor any prior knowledge. Visual Odometry, however, suffers from the instability of feature extraction from the untextured natural terrain.

To date, a number of feature detectors have been proposed for stable feature detection. This paper compares commonly used detectors in terms of robustness, localization accuracy and computational efficiency, and points out their trade-off problems among those criteria. To solve the problem, a hybrid algorithm is proposed which dynamically switches between multiple detectors according to the texture of terrain. Validity of the algorithm is proved by the simulation using dataset at volcanic areas in Japan.

M3A-3

15:30-15:45

**Cost Based Navigation for Autonomous Vacuum Cleaners**

Khaled Al-Wahedi, Aya Darwish, and Basma Kodiah

*The Petroleum Institute, UAE*

In this paper, the Autonomous Vacuum Cleaner Navigation Problem is defined, formulated, and a solution is provided. In the design of an Autonomous Vacuum Cleaner (AVC), the most critical aspect is its navigation. An AVC is required to sweep the whole environment in order to clean it, and hence, this problem belongs to a category of problems known as *Coverage Problems*.

We propose a cost-based navigation algorithm that, at each stage, assigns costs to all the possible moves the AVC can make. These costs are based on certain navigation rules that are preprogrammed into the AVC. After all the rules are applied, the move with the lowest total cost is considered the winning move, and is the one selected by the AVC. The algorithm is tested via simulation, and the simulation results are presented.

M3A-4

15:45-16:00

**Image-based ICP Algorithm for Visual Odometry Using a RGB-D Sensor in a Dynamic Environment**

Deok-Hwa Kim and Jong-Hwan Kim

*KAIST, Korea*

This paper proposes a novel approach to calculate visual odometry using Microsoft Kinect incorporating depth information into RGB color information to generate 3D feature points based on speed up robust features (SURF) descriptor. In particular, the generated 3D feature points are used for calculating the iterative closest point (ICP) algorithm between successive images from the sensor. The ICP algorithm works based on image information of features differently from previous approaches. This paper suggests one of the modified versions for a state-of-the-art implementation of the ICP algorithm. Such an approach makes accurate calculation of the rigid body transformation matrix for visual odometry in a dynamic environment. From this calculation step, dynamically moving features can be separated into outliers. Then, the outliers are filtered with random sample consensus (RANSAC) algorithm for accurate calculation of the rigid body transformation matrix. The experiments demonstrate that visual odometry is successfully obtained using the proposed algorithm in a dynamic environment.

M3A-5

16:00-16:15

## Hybrid Indoor Location Tracking for Pedestrian Using a Smartphone

Seon-Woo Lee, Philhwan Jung and Seong-Ho Song

*Hallym University, Korea*

In this paper, a hybrid indoor location tracking method is proposed for pedestrian using a set of inertial sensors embedded in smartphones. The method is composed of two localization techniques; one is dead-reckoning using inertial sensors and the other is Wi-Fi fingerprinting. The proposed method uses the concept of combined map of topological and geometric map. Introducing user-select points of interest in his/her workplace we can reduce the cost of building a radio map for Wi-Fi fingerprinting method. The dead-reckoning method can track incremental movements of user by detecting steps. Based on acceleration signals we proposed a method to estimate the orientation and position of the phone in a pocket of pants. Experiments verified the performance of the method.

M3B

Behavioral Intelligence III

RM#203

15:00-16:15

Chair: Gon-Woo Kim, Chungbuk National University, Korea

M3B-1

15:00-15:15

## Sway Motion Cancellation Scheme Using a RGB-D Camera-based Vision System for Humanoid Robots

Jeong-Ki Yoo<sup>1</sup>, Seung-Beom Han<sup>2</sup> and Jong-Hwan Kim<sup>2</sup>

<sup>1</sup>*Samsung Electronics, Korea*, <sup>2</sup>*KAIST, Korea*

When a humanoid robot walks dynamically, it generates sway motion which is reflected as an oscillative sine wave-like pattern at its center-of-mass (CoM) trajectory. In order to cancel out such motion from the coordinates of detected obstacles, this paper proposes a sway motion cancellation scheme incorporated with walking pattern generator of humanoid robots along with a RGB-D camera-based vision system. After the preprocessing for the depth information from the RGB-D camera using attitude reference system (ARS)-generated roll and pitch angles of the vision module, the coordinates of detected obstacles are estimated using the ground filtered 3D points. Then, the sway motion cancellation scheme is applied to the coordinates of detected obstacles not only for the lateral direction of the robot but also for the sagittal one by referring the CoM trajectory collected from the walking pattern generator. The proposed sway motion cancellation scheme and the RGB-D camera-based vision system are verified by experiments using a small-sized humanoid robot, HanSaRam-IX (HSR-IX).

M3B-2

15:15-15:30

## Operator Standpoint-based Remote Operation System Considering the Operational Convenience for a Mobile Robot

Chang-Seop Shin and Gon-Woo Kim

*Chungbuk Nat'l University, Korea*

The remotely operated mobile robot is usually controlled in the viewpoint of the mobile robot using the conventional remote operation system. However, it is a little hard to control the mobile robot efficiently when the mobile robot exists in the field of view of the operator. Therefore, we propose the operator standpoint-based remote operation system considering the operational convenience for controlling a mobile robot. For implementing the proposed system, the accurate measurements of the orientation of both the mobile robot and the remote operation system are needed. In order to measure the absolute orientation of the mobile robot and the remote operation system, we exploit the magnetic compass. We also propose the efficient remote operation algorithm in the field of view of the operator using the coordinate transformation method. Finally, we present some experimental results for evaluating the validity of the proposed algorithm. The proposed method can be easily adapted to the common remote operation system by the switching mode approach.

M3B-3

15:30-15:45

### Locomotion of Robotic Fish Using the Univector Field Method in a 3-D space

In-Bae Jeong and Jong-Hwan Kim

*KAIST, Korea*

This paper proposes a univector field navigation method and a tracking controller for robotic fish locomotion in a three-dimensional space. Univector fields are designed to generate a path to the goal position avoiding obstacle collision. The tracking controller is to convert the direction vector into control signals to track the path obtained from the univector field method. Parameters which are needed for univector field generation and the tracking controller are optimized using Quantuminspired Evolutionary Algorithm(QEA). The effectiveness of the proposed locomotion algorithm and controller is demonstrated by computer simulation.

M3B-4

15:45-16:00

### Humanoid Interface for Artificially Intelligent Role-based Game Playing

Lisa J. Golden, Zachary T. Golden, James Michael McAtee, and Eric T. Matson

*Purdue University, USA*

Innovations of technology can change the way humans interact with their world. The demand for robotic technology is not exclusively influenced by the component specifications of what a robot is built of, but instead driven by the applications and potential of a robot. Humanoid robots are the best interface for human and robotic interaction because they are ergonomically designed to physically mimic a person thereby benefiting mankind by having the potential to physically operate in an environment designed for society. Moreover, humans are more apt to treat humanoid robots as companions because humans are more likely to project a personality onto the robot. This paper attempts to explore two topics: the advantages of entertainment based applications for humanoids as a vehicle for role-based game playing, and exploring the model for humanoid interaction with either a human adversary or a humanoid adversary. This paper also mentions entertainment based application implementations on systems with limited resources. We utilized the DARwIn-OP as a vehicle to demonstrate a fundamental application of basic artificial intelligence. In playing the role-based game of tic-tac-toe, we created a model for human to humanoid robot interaction as well as humanoid robot to humanoid robot interaction.

M3B-5

16:00-16:15

### 3D Human-Pose Tracking through a Monocular Vision

Minho Kim, Sihyun Joo and Sungho Jo

*KAIST, Korea*

We develop an algorithm for 3D human-pose tracking through a monocular vision. The algorithm is based on body-silhouette shape matching combined with particle-filter-based selected-region tracking in the 2D view. The selected-region tracking, combined with human-body structural data, restricts the temporal interpretation of 3D human poses to those best corresponding to the 2D silhouette shapes. The experimental results demonstrate that our approach performs real-time human-motion tracking with good quality and reasonable robustness.

M3C

Embodied and Developmental Robotics

RM#204

15:00-16:15

Chair: Napoleon Reyes, Massey University, New Zealand

Chair: Pitoyo Hartono, Chukyo University, Japan

M3C-1

15:00-15:15

### Personalized Emotional Expressions to Improve Natural Human-Humanoid Interaction

Maria Vircikova<sup>1</sup>, Peter Sincak<sup>2</sup> and Dong Hwa Kim<sup>3</sup>

<sup>1,2</sup>Technical University of Kosice, Slovak Republic, <sup>3</sup>Hanbat National University, Korea

We need to prepare robots for the shift from laboratories and industrial environments to join human residential areas. This is one of the reasons why current trends in the field of human-robot interaction are expanding into the social experience of users often involving artificial emotions. Emotional technology in its two forms - as an expression of artificial emotions of the systems and as systems capable of recognizing human emotions - contributes to the creation of personalized systems. We try to move from the knowledge

about human emotional processes to implement a model of artificial emotions based on Plutchik's theories. The emotional model is a part of the autonomous mode for the humanoid robot. The proposed system is able to adapt to the user's expectations and thus, to evolve during the interaction process. The inputs to the system are user's expressions of emotions detected from his/her body movements and gestures. Fuzzy logic approach is used for blending of basic emotions to primary mixed emotions. We used humanoid robot Nao as an experimental setup and the user's expressions are mapped to the humanoid's body. The expressions are used to communicate robot's internal states much like non-verbal signals indicates feelings in human society. As the experiments show, the personalized expressions help users to understand the system and they improve the human-robot interaction.

M3C-2

15:00-15:15

### **Tuning Fuzzy-based Hybrid Navigation Systems Using Calibration Maps**

N. H. Reyes, A. L. C. Barczak and T. Susnjak

*Massey University, New Zealand*

We present a novel approach for the tuning and assessment of a cascade of fuzzy logic systems, working cohesively for robot soccer navigation. We generate calibration maps to comprehensively examine the performance of the cascades, allowing for both the visualisation and quantification of the overall system performance. The experiments demonstrate how the proposed method captures the aggregate effect on system's efficiency of even the slightest changes to the fuzzy rules. It also provides feedback on the mechanics of the fuzzy systems that could be held responsible for any shortcomings. Interestingly, without the aid of the proposed techniques, these minute changes are very difficult, if not impossible to identify through human visual inspection per se. Although the example provided in the paper reflects navigation in the Mirobot league robot soccer scope, the proposed calibration method lends itself amenable to other problem domains where target pursuit and obstacle avoidance behaviours are a necessity. It is also worth-noting that the calibration method can be utilised as a fitness function to a Genetic Algorithm or other optimisation techniques, for a fully-automated calibration. Lastly, we discuss how the calibrated cascade of fuzzy systems neatly integrate with the A\* algorithm to produce a hybrid system for near-optimal navigation.

M3C-3

15:30-15:45

### **Adaptive Fuzzy Cognitive Maps using Interactive Evolution: A Robust Solution for Navigation of Robots**

Daniel Lorencik, Jan Vascak and Maria Vircikova

*Technical University of Kosice, Slovak Republic*

Fuzzy cognitive maps belong to emerging approaches used for various tasks in artificial intelligence. They are especially useful for solving the problem of navigation of vehicles as fuzzy systems are very robust in general. Therefore, they are suitable for the real world applications. One of disadvantages of fuzzy systems is their inability to learn. In this paper, we propose the use of fuzzy cognitive maps for navigation of a humanoid robot Nao and also an adaptive mechanism based on interactive evolution. To get data about the surrounding world, we are using the robot's camera. Depending on the situation in the arena, the best direction is selected with the use of membership functions for target and obstacles. Parameters of these functions can be set manually from a program interface or the optimal parameters can be found using interactive evolution. The interactive evolution was selected to obtain the best results in the shortest time. Two approaches to the interactive evolution were tested. The first type was a simple interactive evolution, the second type used thresholds to find the most promising individuals to hold the ideal parameters and only these were presented to a human for evaluation. Experiments were made using manual setting of the parameters as well as using the adaptation mechanism of the first and the second type, where the second type was able to find the right set of parameters in a shorter time than the first one.

M3C-4

15:45-16:00

## Computational Intelligence for Creating Autonomous Robots

Pitoyo Hartono

*Chukyo University, Japan*

In this paper, some computational intelligence methods that can be applied for generating autonomous robots, proposed by the author, are outlined. Through these on-going studies, the author argues that these methods are promising candidate in at least complementing conventional design process for assembling robots.

M3C-5

16:00-16:15

## Distributed and Incremental Visual Object Categorization for Humanoid Platform NAO

P.Sincak, P.Smolar, M.Vircik, M.Pala

*Technical University of Kosice, Slovak Republic*

Robotics is an essential component of current and future technological existence of mankind. Interaction between human and technology such as robots and their coexistence with humans will be extremely important. In fact, a fully embodied intelligence is one version of the future but another option is distributed intelligence when a part of intelligence is "somewhere in the Cloud", and the second part is on the robot itself. Certainly there are several questions about connectivity and reduced activity in case of off-line robot life comparing to life in on-line robot existence. Meanwhile, a notion of Cloud Robotics came out, and it brings new challenges and endless possibilities for the future. The paper gives theoretical and experimental research about utilization of selected Neural technology specifically modified MF-ARTMAP neural network for object categorization. We used the categorization test-bed a Humanoid platform NAO connected to Global framework (MASS), which categorize in distributive and incremental approach objects. This approach creates a power of sharing knowledge among other robots and building collective intelligence. Papers gives the results of a pilot study and refers about preliminary results on different experimental data with building a database of objects on off-robot ecosystem. The system also works with fuzzy logic relations among objects and maintain a list of statements about the relationship between objects seen by the robot.

M4A

Ambient Intelligence II

RM#202

16:30-17:45

Chair: Nozomu Hamada, Keio University, Japan

Chair: Sergey Sokolov, KIAM RAS/principal scientist, Russia

M4A-1

16:30-16:45

## Development of a Quadcopter Robot with Vision and Ultrasonic Sensors for Distance Sensing and Mapping

Seung-Jae Lee and Jong-Hwan Kim

*KAIST, Korea*

The objective of this paper is to build a map using a quadcopter. To explore the surroundings and build a map, ultrasonic sensors and a camera sensor are used. As ultrasonic and camera sensors get information separately, they have to be synchronized. Through this synchronization, the location of the quadcopter can be recognized. At that point, the four horizontal distances can be calculated by rotating the quadcopter. The map is then built through the reconstruction of information using the information from a camera and ultrasonic sensors. The effectiveness of this scheme is demonstrated in a real environment.

M4A-2

16:45-17:00

## Novel scheme of real-time direction finding and tracking of multiple speakers by robot-embedded microphone array

Daobilige Su, Masashi Sekikawa, Kazuo Nakazawa and Nozomu Hamada

*Keio University, Japan*

Recently, interest on artificial robot audition is growing for developing human-robot interaction. The main purposes of an artificial audio system mounted on mobile robot are localizing sound sources, separating speech signal that is relevant to a particular speaker such

as robot's master, and processing speech sources to extract useful information such as master's uttering commands. This paper reports a novel proposed method of a speaker's direction tracking algorithm, and a realization of the real tracking system on a mobile robot. Basic approach of this study belongs to a category of direction finding known as sparseness-based one which employs time-frequency decomposition and disjoint property between different speech signals. The novel points in the proposed source tracking exist on a reliable data selection from time-frequency cells and the application of mean shift tracking to the kernel density estimator derived from these reliable time-frequency components. A wheel-based mobile robot is developed and built-in audio processing system. Experiments are conducted and demonstrate the ability to localize in real environments.

M4A-3

17:00-17:15

### **Overlapped Object Recognition Using Range and Image Data for a Service Robot**

Honggu Lee, Keonhong Lee and Sungho Jo

*KAIST, Korea*

We propose an algorithm for object recognition in indoor service robots. The problem of object recognition is one of the key challenges in the creation of realistic robotic services. Despite great advancements in the past, sufficiently accurate object recognition for service robots in real-world environments remains problematic. Our algorithm uses image and range data information that is available on a service robotic platform to execute the segmentation and classification steps. The segmentation decision rule is applied to correctly segment objects even in overlapped placements. In the classification step, the bag of words is employed with feature descriptors that are constructed from image and range information of segmented regions. In experiments, a working service robotic platform recognizes objects of similar shapes and colors. In addition, we test the recognition capability of overlapped objects. The results demonstrate the feasibility of the proposed algorithm.

M4A-4

17:15-17:30

### **Development of software and hardware of entry-level vision systems for navigation tasks and measuring**

Sokolov S.M., Boguslavsky A.A., Vasilyev A.I., Trifonov O.V.

*KIAM RAS/principal scientist, Russia*

The article describes methodical and practical aspects for equipping mobile facilities with computer vision systems in order to solve navigation and measuring tasks. There is an overall schematic of software and algorithmic support of the integrated information system based on computer vision for mobile facilities. There described principles of building-up such systems and there provided possible options for software and hardware arrangements. There emphasized questions concerning the automation for operations of calibration of some components of measuring section and that of interconnection of various heterogeneous systems. There are examples of implementing integrated information system for navigation and measuring tasks.

M4A-5

17:30-17:45

### **2D Image Feature-Based Real-Time RGB-D 3D SLAM**

Donghwa Lee, Hyongjin Kim and Hyun Myung

*KAIST, Korea*

This paper proposes a real-time RGB-D (red-green-blue depth) 3D SLAM (simultaneous localization and mapping) system. Kinect style sensors give RGB-D data which contains 2D image and per-pixel depth information. 6-DOF (degree-of-freedom) visual odometry is obtained through the 3D-RANSAC (three-dimensional random sample consensus) algorithm with image features and depth information. For speed up extraction of features, parallel computation is performed on a GPU (graphics processing unit) processor. After a feature manager detects loop closure, a graph-based SLAM algorithm optimizes trajectory of the sensor and 3D map. Experimental results show the processing rate over 20Hz.

M4B

Interfaces between Robots, Humans and Heterogeneous Cyber-Physical Systems

RM#203

16:30-17:45

Chair: Eric Matson, Purdue University, USA

M4B-1

16:30-16:45

### Passive RFID Positioning System Using RF Power Control

Sang Yup Lee<sup>1</sup>, Byung-Cheol Min<sup>2</sup>, Dong Hoe Kim<sup>1</sup>, Jae Seok Yoon<sup>1</sup>, and Dong Han Kim<sup>1</sup>

<sup>1</sup>Kyung Hee University, Korea, <sup>2</sup>Purdue University, USA

This research proposes a method which can be applied into location recognition of mobile robots using patterns and the numbers of recognized tags. As passive RFID tags can only measure existence of tags that are located in a recognizable range of a RFID reader, the physical position of each tag cannot be measured; thus, in order to receive information about positions of tags, a proper method to measure the positions should be selected. Also, in a real environment, results differ from ideal results based on characteristics of antennas and surrounding environments, characteristics of tags. Thus, this paper discusses a method to estimate locations according to values of power control with passive RFID tags in a real environment. In an experiment, a UHF-900MHz RFID reader was utilized with placement of passive RFID tags on a floor; the power of the reader was controlled with 30 different levels. In this paper, the differences according to the levels will be discussed with details. This research can be applied to location recognition with RFID power control in a real environment.

M4B-2

16:45-17:00

### An Islands-of-Fitness Compact Genetic Algorithm Approach to Improving Learning Time in Swarms of Flapping-Wing Micro Air Vehicles

John C. Gallagher

Wright State University, USA

Insect-Scale Flapping-Wing Micro-Air Vehicles (FW-MAVs) may be particularly sensitive to degradation of pose and position control caused by ongoing or pre-existing damage to the airframes. Previous work demonstrated that in-flight recovery of sufficient pose and position control precision via use of an adaptive oscillator component inside traditional SISO controllers. This work will replace previously used oscillator learning algorithms with a hyperplane sampling Evolutionary Algorithm (EA) that employs cross-vehicle islands-of-fitness. It will be demonstrated that this strategy allows swarms of vehicles to cooperatively, and more quickly, find and correct for simulate manufacturing errors that appear in all vehicles - even in the presence of randomized vehicle specific errors that are not common to all vehicles in the swarm. The paper will present specific simulation results demonstrating efficacy of this scheme and discussion of future applications of islands-of-fitness methods in this problem domain.

M4B-3

17:00-17:15

### A Collision Control Strategy for Multiple Moving Robots

Pejman Kamkarian and Henry Hexmoor

Southern Illinois University, USA

We present a solution to prevent collisions among robots that are moving toward their respective goals. A robot may start moving at any time from its station to its goal. For a moving robot, the probability of conflict increases proportionately to the complexity of other robots' respective routes. In terms of lowering possibilities of collision, a proper strategy for controlling robot behaviors before encounters is essential. Prior research presented a negotiation-based solution through a broadcasting method. In our solution, we assume robots are unable or unwilling to negotiate or broadcast data among one another. They should possess a strategy to detect and predict conflict zones, and hence determine strategies to avoid collisions independently.

M4B-4

17:15-17:30

### Communication for Task Completion with Heterogeneous Robots

Danielle Erickson<sup>1</sup>, Max DeWees<sup>2</sup>, John Lewis<sup>3</sup> and Eric T. Matson<sup>3</sup>

<sup>1</sup>Dickinson College, USA, <sup>2</sup>Pennsylvania Embry-Riddle Aeronautical University, USA, <sup>3</sup>Purdue University, USA

The field of robotics and particularly the area of multiagent systems has been growing steadily. There is hope to one day have robots

that not only interact with humans, but also interact among themselves. Before this goal can be reached, work must be done to create a system that promotes heterogeneous robotic agents and allows for change in the number and type of robots it commands. This paper presents a system that accomplishes this by taking vocal commands as input and relaying the commands to three robots of different builds by two different means of communication. The network is tested for accuracy of speech recognition and time response to the execution of commands.

M4B-5

17:30-17:45

### **Semantic Middleware and USARSim for the Rapid Prototyping of Context aware Monitoring Systems**

Faouzi Sebbak<sup>1,2,3</sup>, Abdelghani Chibani<sup>2</sup>, Lyazid Sabri<sup>2</sup>, and Yacine Amirat<sup>2</sup>

<sup>1</sup>LISSI Laboratory, France, <sup>2</sup>EMP, Algeria, <sup>3</sup>LRIA Laboratory, Algeria

Ambient Intelligence aims to build new software capabilities to provide autonomous services like controlling living spaces, assisting people in their daily tasks, react to emergency situations, etc. Managing the context of such environments, need a adapted integration architecture, able to incorporate heterogeneous device and communication technologies and manage environment dynamics. In this paper we present a new framework to build semantic management middleware for ubiquitous computing environments based on a lightweight coupling between multi-agent systems and OSGi framework. Beyond the interoperability and context awareness features, our Framework integrates also services matching capabilities to provide users with the best services matching its location, profile and activity. A prototype of this framework is implemented using USARSim robot simulator and multi-agent Jade platform.

M4C

Knowledge Representation for Robotics Applications

RM#204

16:30-18:00

Chair: Julia M. Taylor, Purdue University, USA

M4C-1

16:30-16:45

### **Possibilistic, Abductive Neural Networks (PANNs) for Decision Support in Autonomous Systems: The Advanced Learning, Abductive Network (ALAN)**

James A. Crowder

*Raytheon Intelligence and Information Systems, USA*

The original McCulloch-Pitts model of a neuron contributed greatly to our understanding of neuron-based systems. However, their model failed to take into account that even the simplest type of human nerve cell exhibits non-deterministic behavior [Newell 2003]. Some have attempted to take this into account through modeling this as randomness, creating a stochastic neural network, but much of the behavior is not random, but carries a type of imprecision which is associated with the lack of a sharp transition from the occurrence of an event to the non-occurrence of the event. This leads us to the definition of a network not steeped in Bayesian statistics (a Bayesian Belief Neural Network - BBNN), but one utilizing possibilistics, based on fuzzy characteristics, combined with an abductive, hypothesis-based decision network; and thus creating a Possibilistic, Abductive Neural Network (PANN). Described here is the theory and architecture for a Possibilistic, Abductive Neural Network capable of complex hypothesis generation and testing, leading to artificial creativity and discovery within an artificially intelligent system.

M4C-2

16:45-17:00

### **Robotic Reasoning with Ontological Semantic Technology**

Max Petrenko, Christian F.Hempelmann

*TAMU Commerce, USA*

The paper discusses the ways in which Ontological Semantic Technology (OST) can contribute to current robotic systems. Based on the example of a robotic car oil changer, the paper demonstrates how OST can represent background knowledge and drive object-based inference and anomaly detection rules as well as complex script-based behavior in field and service robots.

M4C-3

17:00-17:15

## **Understanding and Processing Information of Various Grain Sizes**

Julia M. Taylor

*Purdue University, USA*

This paper explores the ideas of humor communication with robots by issuing commands in natural language. Special attention is being paid to vague commands and similar commands and whether it is possible for a robot to process them. The paper discusses various aspects of similarity of information in general as well as in relation to a particular physical capability that a robot may or may not have. All aspects are addressed on the Ontological Semantic Technology foundation.

M4C-4

17:15-17:30

## **Autonomous Robotic Systems for Collaborative Shared Awareness**

James A. Crowder

*Raytheon Intelligence and Information Systems, USA*

The ability to reason within an autonomous information processing system denotes the ability to infer about information, knowledge, observations and experiences, and affect changes within the system to perform new tasks previously unknown, or to perform tasks already learned more efficiently and effectively [Crowder 1996]. The act of reasoning and inferring allows an autonomous system to construct or modify representations of concepts or knowledge that the system is experiencing and learning. Reasoning allows an autonomous system to fill in skeletal or incomplete information or specifications about one or more of its domains (self-assessment). The research described here details architectures and algorithms for a cognitive system of Intelligent information Software Agents (ISAs) to facilitate Collaborative Shared Situational Awareness [Crowder, Scally, and Bonato 2012]. The purpose of this research is to design the algorithms and architectures needed for a system of heterogeneous software agents to autonomously mimic human reasoning in the way brain processes information and develops knowledge [Crowder 2010], while providing the human operators with the ability to monitor the autonomous system and allowing the operator to provide feedback and instruction to the system to facilitate improvement. This knowledge takes the form of answering questions and explaining situations that the autonomous system might encounter. The ISAs are persistent software components, called Cognitive Perceptrons, which perceive, reason, act, and communicate. The research described here entails the design and implementation of the ISA Cognitive Perceptron algorithms and the ISA architecture required to provide a system capable of autonomously managing a complex network of space, ground, and air assets to enhance Situational Awareness and optimize network asset utilization. This research includes algorithms and architectures that facilitates system learning from interaction with operators via the Human Mentored Software This system is called the Cognitive, Interactive Training Environment (CITE) and will allow Human Interaction Learning [Crowder and Friess 2012].

M4C-5

17:30-17:45

## **THE NOT SO SIMPLE ONTOLOGY OF A "PRIMITIVE" ROBOT**

Victor Raskin

*Purdue University, USA*

The paper addresses the important issue of (enhancing) robotic intelligence and enhancing the robots' communication with humans, intelligent agents, sensors and machines. First, it proposes a way to achieve communication in natural language for the agents in hybrid groups with the help of the Ontological Semantic Technology (OST), currently the only approach to accessing deep and comprehensive meaning of language and other data, thus turning it into information, but in principle, one of potentially numerous competing proposals that may ultimately eclipse this early bird. The main thrust of the paper and, I believe, the main reason my colleagues are not ready (yet) to jump into my boat, as it were, is in the second, much more tentative and controversial part of the paper which is philosophical, at least in part. It is attempting to build up a theoretical foundation for a close look at the world of a "primitive" robot and argues that its ontology is not so primitive at all, and it is the theoretical foundation which brings it all to the surface in a pretty straightforward fashion. Contrary to what it may sound, that does not make the OST or any other rich-ontology-based approach to robotic intelligence and communication any more complicated—on the contrary, it reduces it to the well-traveled and -tested situation of domain expansion, a standard feasible procedure, increasingly automated but still including a limited and highly constrained/templated participation by a native speaker.

M4C-6

17:45-18:00

## **Real-Time Data Storage and Retrieval in Autonomous Robotic Systems**

James A. Crowder

*Raytheon Intelligence and Information Systems, USA*

Current and future space, air, and ground systems are growing in complexity and capability, creating a serious challenge to operators who monitor, maintain, and utilize systems in an ever growing network of assets [Crowder 1996]. The growing interest in autonomous systems with cognitive skills to monitor, analyze, diagnose and predict behaviors real time makes this problem even more challenging. Systems today continue to struggle with satisfying the need to obtain actionable knowledge from an ever increasing and inherently duplicative store of non-context specific, multi-disciplinary information content. Additionally, increased automation is the norm and truly autonomous systems are the growing future for atomic/subatomic exploration and within challenging environments unfriendly to the physical human condition. Simultaneously, the size, speed, and complexity of systems continue to increase rapidly to improve timely generation of actionable knowledge. However, development of valuable readily consumable knowledge density and context quality continues to improve more slowly and incrementally. New concepts, mechanisms, and implements are required to facilitate the development and competency of complex systems to be capable of autonomous operation, self-healing, and thus critical management of their knowledge economy and higher fidelity self-awareness of their real-time internal and external operational environments. Presented here are new concepts and notional architectures to solve the problem of how to take the fuzziness of information content and drive it towards context-specific topical knowledge development. We believe this is necessary to facilitate real-time cognition-based information discovery, decomposition, reduction, normalization, encoding, memory recall (knowledge construction), and most importantly enhanced/improved decision making for autonomous robotic systems.

## Tuesday, 18 December

PS III

Plenary Session III

RM#206 + 207

Chair: Jun Jo, Griffith University, Australia

8:50-9:40

**Understanding Minds through Synthesis: A Neuro-Robotics Research Project**

Prof. Jun Tani, KAIST, Korea

T1A

Collective Intelligence I

RM#203

09:50-11:05

Chair: Ji Hyun Yang, Naval Postgraduate School, USA

Chair: Fusaomi Nagata, Tokyo University of Science, Japan

T1A-1

09:50-10:05

**Particle Swarm Optimization-based Distributed Control Scheme for Flocking Robots**

Seung-Mok Lee and Hyun Myung

*KAIST, Korea*

This paper proposes a Nash equilibrium-based model predictive control (MPC) scheme incorporating a cooperative particle swarm optimization (CPSO) to deal with the control of flocking robots whose state vectors are coupled in a cost function. In conventional distributed MPC, the stability is assured by guaranteeing a bounded error between what a subsystem plans to do and what neighbors believe that the subsystem plans to do over a finite prediction horizon. This condition is referred to as compatibility constraint, and the closed-loop control performance largely depends on the responses computed at the previous time step. As an alternative of the compatibility constraint, the distributed CPSO is suggested in an MPC framework, which guarantees the stability without enforcing the compatibility constraint. A numerical simulation is performed on a group of nonholonomic mobile robots to demonstrate the effectiveness of the proposed MPC scheme incorporating CPSO.

T1A-2

10:05-10:20

**Autonomy balancing in a manned-unmanned teaming (MUT) swarm attack**

Ji Hyun Yang, Marek Kapolka and Timothy H. Chung

*Naval Postgraduate School, USA*

In this paper, we describe a framework for developing an interactive feedback model of manned-unmanned teaming (MUT) operational mode selections for a broad spectrum of unmanned vehicle (UV) autonomy levels. Though the highest autonomy levels are within reach as technology continues to advance, lower level autonomy or human manual control will still be needed depending on mission scenarios and dynamic situations. Understanding when and how we change the autonomy level of MUT is critical to ensure system safety and to maximize system performance. Thus, we propose to integrate feedback from various human state variables (i.e., physiological and behavioral signals such as heart rate, skin conductance level, and postures) for estimating human workload and interest level and key task performances (accuracy and speed for assigned missions, task interaction) into MUT systems so that the MUT adapts its mode automatically as needed. We developed RESCHU-SA (Research Environment for Supervisory Control of Heterogeneous Unmanned Vehicles Swarm Attacks), a modified version of the RESCHU simulator originally developed at MIT. We designed a human-in-the-loop experiment to collect baseline data for varying levels of autonomy using the RESCHU-SA along with a physiological sensor BioHarness. Different levels of autonomy include 1) high level autonomy using an auction algorithm or nearest-neighbor assignment algorithms, 2) low level autonomy using manual assignment, and 3) interactive autonomy level which allows operators change between high and low autonomy level. The purpose of the research is to investigate the level of autonomy that should be given to unmanned vehicles (UVs) to successfully complete a mission using a MUT in a swarm attack scenario.

T1A-3

10:20-10:35

## **A Full-functional Simulation and Test Platform for Rotorcraft Unmanned Aerial Vehicle Autonomous Control**

Ziming Wang<sup>1</sup>, Da-lei Song<sup>1</sup>, Juntong Qi<sup>1</sup>, Jianda Han<sup>1</sup>, Yu Miao<sup>2</sup>, Lijun Meng<sup>2</sup>, Shuaike Zhao<sup>2</sup>, and Ming Li<sup>2</sup>

<sup>1</sup>Chinese Academy Science(CAS), China, <sup>2</sup>Liaoning Benxi Power Supply Company, China

In this paper, a prototype Hardware in the loop (HIL) simulation and test platform for ServoHeli40 and ServoHeil120 rotorcraft unmanned aerial vehicles have been developed in Shenyang Institute of Automation, Chinese Academy of Science. This simulation system includes a 3D flight and scenery simulator, a flight control systems, a ground control station, and a RC pilot controller. Based on a semi-decoupled flight dynamic model, which is acquired from a frequency domain system identification method using real flight hovering data, an autonomous PID controller is implemented and verified in both simulation and real flight tests. To fulfill agricultural, marine and industrial applications, the application oriented functionalities of the flight control system has been developed and fully tested before deployment in the field. And it is also beneficial to further research such as human factors in operating UAV systems and UAV task load issues.

T1A-4

10:35-10:50

## **Market-based Multiagent Framework for Balanced Task Allocation**

Dong-Hyun Lee, Ji-Hyeong Han and Jong-Hwan Kim

*KAIST, Korea*

This paper proposes a market-based multiagent task allocation framework for allocating tasks in a balanced manner based on the energy levels of robots. In this framework, a market-based agent is designed for trading tasks considering the robot capabilities, task requirements and energy level of the robot. The framework utilizes a bid weight for distributing the tasks in a balanced manner without frequent using of particular robots. To demonstrate the effectiveness of the proposed framework, a simulation experiment was carried out for a cleaning mission consisting of collecting, carrying, sorting and disposal tasks.

T1A-5

10:50-11:05

## **Control Strategies for heterogeneous, autonomous Robot Swarms**

Stefan Thamke<sup>1</sup>, Markus Ax<sup>1</sup>, Lars Kuhnert<sup>1</sup>, Klaus-Dieter Kuhnert<sup>1</sup>, Marco Langerwisch<sup>2</sup>, Thomas Remmersmann<sup>3</sup>

<sup>1</sup>University of Siegen, Germany, <sup>2</sup>Leibnitz University of Hannover, Germany, <sup>3</sup>Fraunhofer Institute for Communication, Germany

Having robots as reliable and robust mobile sensor platforms in un-known environments is getting more and more attractive. The control of each robot as a single machine is often complicated enough. But if there are more than one robots in a given scenario, the task get's even harder. The operators then do not only have to care about steering their robot, but they also have to cooperate with each other. In this paper we describe the results of a research project regarding control strategies for a group of heterogeneous, autonomous robots. The swarm receives orders from a central control station, that uses a Battle Management Language, which is abstract, but human readable. An ab-stract language postulates a certain degree of intelligence within each robot of the cooperation, because the orders are mostly more complex than simple moves from A to B. There is a command hierarchy within the swarm, but every robot implements its own control strategies, to fulfill the overall goal of the or-ders. The technical as well as the operational realizations are described and dis-cussed mostly with the focus on the unmanned aerial robots.

T1B

Design and Control for Industrial Applications

RM#204

09:50-11:05

Chair: Hyunmin Do, Korea Institute of Machinery and Materials, Korea

T1B-1

09:50-10:05

### Software Platform for the Industrial Dual-arm Robot

Taeyong Choi, Hyunmin Do, Chanhun Park, Dongil Park, Seunghwi Lee and Jinho Kyung  
*Korea Institute of Machinery and Materials, Korea*

Human rights at poor working condition is the severe problem in modern manufacturing system. The industrial dual-arm robot is being developed to meet these social issues fundamentally. The software platform for the industrial dual-arm robot is also being developed, which have many differences compared to the conventional robot software platforms. The software platform for the industrial dual-arm robot which are being developed should have the realtime control capability, the precise motion command interface and the convenience of usage. A special architecture for the mentioned functions is introduced. The proposed architecture consists of the multiple user command input tools, the translator for the unique robot language and the robot control framework with the realtime control property controlled by the unique robot language.

T1B-2

10:05-10:20

### Design of Dual-arm Robot for Cell Production

Hyun Min Do, Chanhun Park, Kyoungtaik Park and Jin Ho Kyung  
*Korea Institute of Machinery and Materials, Korea*

Needs for an automation in a cell production line is recently increasing with an increasing number of aged people and an decreasing number of population. Since skilled workers are required more due to the nature of a cell production line, much attention is given to a dual arm robot as a solution for an automated cell production system. Dual arm robot can work in a very similar way with a human worker and thus it is very proper for a cell. This paper presents a design of a dual-arm robot for an application to the cell production line in packaging and assembling of IT products like cell phone, television and so on. A requirement for a design parameter is suggested and the design concept and some implementation results are proposed.

T1B-3

10:20-10:35

### Design of rotor and magnetic bearings for 200RT class turbo refrigerant compressor

Cheol Hoon Park and Sang Kyu Cho  
*Korea Institute of Machinery and Materials, Korea*

For turbo refrigerant compressor, oil-free bearing has merits that the continuous operation is possible because the lubrication system is not required and the refrigerant is not contaminated by the oil. Magnetic bearing is one of oil-free bearing and recently it started to be applied to a few turbo refrigerant compressors because of easy maintenance thanks to no friction and no wear in bearing. 200RT class turbo refrigerant compressor using oil-free bearing is under development after finishing the development of 145RT compressor. This paper presents the design modification from 145RT compressor and design procedure of hybrid thrust magnetic bearing using both of permanent magnet and electromagnet. Thrust magnetic bearing are designed to support 2,000N thrust force by compressor at 18,000rpm operating speed. The controller for magnetic bearing was designed and the rotordynamic analysis such as critical speed, and unbalance response in case that the rotor is supported by magnetic bearings are simulated by using finite-element method.

T1B-4

10:35-10:50

### An Interactive Approach to Deployment of Functional SW Blocks for an Industrial Manipulator

Saang-Hoon Ji, Byung-Wook Choi, and Sang-Moo Lee  
*Korea Institute of Industrial Technology, Korea*

Recently the interest about the open source based robot SW has increased. These kinds of robot SWs are focusing on the easy development or software reusability. But it is difficult to general SW fails to meet real-time requirements or dependability which is very important characteristic for the industrial manipulators. Therefore, we suggest a method how to make industrial robot software based on open source have reactive semantics. For this aim, we use OPRoS (Open software Platform for Robotic Services) and application centric language interpreter. In this framework, state machine component connected abstracted sensor model components invoke

signal to an interpreter component in order to handle various external operation conditions. And the interpreter determines which robot behaviors will be executed for the signals and make suitable robot behavior components work. Finally, we implement our robot software on a multi-core system in order to meet real-time needs including low-latency and strict period time.

**T1B-5**

**10:50-11:05**

### **Dynamic Control of Parallel Manipulator**

Kap-Ho Seo, Yongsik Park, Sungjo Yun, Sungho Park, Jungsoo Jun, and Jeongtaek Min

*Korea Institute of Robot and Convergence, Korea*

Parallel manipulator with longer legs and heavy load is applied in most of the current high fidelity simulators, which is used to simulate various motions in different environments by exporting varying displacement and orientation.

A novel model-based controller for 6-DOF parallel manipulator with gravity compensation is developed, in order to improve the control precision of 6-DOF parallel manipulator with high speed and heavy load. The effectiveness of the proposed algorithm will be discussed based on experiments.

**T2A**

**Collective Intelligence II**

**RM#203**

**11:20-12:35**

**Chair: Takuya Hashimoto, Tokyo University of Science, Japan**

**T2A-1**

**11:20-11:35**

### **Decentralized Task Re-Planning Approaches with en Route Information Rewards**

Sung-Hoon Kim, Sung-Tae An and Han-Lim Choi

*KAIST, Korea*

This paper presents extensions to the consensus-based bundle algorithm (CBBA) for distributed task planning to take into account rewards obtained en route in the information-gathering missions. The key idea is to incorporate acquired information on the fly when defining scores of the assigned tasks in the re-plan process so that agents can react to the changes in the environment with correct awareness of the executed task scores. Two methods are proposed to quantify this en route acquired information - linear heuristic and entropy-based reward. Numerical simulation results demonstrate that the proposed methods facilitate agents to perform more tasks and thus achieve higher overall scores.

**T2A-2**

**11:35-11:50**

### **Improved CAMshift based on Supervised Learning**

Nur Ariffin Mohd Zin<sup>1</sup>, Siti Norul Huda Sheikh Abdullah<sup>2</sup>, Azizi Abdullah<sup>2</sup>

*<sup>1</sup>Universiti Tun Hussein Onn Malaysia, Malaysia, <sup>2</sup>Universiti Kebangsaan Malaysia, Malaysia*

CAMshift algorithm refers on back-projected distribution of target object's colour to locate the location of the target object in the subsequent frame. However, this mechanism becomes inaccurate when one or more foreign objects that share the same colour features with the target object are very close to one another, resulting these objects are in the same search window. Therefore, this study proposed the embedding of two binary classifiers trained by SVM into the existing CAMshift. These classifiers were modeled to verify the back-projected distribution under 4 types of representations and to distinguish target and non target objects. The aim is to maintain the search window to cover only the target object during tracking. Experiments were conducted to verify the performance of the classifier under three environments namely easy, adjacent and cluttered. Results have shown that the classifier has managed to classify true detection with up to 80%.

**T2A-3**

**11:50-12:05**

### **Context-aware Decision Making for Maze Solving**

Sheir Afgen Zaheer and Jong-Hwan Kim

*KAIST, Korea*

This paper proposes a context-aware decision making framework for a maze solving robot. The proposed architecture utilizes a fuzzy integral based decision making scheme to select the best behavior according to the current environmental context of the robot. The

simulation results show that despite having no prior information about the arrangement of the maze, the proposed cognitive architecture for context-aware decision making successfully enabled the robot to find its way through the maze.

T2A-4

12:05-12:20

### Development of a Fall Detection System with Microsoft Kinect

Christopher Kawatsu, Jiaxing Li and CJ Chung  
Lawrence Technological University, USA

Falls are the leading cause of injury and death among older adults in the US. Computer vision systems offer a promising way of detecting falls. The present paper examines a fall detection and reporting system using the Microsoft Kinect sensor. Two algorithms for detecting falls are introduced. The first uses only a single frame to determine if a fall has occurred. The second uses time series data and can distinguish between falls and slowly lying down on the floor. In addition to detecting falls, the system offers several options for reporting. Reports can be sent as emails or text messages and can include pictures during and after the fall. A voice recognition system can be used to cancel false reports.

T2A-5

12:20-12:35

### SEMI-AUTONOMOUS CONTROL OF ROBOTIC MULTI-AGENTS

Jae H. Chung<sup>1</sup>, Christopher Kim<sup>2</sup>  
<sup>1</sup>Stevens Institute of Technology Hoboken, USA, <sup>2</sup>Horace Mann School, USA

The teleoperation systems involving cooperative multirobots to cope with different tasks on a single target with a team of homogeneous robots have been developed with (1) modified potential field based leader-follower formation, (2) adaptive multi-robotic impedances, (3) compensation for contact forces. However, most of the homeland security applications, e.g. military reconnaissance, exploration, and etc, need a team of heterogeneous robots to work on the multi-task simultaneously on the multi-target with a robot-task-target pairing. Therefore, the main contribution of this paper is to propose the cooperative teleoperation control method integrating not only (1-3) but also the robot-task-target pairing for a multi-robot multi-task multitarget defensive application.

The robot-task-target pairing is derived from the proven auction algorithm for multi-robot multi-task multi-target cases, which optimizes effects-based robot-task-target pairing based on a heuristic algorithm. The pairing method for the robot-task-target pairing is developed to produce a weighted attack guidance table (WAGT), which includes the benefits of assignments of robotic combinations (subteams) to tasks and targets. Therefore, the optimal robot-task-target pairs are computed based on WAGT with the heuristic algorithm. Simulation studies illustrate the efficacy of the teleoperation system with the proposed control method for multi-task multi-target scenarios.

T2B

Intelligent Systems and Applications for Robotics and Vehicles

RM#204

11:20-12:35

Chair: Young J. Ryoo, Mokpo National University, Korea  
Chair: Gourab Sen Gupta, Massey University, New Zealand

T2B-1

11:20-11:35

### Research on Distance-first Based Role Assignment Strategy of Soccer Robot

Da-Lei Song, Bing-Wei Wu, Xiu-Fang Li, Li-Ping Chen and Chuan-Jun Liu  
Ocean University of China, China

This paper studies a dynamic role assignment strategy in robot soccer game and illustrates the disadvantages of the shortest distance assigning algorithm. Based on that algorithm, the distant role-first assigning algorithm is proposed. The algorithm takes the factors into account, such as the obstacle-avoiding when the players position their places, balance of power consumption of the players and short moving distance. Finally, the simulation experiment is conducted to verify the advantages of the distant role-first assigning algorithm based on typical defense formation and half-encircled formation. The results show that the algorithm we proposed performs well in practical applications.

T2B-2

11:35-11:50

## **An approach to the specification of security concerns in UML**

Vinh Xuan Tran<sup>1</sup>, Ninh-Thuan Truong<sup>1</sup>, Anne T.A.<sup>2</sup>

<sup>1</sup>VNU University of Engineering and Technology, Vietnam, <sup>2</sup>Griffith University, Australia

The Object Oriented methodology has been applied in software engineering for a wide range of large and critical systems. One of the modeling languages frequently used for this purpose is UML. As yet, however, the means provided by UML to specify and deal with security concerns are rather sparse. In this paper we propose a practical approach that could readily be incorporated into existing software development processes. We begin by reviewing the main types of security concerns in the various phases of the software development cycle, and set up stereotypes to specify those concerns. The stereotypes are then attached to use case diagrams and later to activity diagrams (and other derived diagrams). At the implementation stage, security concerns can be transformed into more detailed aspects via AOP (aspect oriented programming) techniques. By maintaining the consistency of security stereotypes from phase to phase, the concerns about system security are implemented in a traceable fashion. Such use of security stereotypes does not require a high level of skills or deep knowledge of UML, and can therefore be integrated, with relatively little effort, with many current system development methodologies.

T2B-3

11:50-12:05

## **Intelligent Blowing Controller for Autonomous Underwater Flight Vehicle**

Hyun-Sik Kim

*Tongmyong University, Korea*

In case of flooding, the underwater flight vehicle (UFV) usually executes the emergency blowing by blowing ballast tanks off using high pressure air (HPA) while it also uses control planes and a propulsion unit to reduce the overshoot depth caused by a flooding and blowing sequence. However, the conventional whole HPA blow-off method lets the body on the surface after blowing despite a slight flooding. This results in the unnecessary mission failure or body exposure. Therefore, it is necessary to keep the body at the near surface by the blowing control while reducing the overshoot depth. To solve this problem, an intelligent blowing controller (IBC) using expert knowledge and the fuzzy basis function expansion (FBFE) is proposed here. To verify the performance of the proposed controller, the blowing control of UFV is performed. Simulation results show that the proposed algorithm effectively solves the problems in the UFV blowing control system online.

T2B-4

12:05-12:20

## **Fuzzy Visual Navigation Using Behavior Primitives for Small Humanoid Robot**

Yong-Tae Kim<sup>1</sup> and Su-Hee Noh<sup>2</sup>

<sup>1</sup>Hankyong National University, Korea, <sup>2</sup>Kohyoung Technology, Korea

In this paper, we present a fuzzy visual navigation method that uses behavior primitives for humanoid robots. We define behavior primitives that consist of locomotion and motion primitives. The fuzzy navigation system consists of four control algorithms: autonomous walking, target tracking, obstacle avoidance, and behavior control based on marker recognition. We verify the proposed method through navigation experiments by using a developed small humanoid robot. The experimental results demonstrate that the humanoid robot can navigate efficiently and stably to the target and show improved performance of behavior planning for humanoid navigation.

T2B-5

12:20-12:35

## **Development of Steer-by-Wire for Manned and Unmanned Electric Vehicle**

Yong-Jun Lee and Young-Jae Ryou

*Mokpo National University, Korea*

In this paper, a steer-by-wire system for a manned and an unmanned electric vehicle using an electric clutch is proposed. When electric vehicles have unmanned driving function, an automatic steering system for the vehicle to follow along the path would be required. A steering mechanism was developed of electric vehicles for unmanned driving. The Steering motor using BLDC motor and an electric clutch are used to transmit motor power to steering axis steering mechanism. Also, the electric vehicle was tested to examine usefulness of the developed steering mechanism. The developed steer-by-wire system may be enable or enhance vehicle control technologies related to collision avoidance, lane keeping, and enhanced stability control.

PS IV

Plenary Session IV

RM#206 + 207

Chair: Hyun Myung, KAIST, Korea

14:00-14:50

## Control for the Autonomy of Robots: Algorithm, Experiment and application

Prof. Jianda Han, Shenyang Institute of Automation, Chinese Academy of Sciences, P. R., China

T3A

Intelligent Robots in Education

RM#203

15:00-16:25

Chair: Igor Verner, Technion - Israel Institute of Technology, Israel

T3A-1

15:00-15:15

### Innovative Experimental System Supporting Mechatronics Education

Fusaomi Nagata<sup>1</sup>, Akimasa Otsuka<sup>1</sup>, Sakakibara Kaoru<sup>2</sup>, Keigo Watanabe<sup>3</sup> and Maki K. Habib<sup>4</sup>

<sup>1</sup>Tokyo University of Science, Japan, <sup>2</sup>C-TASK Co. Ltd., Japan, <sup>3</sup>Okayama University, Japan, <sup>4</sup>American University, Egypt

Recently, many studies on educational system are conducted. In this paper, a unique educational experiment system is proposed for undergraduate students to be able to efficiently learn basic mechatronics techniques. The system is composed of three subsystems. The first subsystem is used to learn input/output port operations, periodically LED lights ON/OFF and a stepping motor control. The second subsystem is effective to learn AD transformation for several sensor information, DA transformation for DC motor control and a PID control method. Further, the third subsystem is designed by using a robot arm with four-DOFs to learn PWM (Pulse Width Modulation) control of a DC motor and force control of an end-effector. The effectiveness of the proposed system was confirmed through experimental instructions in Tokyo University of Science, Yamaguchi.

T3A-2

15:15-15:30

### Fostering Students' Spatial Skills through Practice in Operating and Programming Robotic Cells

Igor M. Verner, Sergei Gamer, Avraham Shtub

Technion - Israel Institute of Technology, Israel

This paper presents results of our educational experiments aimed to raise awareness of freshmen engineering and senior high school students on the importance of spatial skills and develop strategies for spatial learning through practice of remote operation and programming robot systems in automated manufacturing labs. In the first experiment senior high school students performed two assignments: (a) design of a multi-robot system for automatic labeling of blocks, and (b) picture puzzle assembly by teleoperating a robot manipulator. Pre-course and post-course paper-and-pencil spatial tests indicated considerable improvement in performing cube rotation tasks. An additional indicator of spatial learning was the substantial reduction of the assembly completion time with training. In the second experiment undergraduate freshmen students majoring in industrial engineering performed an exercise: to program the robot to assemble a structure consisting of blocks of different types in a virtual robotic environment RoboCell. Responses to the questionnaire conducted after the exercise indicated that almost all the students aware on importance of spatial skills for their future profession. Majority of them noted that the exercise effectively presented spatial problems in planning and programming robot systems.

T3A-3

15:30-15:45

### Measuring the information quality of e-learning systems in KSA: attitudes and perceptions of learners

Salem Alkhalaf, Anne Nguyen, Steve Drew and Vicki Jones

Griffith University, Australia

The introduction of e-learning, with the easy availability of course materials and related resources, has had a major impact on students and lecturers in higher education. However, few studies have been conducted to measure the information quality of e-learning on educational institutions in Saudi Arabia. This paper looks at the issues of using e-learning systems and the effect on higher education institutions in the Kingdom of Saudi Arabia (KSA). The findings of this study show positive attitudes towards e-learning systems in higher education, as well as learning improvement and the positive effect of employing a collaborative style of e-learning. Keywords: e-Learning; IS success; IS impact; Kingdom of Saudi Arabia, Information Quality

T3A-4

15:45-16:00

### Humanoids at the Assistive Robot Competition RoboWaiter 2012

Igor Verner<sup>1</sup>, Dan Cuperman<sup>1</sup>, Amit Cuperman<sup>1</sup>, David Ahlgren, Steve Petkovsek<sup>2</sup>, Vlad Burca<sup>2</sup>, Binay Poudel<sup>2</sup>, Junius Santoso<sup>2</sup>

<sup>1</sup>Technion - Israel Institute of Technology, Israel, <sup>2</sup>Trinity College, USA

This paper presents the rationale for focusing educational robotics projects on the development of humanoid assistive robots. We discuss our first experience of such projects and their presentation at the international assistive robotics competition RoboWaiter 2012. The RoboWaiter challenge is to create a robot that autonomously, accurately, and efficiently performs an assistive food fetch task in a model kitchen. Since its inception in 2009, only wheeled robots have participated in the competition, while our effort is to introduce a humanoid category. In the paper we describe the design considerations of our humanoid robots, named "Technion Ed" and "Trinity College Maximus", and their performance at the competition. The educational implementation of the Technion project was in the framework of a school outreach robotics course, the Trinity project was carried out by an independent study team.

T3A-5

16:00-16:25

### Human-like Robot as Teacher's Representative in a Science Lesson: An Elementary School Experiment

Takuya Hashimoto<sup>1</sup>, Igor Verner<sup>2</sup>, and Hiroshi Kobayashi<sup>1</sup>

<sup>1</sup>Tokyo University of Science, Japan, <sup>2</sup>Technion - Israel Institute of Technology, Israel

This paper reports results of our experiment aimed to investigate the educational process in an elementary school science class, in which teaching functions are carried out by an android robot remotely teleoperated by a human instructor. The robot SAYA, used in the experiments, has human-like appearance and behaviors such as facial expressions, head and eye movements, and speech. In the experiment the instructor remotely controlled SAYA's behaviors, thus managing the interaction of the robot with the students. The experiment recreated a typical lesson on levers that was given to two ordinary groups of sixth graders (23 and 22 students) in their science classroom. The lesson included theoretical learning, experiments with lever balances, and assessment activities. The study utilized qualitative research methods so as to elicit characteristic features of the educational process related to in-class communication, instructional strategies, learning activities, and knowledge acquisition. The paper presents our findings and discusses directions of further research.

T3B

Applications

RM#204

15:00-16:15

Chair: Donald Bailey, Massey University, New Zealand  
Chair: Seul Jung, Chungnam National University, Korea

T3B-1

15:00-15:15

### A Method for Controlling Wheelchair Using Hand Gesture Recognition

Nguyen Kim-Tien, Nguyen Truong-Thinh and Trinh Duc Cuong

*Ho Chi Minh City University of Technical Education, Viet Nam*

This paper presents an approach for controlling wheelchair movement using hand gesture recognition. This method was developed based on the curvature of a hand shapes contour. It is simple and has some features to recognize and offers robustness recognizing gestures of one hand. The curvature based hand gesture recognition algorithms recognizes hand gestures using a combination of hand shape contour geometry and calculating the distance from the center of hand to the convex hull on the fingertips. In this paper, this method is able to recognize 5 different hand gestures in same backgrounds for five status movement of wheelchair like as: forward, reverse, left, right and stop. Experiments are presented to show that the wheelchair is able to move and avoid obstacles autonomously while controlled by its user via the hand gesture.

T3B-2

15:15-15:30

### Forming Complicated Surface in Shipyard using Neural Network System

Nguyen Truong-Thinh, Tuong Phuoc Tho and Trinh Duc Cuong

*Ho Chi Minh City University of Technical Education, Vietnam*

Determining the positions of triangle heating in and parameters of heating process are important for deforming the concave surfaces

in shipyard, as well as airplane. The objective of this study was to develop an artificial neural network (ANN) model to predict positions of induction heating and parameters of heating process based on analytical solutions. This model of ANN can help manufacturers determine the positions of induction heating lines and their heating parameters to form a desired shape of plate. The backpropagation neural network systems for determining line-heating positions from object shape of plate are presented in this paper. An artificial neural network model is developed with the relationship between the desired shape of plate and the paths of induction heating. The input data are vertical displacements of plate and the output data are selected heating lines composed by the areas. The outputs of the models were positions of induction heating on plate as well as their parameters. imulated values obtained with neural network correspond closely to the experimental results.

T3B-3

15:30-15:45

### **Position Control of a Quad-rotor System**

Seungho Jeong and Seul Jung

*Chungnam National University, Korea*

Research on unmanned aerial vehicles (UAV) has been quite active in robotics and control communities. Most of UAVs have been utilized for military missions in war zones. Recently, quad-rotor systems as one of UAVs are getting more attention in civilian applications since they have an omni directional movement capability and their control is relatively simple. In this paper, the Cartesian trajectory control of a quad-rotor system is presented along with attitude control. In order for a quad-rotor to perform the Cartesian position control task, global positioning sensors are required to locate the position. Here we are using a camera as a global sensor. Simulation and experimental studies are performed to test the feasibility of the proposed control method.

T3B-4

15:45-16:00

### **Mathematical Formula Recognition based on Modified Recursive Projection Profile Cutting and Labeling with Double Linked List**

Yong-Ho Yoo and Jong-Hwan Kim

*KAIST, Korea*

Recognizing mathematical expression is important to reduce time in converting image-based documents like PDF to text-based documents that are easy to use and edit. In case of general character recognition, the sequence of character segmentation is from left to right, and from top to bottom. However, mathematical expression is a kind of two-dimension visual language. Thus, segmentation is more complex than one-dimension language. This paper proposes a modified recursive projection profile cutting method of character segmentation in images of mathematical formula, using depth first search for arranging and double linked list for re-arranging. The proposed method is demonstrated through various kinds of experiments, and shows this method can yield results of high accuracy for the recognition of mathematical formula.

T3B-5

16:00-16:15

### **Artificial Memory Reconstruction**

James A. Crowder

*Raytheon Intelligence and Information Systems, USA*

Any realistic artificial cognitive processing system must be able to store and recall (reconstruct) complex sequential patterns. Such a system must contain both episodic and semantic memories and demonstrate these memory properties within a cognitive domain of a large number of spatio-temporal memory patterns (episodes), given only a simple example or representation of such a pattern (a partial memory). The cognitive system must be able to construct memories from information fragments without significant interference, as well as exhibit similarity-based category generalization described as semantic memory properties in humans.

Presented here is the theory and architecture for an artificial cognitive system that provides information fragment storage and memory reconstruction utilizing methodologies similar to human memory reconstruction processes. We will describe the overall architecture, called Intelligent Information Software Agents (ISAs) to facilitate Artificial Consciousness (ISAAC) which includes the cognitive and memory cycle required for memory storage and retrieval (reconstruction).

T4P-1

16:15-17:45

### **Control for Smart Transportation Vehicle based on Dynamic model**

Phan Le Hung, Trinh Duc Cuong and Nguyen Truong Thinh

*Ho Chi Minh City University of Technical Education, Vietnam*

In this paper, we mention the design, modelling and development of a mobile robot based on the structure of smart transportation vehicle carrying passengers. Smart transportation vehicle is being driven by electric motor automatically and is modeled dynamical systems with non-holonomic movement is rolling and non-sliding. This vehicle is being used increasingly often for a range of tasks. The contents of this article will address the control tracking for desired trajectories, kinematic, dynamics. Then the results of the method of problem-driven dynamics and kinematics followed a given trajectory is evaluated based on experimental data.

T4P-2

16:15-17:45

### **Development and Implementation of Break Falling System for a Biped Robot**

Seung Je Woo, Sung G. Lee, Jung Seul Ok, Jong Hwan Kim

*KAIST, Korea*

The development of humanoid robots is becoming more popular these days. While the robotics community is outputting varieties of enabling results for humanoid robots to perform many different types of tasks such as locomotion or entertainment, there has not been much research on securing their safety in motion. A way to make humanoid robots prepare for some dangerous incidents should be given attention in order to prevent the developers from losing expensive and important parts of robots and efforts they put in. The main focus of this research is to make a robot break-fall when external forces are exerted behind the robot. This paper is organized as follows: the research robotic platform that is used in order to test break-fall motions of robots is introduced. Various methods of break-fall motions are designed and evaluated. We conclude that among the types of motion we investigated, motion type C-2, stretching arms forward & bending knees & damping motion, is the best breakfall motion. Application of our algorithm to other practical robots may result in reduction of precarious incidents of robots falling down, which will be beneficial for robot developers.

T4P-3

16:15-17:45

### **Intelligent Camera for Object Identification and Tracking**

Donald G Bailey, Gourab Sen Gupta and Miguel Contreras

*Massey University, New Zealand*

Intelligent cameras extend the concept of smart camera by directly processing the pixels as they stream from the sensor. Working in a synchronous streamed pipeline processing mode, an FPGA incorporated into the camera is able to operate at the camera pixel clock rate. With careful design, this scheme minimizes memory accesses and reduces the latency over DSP based smart cameras. The transformation of the software image processing algorithm to an efficient intelligent camera implementation is demonstrated for global vision within robot soccer. The resulting intelligent camera requires no memory outside of the FPGA, and is able to provide the position and orientation of the objects while the image is being streamed from the sensor.

T4P-4

16:15-17:45

### **Simultaneous Localization Assistance for Mobile Robot Navigation in Real, Populated Environments**

Peshala G. Jayasekara<sup>1</sup>, Hideki Hashimoto<sup>2</sup> and Takashi Kubota<sup>3</sup>

*<sup>1</sup>The University of Tokyo, Japan, <sup>2</sup>Chuo University, Japan, <sup>3</sup>Inst. of Space and Astronautical Science, Japan*

Developing autonomous mobile robots that can coexist with human in populated environments is still considered a big challenge. To address this problem the authors propose a novel scheme to assist mobile robots by providing localization information externally. This scheme combines the autonomous navigation and target tracking research fields to arrive at a structured assistance system for autonomous mobile robots. In the proposed scheme, the environment is sensed using a laser range finder and camera based sensor unit. Using Rao-Blackwellized particle filter technique, the robots that need assistance are continuously tracked. In contrast with

conventional laser range finder based tracking systems, the placement of sensor is changed to a level above average human height and the mobile robots are modified by attaching a cylindrical pole. The experiments show the validity of the proposed scheme for simultaneous localization assistance for multiple mobile robots. Two mobile robots were simultaneously navigated in given trajectories using assistance data, successfully.

T4P-5

16:15-17:45

### **TASK PLANNING FOR SERVICE ROBOTS WITH SUPERVISORY CONTROL**

Chung-Woon Park, Jung-Woo Lee, and Jong-Tae Lim

*KAIST, Korea*

Without an appropriate task planning scheme for service robots (SRs) in a ubiquitous robotic companion (URC) environment, the SRs degrade the system performance and they do not achieve the desired goal and the customers' requirements. In addition, the system resources might be wasted. In this paper, we propose a new task planning scheme for SRs to balance a desired goal and the system resources with a supervisor. In particular, we propose a high work-metric SR selection scheme using work metric (WM) information to provide the flexible trade-off with the limited communication resources. As a result, the proposed scheme not only reduces a significant communication feedback overload but also considers task planning in an URC environment. Simulation results show that the proposed scheme achieves the high customers' requirements with the limited communication resources.

T4P-6

16:15-17:45

### **Differential Kinematics of Flexible Manipulator for Calibration of Model Parameters**

Bum-Joo Lee

*Myongji University, Korea*

In this paper, a noble algorithm was proposed which improves the accuracy of the manipulation of the robot by calibrating the model parameters such as the Denavit-Hartenberg parameters, joint compliances, and CM positions of the links. Even though the mechanical parts are manufactured and assembled accurately, always small differences between the designed and the actual system exist due to both the geometric and the unmodeled error. In order to resolve these problems, the proposed algorithm employs an estimation system which consists of a structured light module with a stationary camera and a screen. After derivation of the Jacobian which represents the relationship between the model parameters and the laser points on the screen, the model parameters are updated by using an iterative estimation algorithm such as least-squares manner. This algorithm is advanced by considering the joint flexibility from the previous work which used a rigid link model [1]. Effectiveness of the proposed algorithm was verified by the computer simulation with a 6 DOF manipulator robot.

T4P-7

16:15-17:45

### **Speaker Dependent Visual Speech Recognition by Symbol and Real Value Assignment**

Jeongwoo Ju, Heechul Jung, and Junmo Kim

*KAIST, Korea*

In this paper, we propose a visual speech recognition method using symbol or real value assignment. Our method is inspired by Bag of Word (BoW) [1] model which is usually applied to an object matching problem. In the BoW model, a codebook is produced by using K-means clustering, and a feature vector extracted from an image is converted to corresponding symbol. Similarly, we generate codebook by running K-means algorithm on a pool of pHog (Pyramid Histogram of Oriented Gradients) feature vectors extracted from a subset of lip database. Then, the remaining lip images are assigned a particular value after comparing the chi-square distance to each cluster. Based on the type of this value, two methods are suggested so as to assign the value to a lip image frame. The first method is to find the cluster whose element image has the minimum chi square distance to the processing frame, and assign the cluster label to the frame. Second one is to calculate the distances between the frame and all cluster's centroids, obtain multi-dimensional vector for the frame which directly becomes an assigned value for the frame. Following these methods, each time sequence is converted into symbolized or multi-dimensional real valued sequence. To measure the similarity between two time sequences, we use Dynamic Time Warping for real valued time sequence and Edit distance for symbolized sequences.

T4P-8

16:15-17:45

### **Automatic Image Segmentation Using Saliency Detection and Superpixel Graph Cuts**

Sandeul Kang, Hansang Lee, Jiwhan Kim, and Junmo Kim

*KAIST, Korea*

Image segmentation, which divides an image into foreground and background, is an important task for several applications in vision area such as object detection and classification. In this paper, we introduce a novel algorithm for automatic image segmentation technique which does not require further learning processes to perform segmentation. To achieve this automatic image segmentation, we incorporate saliency map for an image as an initial cue for image segmentation. An enhanced saliency detection method for generating saliency map is proposed. With over-segmented superpixels for an image and the generated saliency map, we perform image segmentation using graph cuts. To adapt graph cut segmentation to superpixel graph and saliency map, we suggest edge costs for superpixel graph based on Gaussian mixture models (GMM). As a result, superpixel graph enhances computational efficiency for our image segmentation technique and saliency map provides helpful cue for foreground region. We evaluate the performance of our algorithm on MSRA database demonstrate experimental results.

T4P-9

16:15-17:45

### **A Survey: Stereo Based Navigation for Mobile Binocular Robots**

Da-lei Song, Qian-li Jiang, Wei-cheng Sun and Le-le Yao

*Ocean University of China, China*

Stereo based navigation is essential and crucial in the domains of both vision and control. It is becoming more and more common and important in autonomous navigation and it has been applied in traditional Autonomous Ground Vehicles (AGV), Unmanned Aerial Vehicles (UAV) and Autonomous Underwater Vehicles (AUV). So this survey presents those related works, which constitute a wide progress in stereo-based navigation techniques such as land navigation techniques, aerial navigation techniques and autonomous underwater vehicles navigation techniques. The paper deals with two key major approaches: camera calibration and stereo matching. The camera calibration is the basis of accurate navigation. In this paper, we discuss and analyze three camera calibration methods and their latest progress and applications. Also, we propose the latest stereo matching algorithms that suited for the robot navigation and the progress of various real-time stereo methods. The challenges the stereo matching methods confront are analyzed, and the recent algorithms proposed aim to tackle the real-time demands and the robustness problem.

T4P-10

16:15-17:45

### **EtherCAT based Parallel Robot Control System**

Jung-Hoon Kim, Sun Lim, and Il-Kyun Jung

*Korea Electronics Technology Institute, Korea*

In this paper, we describe the control strategy of high speed parallel robot system with EtherCAT network. This work deals the parallel robot system with centralized control on the real-time operating system such as window RTX, intime etc. Most control scheme and algorithm is implemented master platform on the PC, the input and output interface is ported on the slave side. The data is transferred by maximum 20usecond with 1000byte. EtherCAT is very high speed and stable industrial network. The control strategy with EtherCAT is very useful and robust on Ethernet network environment.

T4P-11

16:15-17:45

### **Real-time Trajectory Generation for Both Arms of a Humanoid Robot**

Chang-Young Jung and Jong-Hwan Kim

*KAIST, Korea*

This paper proposes a real-time trajectory generation algorithm for both arms of a humanoid robot. Since it is hard to find a closed form of inverse kinematics for each arm of seven degrees of freedom, the damped least-squares method is employed to obtain the inverse kinematics. The trajectory is generated by the minimum-jerk method to maximize the position accuracy. Considering the performance in computation time, a software SD/FAST is used to find a Jacobian matrix of the arm. Computer simulation was performed to verify the effectiveness of the proposed algorithm using a Webot simulator for the upper body of Mybot developed in the RIT Lab., KAIST. The results show that the proposed algorithm generates trajectory in real-time and it is robust to singularity.

T4P-12

16:15-17:45

## Design of Milking Automatic System with Robot Arm Using Laser Scanning Sensor

Kyoo-Jae Shin<sup>1</sup> and Jae-Young Lim<sup>2</sup>

<sup>1</sup>*Suncheon First College, Korea*, <sup>2</sup>*Seojin Technology Ltd, Korea*

The milking robot system is important to detect correctly the teats position with moving cow. Also, the robot arm must control tracking the teat cup to the detected teat position. The presented milking robot is designed the one point laser sensor for teat position detection, which is detected by the 3 axes moving unit of robot arm. The presented Laser linear scanning method can detect simply the teat position. This robot system has the advantages of a simple, low cost and very quiet, because the designed robot arm is realized by the dynamically electrical motor and servo position control algorithm with velocity compensation. The presented robot is realized using the teat detection unit, 4 teat cups, 3 axes robot arm, 6 servo motors and automatic milking line. The designed robot is experimented in the cow farm and is satisfied with the performance of designed specification for milking robot.

T4P-13

16:15-17:45

## Wheel of Online Retailing Development in Saudi Arabia

Rayed AlGhamdi<sup>1</sup>, Anne Nguyen<sup>2</sup> and Vicki Jones<sup>2</sup>

<sup>1</sup>*King Abdulaziz University Jeddah, Saudi Arabia*, <sup>2</sup>*Griffith University, Australia*

Online retailing is growing world-wide, with companies in many countries showing increased sales and productivity as a result. It has great potential within the global economy. This paper looks at the current status of online retailing in Saudi Arabia, with particular focus on what inhibits or enables both the customers and retailers. It also analyses the status of Government involvement and proposes a layered model, known as the "Wheel of Online Retailing" which illustrates how Government intervention can benefit the e-commerce in Saudi Arabia.

T4P-14

16:15-17:45

## Cognitive Architecture to Composite Emotions from Autonomic Nervous System for Robotic Head

Amandine Charmasson<sup>1,2</sup>, Jong-Hwan Kim<sup>2</sup>, Kambiz ARAB TEHRANI<sup>1</sup>

<sup>1</sup>*ESIGELEC, France*, <sup>2</sup>*KAIST, Korea*

In this paper, methods are proposed for generating facial expression defined by Ekman's facial expression database from a robotic head. This paper gives rise to how to generate two emotions at the same time and how to solve problems between two conflicting emotions. Among others, it uses a cognitive architecture and some biological values in generating several probabilities from the hidden Markov model. The cognitive architecture is characterized by three main parts: perception and decoding module for simulating brain system, thalamus, amygdala, hypothalamus and hippocampus; learning module to memorize the data and transmit the behavior of an emotion to the emotion module which will generate facial expression to the robotic head from a given environment. This paper presents two basic emotions, not only one as we have already tested. However, according to psychologists, some conflicts exist between emotions. This research develops a table of compatibility of emotions from the Robert Plutchik's research, who is one of the precursors of emotional intelligence. To use Robert Plutchik's Emotion database and Paul Ekman Emotion database, we decide to work with the 6 universal basic emotions, anger, disgust, fear, joy, sadness and surprise, which can be combined. The problem of conflicting composite emotion can be solved by using the properties of the biological stimuli. By this way, the composite emotion is made possible.

T4P-15

16:15-17:45

## Strategic decision-making of MASTER software agent in terms of the behavior of mobile robot agents

Mikulas Hajduk, Marek Sukop, Rudolf Janos, Jan Semjon and Jozef Varga

*Technical Univerzity of Kosice, Slovakia*

This paper describes the strategic decision making of the master software agent in terms of behavior of robotic agents of mobile robot soccer team FME TUKE Robotics. The proposed approach is designed for category 5 vs. 5 MiroSot. The description is based on a hierarchy of multi-agent system with six agents. The proposed structure has one completely software master agent with inferior mobile robotic agents (players). In the first part of the paper there is a description of hardware and software modules and the overall strategy of system behavior. The body of paper describes process of decision making and strategy of master agent based on more information about the real situation on the field. Conclusion of the article gives an example of an attack strategy.

T4P-16

16:15-17:45

## Application of Fuzzy Logic in Learning Autonomous Robots Systems

Maria Laura Gonzalez<sup>1</sup>, Jorge Salvador Ierache<sup>1,2</sup>

<sup>1</sup>University of Buenos Aires, Argentina, <sup>2</sup>Institute of Intelligent Systems and Robotics Experimental Teaching, Argentina

Autonomous Robots Systems (ARS) can learn by establishing plans, executing them in a given environment and analyzing the results of the execution. The logic used among this process is usually the classic logic, which most of the times ends up being too restrictive and not consistent with the world the ARS is facing. This paper proposes the application of fuzzy logic to address this issue and improve the ARS learning curve considerably.

T4P-17

16:15-17:45

## Towards an Ami-Robot Applied to Greenhouses

Antonio Bautista-Hernández, Fernando Ramos-Quintana

*Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico*

This work proposes the use of the concept of Ambient Intelligence to facilitate some tasks to be performed by a mobile Ami-Robot within a greenhouse of tomato plants. Although, the application of this Ami-Robot will be mainly focused on the navigation, inspection and fumigation tasks, we report in this work the navigation task. A particular mobile robot with basic functions has been built for this application. In addition, we have developed a monitor system based on Petri Nets, whose main purpose is to track the navigation tasks being performed by the robot and serve as monitor for the producer through a graphical interface. A set of sensors, guide lines and code bars are installed within the green house to facilitate the navigation of the Robot. This Ambient Intelligence, wherein the robot acts as the recipient of all the information, is being tested within a real greenhouse environment. So far, the design and development of this application promise to be easier than a traditional robot application from a hardware and software point of view.

T4P-18

16:15-17:45

## Robot Control on the basis of Bio-electrical signals

Jorge Ierache<sup>1,2</sup>, Gustavo Pereira<sup>1</sup>, Iris Sattolo<sup>1</sup>, Juan Iribaren<sup>1</sup>, Nicolás Suiffet<sup>1</sup>

<sup>1</sup>Instituto de Sistemas Inteligentes y Enseñanza Experimental de la Robótica FICCTE, Argentina, <sup>2</sup>University of Buenos Aires, Argentina

This article shows the experiences carried out in the context of human/robot communication, on the basis of brain bio-electrical signals, with the application of the available technologies and interfaces which have facilitated the reading of the user's brain bio-electrical signals and their association to explicit commands that have allowed the control of biped and mobile robots through the adaptation of communication devices. Our work presents an engineering solution, with the application of technological bases, the development of a high- and low-level communication framework, the description of experiments and the discussion of the results achieved in field tests.

T4P-19

16:15-17:45

## Experience with the Children-Humanoid Interaction in Rehabilitation Therapy for Spinal Disorders

Maria Vircikova and Peter Sincak

*Technical University of Kosice, Slovakia*

This paper deals with the social human-robot interaction with children towards the application outside tightly controlled and constrained laboratory environments. We present our experience of using the Nao humanoid robotic platform in a role of a physiotherapist for rehabilitation and prevention of scoliosis in a children's hospital and an elementary school in Slovakia. Before and between the exercise units, children could freely interact with a robot, what contributed to building-up robot-children relationship. The results indicate the potential of humanoids to enhance the quality of life of children in an entertaining and effective way.



## Author Index

<b>A</b>		CHANG-YOUNG JUNG	T4P-11	ERIC T. MATSON	M3B-4, M4B-4
A. L. C. BARCZAK	M3C-2	CHANHUN PARK	T1B-1, T1B-2	<b>F</b>	
ABDELGHANI CHIBANI	M4B-5	CHEOL HOON PARK	T1B-3	FAOUZI SEBBAK	M4B-5
AKIMASA OTSUKA	T3A-1	CHRIOSTOPHER KIM	T2A-5	FERNANDO RAMOS-QUINTANA	T4P-17
AMANDINE CHARMASSON	T4P-14	CHRIS LOKAN	M1A-4	FUSAOMI NAGATA	T3A-1
AMIT CUPERMAN	T3A-4	CHRISTIAN F. HEMPELMANN	M4C-2	<b>G</b>	
ANN STEVENS	M2C-2	CHRISTOPHER KAWATSU	T2A-4	GENYA ISHIGAMI	M3A-2
ANNE NGUYEN	T3A-3, T4P-13	CHUAN-JUN LIU	T2B-1	GON-WOO KIM	M3B-2
ANNE T.A.	T2B-2	CHUNG-WOON PARK	T4P-5	GOURAB SEN GUPTA	T4P-3
ANTONIO BAUTISTA-HERNÁNDEZ	T4P-17	CJ CHUNG	T2A-4	GUSTAVO PEREIRA	T4P-18
AVRAHAM SHTUB	T3A-2	CLARENCE TAN	M2C-2	<b>H</b>	
AYA DARWISH	M3A-3	<b>D</b>		HANGUEN KIM	M1B-1
AZIZI ABDULLAH	M1C-3, T2A-2	DA-LEI SONG	T1A-3, T2B-1, T4P-9	HAN-LIM CHOI	T2A-1
<b>B</b>		DAN CUPERMAN	T3A-4	HANSANG LEE	T4P-8
B.A. KALASHANKAR	M1C-4	DANIEL LORENCIK	M3C-3	HEECHUL JUNG	T4P-7
BASMA KODIAH	M3A-3	DANIELLE ERICKSON	M4B-4	HENRY HEXMOOR	M4B-3
BIN ZHANG	M1B-3	DAOBILIGE SU	M4A-2	HIDEKI HASHIMOTO	M2A-1, T4P-4
BINAY POUDEL	T3A-4	DAVID AHLGREN	T3A-4	HIROFUMI KOMATSU	M1B-2
BING-WEI WU	T2B-1	DEOK-HWA KIM	M3A-4	HIROSHI KOBAYASHI	T3A-5
BOGUSLAVSKY A.A.	M4A-4	DONALD G BAILEY	T4P-3	HONGGU LEE	M4A-3
BUM-JOO LEE	T4P-6	DONG HAN KIM	M4B-1	HUSSEIN A. ABBASS	PS I, M1A-2, M1A-4, M1B-3
BUM-SOO YOO	M2A-2	DONG HOE KIM	M4B-1	HYONGJIN KIM	M3A-1, M4A-5
BYEOLTEO PARK	M1B-1	DONG HWA KIM	M3C-1	HYOUNG IL SON	M2A-1
BYUNG-CHEOL MIN	M4B-1	DONGHOON KIM	M3A-1	HYOUNG-KI LEE	M1C-1
BYUNG-WOOK CHOI	T1B-4	DONGHWA LEE	M3A-1, M4A-5	HYUN MIN DO	T1B-1, T1B-2
<b>C</b>		DONG-HYUN LEE	T1A-4	HYUN MYUNG	
CESAR H. VALENCIA	M1B-5	DONGIL PARK	T1B-1		
CHANG-SEOP SHIN	M3B-2	<b>E</b>			
CHANG-SOO PARK	M2B-5	ELENI PETRAKI	M1A-2		
		ENAS A. A. EQLOUSS	M1C-3		

### I

IGOR M. VERNER	T3A-2, T3A-4, T3A-5
IL-KYUN JUNG	T4P-10
IN-BAE JEONG	M3B-3
IRIS SATTOLO	T4P-18

### J

JAE H. CHUNG	T2A-5
JAE SEOK YOON	M4B-1
JAE-UK SHIN	M3A-1
JAE-YOUNG LIM	T4P-12

JAMES A. CROWDER  
M4C-1, M4C-4, M4C-6, T3B-5

JAMES MICHAEL MCATEE	M3B-4
JAN SEMJON	T4P-15
JAN VASCAK	M3C-3
JEONG-KI YOO	M1C-5, M3B-1
JEONGTACK MIN	T1B-5
JEONGWOO JU	T4P-7
JI HYUN YANG	T1A-2
JIANDA HAN	PS IV, T1A-3
JIAXING LI AND	T2A-4
JI-HYEONG HAN	M2A-5, T1A-4
JIN HO KYUNG	T1B-1, T1B-2
JIWHAN KIM	T4P-8
JOHN C. GALLAGHER	M4B-2
JOHN LEWIS	M4B-4
JONG-HWAN KIM	
M1A-3, M1A-5, M1C-5, M2A-2, M2A-5, M2B-2, M2B-5, M2C-1, M2C-5, M3A-4, M3B-1, M3B-3, M4A-1, T1A-4, T2A-3, T3B-4, T4P-2, T4P-11, T4P-14	
JONGDAE JUNG	M1C-1
JONG-TAE LIM	T4P-5
JORGE IERACHE	T4P-18
JORGE SALVADOR IERACHE T	4P-16
JOZEF VARGA	T4P-15
JUAN IRRIBAREN	T4P-18

JULIA M. TAYLOR	M4C-3
JUN H. JO	M2C-2, M2C-3
JUN TANI	PS III
JUNG SEUL OK	T4P-2
JUNG-HOON KIM	T4P-10
JUNGSOO JUN	T1B-5
JUNG-WOO LEE	T4P-5
JUNIUS SANTOSO	T3A-4
JUNMO KIM	T4P-7, T4P-8
JUNTONG QI	T1A-3
JUN-YEUP KIM	M2B-3

### K

KAMBIZ ARAB TEHRANI	T4P-14
KAMRAN SHAFI	M1A-4, M1B-3
KAP-HO SEO	T1B-5
KARLA T. FIGUEIREDO	M1B-5
KATSUNARI SHIBATA	M2C-4
KATSUNARI SHIBATAY	M1C-2
KAZUO NAKAZAWA	M4A-2
KEIGO WATANABE	T3A-1
KEONHONG LEE	M4A-3
KHALED AL-WAHEDI	M3A-3
KI-BAEK LEE	M1A-3
KLAUS-DIETER KUHNERT	T1A-5
KOJIRO IIZUKA	M1A-1, M1B-2
KOSHI HOSHINO	M2A-3
KUN WANG	M1A-2
KWANG-EUN KO	M2A-4, M2B-3
KWEE-BO SIM	M2A-4, M2B-3
KYOHEI OTSU	M3A-2
KYOO-JAE SHIN	T4P-12
KYOUNGTAIK PARK	T1B-2
KYUNG CHUL SHIN	PS II
LARS KUHNERT	T1A-5
LE-LE YAO	T4P-9

### L

LIJUN MENG	T1A-3
LI-PING CHEN	T2B-1
LISA J. GOLDEN	M3B-4
LYAZID SABRI	M4B-5

### M

M.PALA	M3C-5
M.VIRCIK	M3C-5
MAKARA VANNY	M2A-4
MAKI K. HABIB	T3A-1
MANUELA CARMONA	M2C-3
MARCO LANGERWISCH	T1A-5
MAREK KAPOLKA	T1A-2
MAREK SUKOP	T4P-15
MARIA LAURA GONZALEZ	T4P-16
MARIA VIRCIKOVA	M3C-1, M3C-3, T4P-19
MARKUS AX	T1A-5
MARLEY M. B. R. VELLASCO	M1B-5
MASASHI SEKIKAWA	M4A-2
MASATSUGU OTSUKI	M3A-2
MAX DEWEEES	M4B-4
MAX PETRENKO	M4C-2
MIGUEL CONTRERAS	T4P-3
MIHOKO NIITSUMA	M2A-1
MIKULAS HAJDUK	T4P-15
MING LI	T1A-3
MINHO KIM	M3B-5
MOHAMAD FAIZAL BIN SAMUSUDIN	M1C-2
MOHAMMAD FAIDZUL NASRUDIN	M2B-4
MUHAMMAD NURUDDIN SUDIN	M2B-4

### N

N. H. REYES	M3C-2
N.N.S.S.R.K. PRASAD	M1C-4
NGUYEN KIM-TIEN	T3B-1
NGUYEN TRUONG THINH	
T3B-1, T3B-2, T4P-1	
NICOLÁS SUIFFET	T4P-18



# MEMO



A series of horizontal dashed lines for writing.

# MEMO



A series of horizontal dashed lines for writing.

# MEMO



A series of horizontal dashed lines for writing.