2018 15th International Conference on Control, Automation, Robotics and Vision (ICARCV)

November 18-21, 2018, Marina Bay Sands Expo and Convention Centre, Singapore

Program at a Glance Monday Tuesday Wednesday Author Index Keyword Index My Program

Last updated on November 6, 2018. This conference program is tentative and subject to change

Technical Program for Monday November 19, 2018

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MoKN Plenary Session, Ballroom 4001AB Add to My Program

Opening by Prof Phee Soo Jay, Louis, Dean of CoE, NTU
Plenary 1:
SERoCS: Safe and Efficient Robot Collaborative Systems for Next Generation Intelligent Industrial Co-Robots
Speaker: Prof Masayoshi Tomizuka, Univ. of California, Berkeley, USA

Chair: Hu, Guoqiang Nanyang Technological University

MoPP Plenary Session, Ballroom 4001AB Add to My Program

Plenary Panel Session on Control Research: The Presence and the Future

Chair: Prof Lihua Xie; Co-Chair: Prof Rong Su
Panelists: Prof Ben M. Chen, Prof Gary Feng, Prof Jie Huang, Prof Chris Manzie, Prof Masayoshi Tomizuka

Chair: Xie, Lihua Nanyang Tech. Univ
Co-Chair: Su, Rong Nanyang Technological University

MoBT1 Invited Session, Lotus 4D Add to My Program

Best Paper Award Finalist Presentations (Part 1) - Vision and Robotics

Chair: Wang, Danwei Nanyang Tech. Univ
Co-Chair: Hu, Guoqiang Nanyang Technological University

13:30-13:45, Paper MoBT1.1 Add to My Program

Outlier Detection Using Hierarchical Spatial Verification for Visual Place Recognition (I)

Yuan, Miaolong Institute for Infocomm Research
Li, Zhengguo Institute for Infocomm Research, A*STAR
WAN, Kong Wah Institute for Infocomm Research
Yau, Wei Yun Institute for Infocomm Research

Keywords: Vision for robots, Scene analysis, Object recognition

Abstract: Spatial verification is a key step to remove outliers for accurate feature matching in visual place recognition. In

this paper, we propose a novel method for outlier detection using a hierarchical spatial verification scheme. Given a set of putative correspondences between a pair of images, we convert the matching problem into a 4D transformation space and identify promising similarity transformations usingHough voting. In the hierarchical scheme, we first use a hypothesize-and-verify technique to identify groups of correspondences according to each similarity transformation. Second, the group with the largest number of correspondences serves as a standard to subsequently remove outliers in other groups by explicit geometric consistency checking. We have compared the proposed method with the state-of-the-art solutions on five popular public datasets to show that our method has better performance in place recognition and loop closure detection.

13:45-14:00, Paper MoBT1.2 Add to My Program

Application of a Bio-Inspired Localization Model to Autonomous Vehicles

espada, yoan — ETIS Laboratory of Cergy Pontoise University, Institut VEDECOM
cuperlier, Nicolas — ETIS UMR CNRS 8051, Laboratory of Cergy Pontoise University
Bresson, Guillaume — Institut VEDECOM
Romain, Olivier — ETIS, Laboratory of Cergy Pontoise University

Keywords: Localization, navigation and mapping, Vision for robots, Electric vehicles and intelligent transportation.

Abstract: In this paper, we propose an approach to tackle the localization challenge for autonomous vehicles by taking inspiration from biological models. We present a neural architecture based on a neurobotic model of the place cells found in the hippocampus of mammals. This model is based on an attentional mechanism and only takes into account visual information from a mono-camera and the orientation information to self-localize. Such a localization model has already been integrated in a robot control architecture which allows for successful navigation both in indoor and small outdoor environments. The contribution of this paper is to study how it passes the scale change by evaluating the performance of this model over much larger outdoor environments. Six experiments, taken from the KITTI datasets, using real data (image and orientation) grabbed by a moving vehicle are studied. The results show the strong adaptability of the model to different kinds of environments.

14:00-14:15, Paper MoBT1.3 Add to My Program

Prior Knowledge Driven Energy for Saliency Detection

Yan, Ke — The University of Sydney
Zheng, Chaojie — The University of Sydney
Huang, Qiu — Shanghai Jiao Tong University
Kim, Jinman — The University of Sydney
Feng, Dagan — The University of Sydney
Wang, Xiuying — The University of Sydney

Keywords: Object recognition, Feature extraction, grouping and segmentation

Abstract: Saliency detection on images has experienced substantial progress in recent years on the basis of deep neural network (DNN). However, there may exist secondary saliency in the background that distracts DNN learning to mistaken the secondary salient regions as saliency. To address this issue, we propose a dual-term energy to improve inference of saliency on top of DNN estimation, where dense term smoothens salient regions in pixel scale and sparse term extracts prior knowledge to differentiate saliency and non-saliency superpixels. Our prior knowledge including extra- and intra-region priors, contributes to improve overall saliency detection. The extra-region prior knowledge estimates the saliency probabilities for different pre-partitioned regions to eliminate the secondary saliency. The intra-region prior knowledge helps to group the salient regions that otherwise could be ignored by DNN predictor, and thus to provide more complete saliency definition. We evaluated our model on 8,465 images from four well-recognized saliency detection benchmarking datasets, and compared our model to six state-of-the-art comparative methods. Experimental results demonstrated that our model outperformed the state-of-the-art counterpart with improvements of up to 2.51% in terms of F-measure.

14:15-14:30, Paper MoBT1.4 Add to My Program

Adaptive Optimal Receding Horizon Robot Navigation Via Short-Term Policy Development

Jamshidnejad, Anahita — Delft University of Technology, Delft Center for Systems and Con
Frazzoli, Emilio — ETH Zürich

Keywords: Robot control, Control applications, Adaptive control

Abstract: We propose a novel optimal receding-horizon navigation approach for a robot in an unknown search environment, towards a known goal position. The search environment includes several obstacles that are distributed at unknown positions. The proposed approach considers multiple objectives, including reference path tracking, reduction of the energy consumption, restraining the robot's mission time, and asymptotic stability towards the goal position. The navigation policy is determined in the detection zone of the robot's detection sensor at particular update time steps for short time. This policy will be updated at the next update time steps. Moreover, we introduce a novel heuristic algorithm for determining the robot's tracking path trajectory that is simply implementable and fast in computations.

14:30-14:45, Paper MoBT1.5 Add to My Program

Fast Robot Motion Planning with Collision Avoidance and Temporal Optimization

Lin, Hsien-Chung University of California, Berkeley
Liu, Changliu Stanford University
Tomizuka, Masayoshi UC Berkeley/NSF

Keywords: Robot control, Planning, scheduling and coordination

Abstract: Considering the growing demand of real-time motion planning in robot applications, this paper proposes a fast robot motion planner (FRMP) to plan a collision-free and time-optimal trajectory, which applies the convex feasible set algorithm (CFS) to solve both the trajectory planning problem and the temporal optimization problem. The performance of CFS in trajectory planning is compared with the sequential quadratic programming (SQP) in simulation, which shows a significant decrease in iteration numbers and computation time to converge a solution. The effectiveness of temporal optimization is shown on the operational time reduction in the experiment on FANUC LR Mate 200iD/7L.

MoBT2 Regular Session, Lotus 4E Add to My Program

Robotic Control (I)

Chair: Jamshidnejad, Anahita Delft University of Technology, Delft Center for Systems and Control
Co-Chair: Hoshino, Kenta Aoyama Gakuin University

13:30-13:45, Paper MoBT2.1 Add to My Program

Gait Controllers on Humanoid Robot Using Kalman Filter and PD Controller

Martin, Martin Institut Teknologi Bandung
Hadi Putri, Dewi Indriati Institut Teknologi Bandung
Riyanto, Riyanto Institut Teknologi Bandung
Machbub, Carmadi Institut Teknologi Bandung

Keywords: Robot control, Control applications

Abstract: The humanoid robot has a structure that can be shaped or moved like a human, but in order to walk like a human, it needs to be given the controller to correct the posture and gait on the robot. The PD controller is used to control the posture and gait of the humanoid robot and the Center of Mass (COM) is used as a feedback to keep the humanoid robot stable. Determination of the stability criteria is performed to determine the stable state of the humanoid robot. In this study, we used Bioloid GP in order to get a stable stand and walk on uneven surface conditions. IMU sensors are used to read COM angles and to increase the readability accuracy, while the Kalman filter method is used as an estimate of error and white noise filter. Furthermore, the controller will calculate the error between sensor readings and setpoints to obtain angle correction value for the servo motor in Bioloid GP. The PD controller successful to stabilize the robot in the single slope change in the standing area with the experimental result response of 0% of overshoot on the pitch axis and 0% of overshoot on the roll axis. The response has 2 second of rising time for Pitch axis and 2.5 seconds for Roll axis.

13:45-14:00, Paper MoBT2.2 Add to My Program

A Minimum Phase Modeling Approach to a Disturbance Observer Design for Balancing Control of a Single-Wheel Robot

lee, sangdeok Chungnam National University
Jung, Seul Chungnam National University

Keywords: Robot control, Mobile robotics, Control applications

Abstract: Stabilization of the inverse model of the target system is a critical problem in a current disturbance observer (DOB) based control scheme. When the system is identified as a second order system by the recursive least square (RLS) algorithm, the minimum phase (MP) of the model is not guaranteed. This paper addresses a guaranteed minimum phase method of the identified second order model. Jury's test is conducted to check the stability. All-Pass-Filtering

(APF) process are conducted for updating prior parameters of RLS to satisfy the minimum phase criteria. To verify the proposal, a single-wheel robot is identified as a second order model by the RLS method with guaranteed stability. Disturbance observer is designed based on the model. Balancing control experiments of a single-wheel robot are conducted.

14:00-14:15, Paper MoBT2.3 Add to My Program

A Minimum-Energy Trajectory Tracking Controller for Four-Wheeled Omni-Directional Mobile Robot

Wang, Jianbin Zhaoqing University
Chen, Jianping Zhaoqing University
xiao, Qijun Zhaoqing University

Keywords: Robot control, Mobile robotics, Modeling and identification

Abstract: Four-wheeled omni-directional mobile robot driven by four electric motors is a typical redundant system. Aiming at the problem that the traditional trajectory tracking algorithm for this kind of robots cannot consider the input redundancy, a minimum-energy trajectory tracking algorithm is proposed. Firstly, a kinematics model of four-wheeled omni-directional mobile robot is built. Secondly, a trajectory tracking controller is designed based on the kinematics model. And then, considering the wheel velocity redundancy, a particle swarm optimization and genetic algorithm hybrid optimization algorithm (PSO-GA) are applied to search for the best inputs by minimizing the motion energy. Finally, the simulation of trajectory tracking control system is carried out on the platform of Matlab 2016a. The results indicate that the trajectory tracking control system of four-wheeled omni-directional mobile robot based on the designed algorithm has good stability and accuracy with minimum-energy consumption.

14:15-14:30, Paper MoBT2.4 Add to My Program

Center of Mass Based Walking Pattern Generator with Gravity Compensation for Walking Control on Bioloid Humanoid Robot

Riyanto, Riyanto Institut Teknologi Bandung
Adiprawita, Widyawardana Institut Teknologi Bandung
Hindersah, Hilwadi Institut Teknologi Bandung
Machbub, Carmadi Institut Teknologi Bandung

Keywords: Robot control, Mobile robotics, Modeling and identification

Abstract: This research discusses the development of simulation and generator of bipedal robot walking pattern on the sagittal, frontal and transversal planes by setting the trajectory of the sole and the pelvis of the robot with respect to the position of the robot center of mass changes to the biped robot support polygon. The robot center of mass is assumed to lie in the pelvis, and an adjustment is made when the structure of the robot is reconstructed with an additional load. Adjustments made in the form of converting angle of robot torso. The simulation program and the motion generator run out data-driven in the form of simulation data along with the correction data which is the gravity compensation for the reconstructed humanoid Bioloid robot. Data-driven becomes input for RoboPlus program from Robotis to adjust the angular position of each joint, joint rotation speed, robot posture, and static robot balance control. With the data-driven given, the Bioloid robot can achieve walking motion without falling on a flat and even floor without the overlap of a swinging foot to the stance foot, and without significantly affecting the step length and the step height of the initial planning. The resulting running speed is 0.84 seconds per set of steps and reaches a speed of 0.423 m / s

14:30-14:45, Paper MoBT2.5 Add to My Program

Application of Finite-Time Stabilization to Position Control of Quadcopters

Hoshino, Kenta Aoyama Gakuin University

Keywords: Robot control, Mobile robotics, Nonlinear systems

Abstract: This paper discusses an application of finite-time stabilization methods to the control of quadcopters. The finite-time stabilization methods guarantee the finite-time convergence to the equilibrium state and exhibit robustness property with respect to disturbances and modeling errors. The application of the finite-time stabilization to the control of UAV is expected to be effective. This paper shows an application of a finite-time stabilization to quadcopters and investigates the effectiveness of the stabilization via the physics simulation based on ROS and Gazebo. The performance of the finite-time stabilization method is compared with those of an exponentially stabilizing feedback controller.

MoBT3 Invited Session, Ballroom 4010AB Add to My Program

Advanced Control and Observation Methodologies for Complex Dynamical Systems with Industrial Applications

Chair: Huang, Jiangshuai — Chongqing University
Co-Chair: Wu, Zhou — Chongqing University
Organizer: Su, Xiaojie — Chongqing Univ
Organizer: Huang, Jiangshuai — Chongqing Univ
Organizer: Liu, Jianxing — Harbin Inst. of Tech
Organizer: Xu, Dezhi — Univ. of Aeronautics and Astronautics

13:30-13:45, Paper MoBT3.1 Add to My Program

Indirect Neuroadaptive Control Design for High-Order Nonlinear MIMO Systems with Actuator Failures (I)

Gao, Rui — Chongqing University
Huang, Jiangshuai — Chongqing University
Chen, Jiawei — Chongqing University
Xue, Fangzheng — Chongqing University

Keywords: Adaptive control, Robust control, Nonlinear systems

Abstract: The paper focus on its unknown trajectory concluding uncertain dynamics, sensor failures and even unanticipated actuator faults. Introducing a speed function, this work puts forward an indirect adaptive neural network control protocol which is adopted to achieve the object that the uncertain MIMO nonlinear systems tracks the unknown trajectory. We, to be specific, purposes a model to link estimated target trajectory with the actual hidden one mathematically. Similarly, we have the relationship between the predicted and the polluted. It is shown that the instantaneous behavior of the tracking process during the main course of the system operation is improved and all the signals are uniformly ultimately bounded. The numerical simulation examples are taken advantage to expound the effectiveness of controller design scheme in this work.

13:45-14:00, Paper MoBT3.2 Add to My Program

A Sawtooth Growing Exploitation Framework for Memetic Algorithms (I)

Zhang, Xin — Tianjin Normal University
Chai, Yi — Chongqing University
Lihua, Sun — Chongqing University
Wu, Zhou — Chongqing University

Keywords: Complex systems, Hybrid systems, Intelligent systems

Abstract: Memetic algorithms (MAs) refer to hybrid methods of global search and local search, which aims to systematically balance exploitation and exploration for solving an optimization problem. This paper attempts to create a sawtooth growing exploitation framework for MAs. Under the framework, a sawtooth-wave function is used to control ratios of global search and local search, and thus the exploitation is restricted to sawtooth growing patterns. An MA instance is implemented by combining modified differential evolution and neighborhood field algorithms, named as MDE-NF. Compared with several state-of-the-art algorithms, the MDE-NF algorithm shows promising performance on several benchmark functions.

14:00-14:15, Paper MoBT3.3 Add to My Program

Distributed Event-Based Algorithm for Economic Dispatch Problem Over Digraph with Time Delays (I)

Zhao, Zhongyuan — Chongqing University
Chen, Gang — Chongqing University

Keywords: Cyber-physical systems, Smart grid, Energy management systems

Abstract: The economic dispatch problem(EDP) in microgrid over directed networks with communication time delays is investigated. We design a distributed event-based algorithm to handle EDP in microgrid over strongly connected and balanced digraph. Furthermore, the effect of time delays has been considered. By graph theory and Lyapunov method, an appropriate event-triggered condition is obtained and the corresponding sufficient condition which guarantees stability of the proposed algorithm is devised. As the periodic sample control has been adopted, the Zeno behavior is excluded naturally. Finally, Simulation results demonstrate the effectiveness of the algorithm.

14:15-14:30, Paper MoBT3.4 Add to My Program

Study Artificial Potential Field on the Clash Free Layout of Rebar in Reinforced Concrete Beam-Column Joints (I)

Liu, Jiepeng — Chongqing University in China

Xu, Chengran — Chongqing University in China
Ao, Nian — Chongqing University in China
Feng, Liang — Chongqing University in China
Wu, Zhou — Chongqing University

Keywords: Intelligent automation, Intelligent systems

Abstract: Design and construction of reinforced concrete (RC) structures are two important phases in a building construction project. Structural engineers are difficult to reject all rebar clashes in RC beam–column joints at the design phase. Construction engineers and steel fixers have to identify rebar spatial clashes and avoid rebar clashes in a manual way, which is tedious and time consuming. In this paper, an intelligent design method is urgent with the ability to avoid rebar clashes automatically. A novel artificial potential field (APF) approach is presented for the clash free layout of rebar in RC beam-column joints. Using the APF method, the layout of rebar can be regarded as the path planning of multi-agents. APF is used to generate the coordinate of the centerline of clash free rebars in a RC beam–column joint. Repulsive and attractive force can ensure a reachable and optimal solution. The simulation results showed that the proposed method is efficiency and accurate.

14:30-14:45, Paper MoBT3.5 Add to My Program

Improving Liquid State Machine in Temporal Pattern Classification (I)

Luo, Shengyuan — Chongqing University
Guan, Hang — Chongqing University
Li, Xiumin — Chongqing University
Xue, Fangzheng — Chongqing University
Zhou, Hongjun — Chongqing University

Keywords: Neural networks, Intelligent systems, Intelligent automation

Abstract: Liquid State Machine (LSM) is a biologically plausible neural network model for real-time computing on time-varyinginputs,whichisshowntobebeneficialforperform computational tasks like pattern classification. The LSM uses spiking neurons with dynamic synapses to projects inputs into high-dimensional space, facilitating subsequent linear pattern recognition In this paper, we present two different methods to improve LSM in real-time pattern classification from perspectivesofspatialintegrationandtemporalintegration.Wedevelop the reservoir for LSM with a self-organizing network (SON) constructed by refining synaptic connectivity based on spiketime-dependent plasticity (STDP). Our study shows LSM with SON has better performance than LSM with random reservoir in spike train classification especially for small amount of templates due to spatial integration. For temporal integration, we show that increasing time constant of the linear filter, which transform spikes into smoothly changing states, is able to lead a better performance and is robust to the amount of templates.

14:45-15:00, Paper MoBT3.6 Add to My Program

Fault Diagnosis for Open-Circuited Faults in 3-Phase Uncontrolled Rectifier of Wind Energy Power Conversion Systems (I)

Sharan, Bindu — Indian Institute of Technology Mandi
Jain, Tushar — Indian Institute of Technology Mandi

Keywords: Energy management systems, Intelligent automation

Abstract: This paper proposes an open-circuited (OC) fault diagnosis methodology for 3-phase uncontrolled rectifier used in wind energy power conversion systems. We have developed the fault diagnosis algorithm using a signal based method, where the magnitude and phase of fundamental and other harmonic components of the rectified DC voltage play a major role. The novelty of the proposed scheme lies in identification of exact location of OC diode(s), which is established by introducing a specifically designed resistance. The effectiveness of the proposed scheme is demonstrated on a variable power fed 3-phi uncontrolled rectifier connected to the boost converter.

MoBT4 Invited Session, Ballroom 4011 Add to My Program

Untethered Mobile Microrobots for Biomedical Applications

Chair: Xu, Tiantian — Shenzhen Institute of Advanced Integration Technology, Chinese Academy of Sciences
Co-Chair: LIU, Xiaoming — Beijing Institute of Technology
Organizer: Xu, Tiantian — Chinese Academy of Sciences
Organizer: Xie, Hui — Harbin Institute of Technology

13:30-13:45, Paper MoBT4.1 Add to My Program

Detection and Compensation of Motion Error for Nanomanipulation Platform in Scanning Electron Microscope (I)

Wang, Mingyu Soochow University
Wang, Yaqiong Soochow University
Yang, Zhan Soochow University
Chen, Tao Soochow University
Sun, Lining Soochow University

Keywords: Biomedical instrumentation and applications

Abstract: Nanomanipulation system based on scanning electron microscope(SEM) with good real-time visual feedback and nanoscale observation resolution had high operability in a vacuum working environment. Different nanomanipulation tasks of carbon nanotubes (CNTs) are carried out through the nanomanipulation system in SEM. Nanomanipulation platform existed inherent manufacture errors, installation errors and other errors, and imprecise nanomanipulation system were also time-consuming and laborious for operators. This paper presentes a method of combining the visual feedback and feedforward control to detect and compensate the motion error of the multi-dimensional SmarAct nanomanipulation platform in the nanomanipulation system in SEM. This method reduces the motion error in the X-Y direction and achieved higher operating accuracy. At the different step speed, the motion error in the X direction and Y direction is 135.7nm and 112.9nm respectively. After the feedforward compensation, the motion error in the X direction and Y direction reduces to 61.3nm and 54.1nm respectively.

13:45-14:00, Paper MoBT4.2 Add to My Program

High-Throughput Microchannels for Single Cell Immobilization (I)

Tang, Xiaoqing Beijing Institute of Technology
LIU, Xiaoming Beijing Institute of Technology
Li, Pengyun Beijing Institute of Technology
Lin, Yuqing Beijing Institute of Technology
Arai, Tatsuo Beijing Institute of Technology
Huang, Qiang Beijing Institute of Techenology

Keywords: Mechanism design and applications., Micro robots and micro-manipulation, Biomedical instrumentation and applications

Abstract: Nowadays single cell analysis becomes a more and more important method to gather the information of individual cells and study the heterogeneity of cells caused by random expression of gene, protein and the level of metabolism. Many device and technologies of single cell analysis have been developed to meet these needs. In this paper, we propose a high-throughput microchannel for single cell immobilization with small sheer pressure. It features high density arrays which can accommodate up to 130~300 traps within 1~2 mm2. According to our experiment, about 91% of trapping unit can be occupied by the single cell in 40 s, using the optimized structure of microchannels. Therefore, we expect that the high throughput microchannels can be of great importance for the biological research.

14:00-14:15, Paper MoBT4.3 Add to My Program

Transporting Microobjects Using a Magnetic Microrobot at Water Surfaces (I)

He, Yuanzhe Harbin Institute of Technology
Wang, Lefeng Harbin Institute of Technology
Zhong, Lifu Harbin Institute of Technology
Liu, Yang Harbin Institute of Technology
Rong, Weibin Harbin Institute of Technology

Keywords: Micro robots and micro-manipulation

Abstract: Microobject transporting is an important task in numerous micromanipulation applications. In this paper, we propose a novel method to transport microobjects using a magnetically actuated microrobot at water surfaces. The microrobot is a pentagram-shaped magnetized sheet with typical diameter of 800μm. By applying magnetic gradient generated by electromagnetic coils, the microrobot can move controllably at water surfaces. Microobjects at water surfaces can be trapped by the microrobot due to the capillary attraction. Microobject transporting is realized by direct push of the microrobot. A releasing strategy by accelerating the microrobot is also presented to separate the microobject

from the microrobot. The experimental results show that the maximum transporting speed for solder balls achieved 3.3mm/s with a magnetic gradient of 79mT/m.

14:15-14:30, Paper MoBT4.4 Add to My Program

Manipulation of Lotus-Root Fiber Based Soft Helical Microswimmers Using Rotating Gradient Field (I)

Su, Meng — Shenzhen Institutes of Advanced Technology, Chinese Academ

Xu, Tiantian — Shenzhen Institute of Advanced Integration Technology, Chinese A

liu, jia — Shenzhen Institutes of Advanced Technology, Chinese Academy of S

Manamanchaiyaporn, Laliphat — Shenzhen Institute of Advanced Technology

Guan, Yanming — Shenzhen Institutes of Advanced Technology, Chinese Academ

Hao, Zhiming — Shenzhen Institutes of Advanced Technology, Chinese Academ

wu, xinyu — Shenzhen Institutes of Advanced Technology (SIAT), CAS

Keywords: Micro robots and micro-manipulation, Medical robots and bio-robotics

Abstract: Untethered and wirelessly-controlled microrobots have many applications in the field of biomedicine. Therefore, many laboratories and scientists have invested more scientific research into magnetic microrobots which can make more contributions to medical care. Many magnetic field devices and microrobots are manufactured. In the development of microrobots, helical microrobots have been well developed. Rigid-body robots account for the majority of these, but they may cause damage to human organs during treatment. However, soft and deformable robots can relieve more medical restrictions. In general, helical microrobots are driven by uniform fields which have their own limitations while the gradient magnetic field can relieve more restrictions and have more functions. This paper presents a flexible deformable helical swimmer controlled in a rotating gradient magnetic field. Helical swimmers are covered with magnetic nano-particles and the helical structure is derived from the inner fiber structure of the lotus root.The soft helical swimmers are controlled to swim several special trajectories in the rotating gradient magnetic field and we analyze the frequency and other factors for velocity or other effects.

14:30-14:45, Paper MoBT4.5 Add to My Program

IoT-Enabled Heart Monitoring Device with Signal De-Noising and Segmentation Using Discrete Wavelet Transform

Choo, Keng Wah — Nanyang Polytechnic

Low, Jia Xin — Nanyang Polytechnic

Keywords: Biomedical instrumentation and applications, Internet of things, Intelligent systems

Abstract: This paper describes an implementation of a BLE-enabled smart heart monitoring system by incorporating synchronous capturing of critical heart physiological signals in a single device, allowing the heart condition of a heart patient to be monitored from home, as well as allowing the captured signals to be stored in a smartphone and subsequently uploaded onto a cloud storage for further processing and analysis. The system aims to reduce the time needed for heart patients to visit hospitals in their regular check-ups for monitoring of their heart condition. With this device, heart patients will to be able to monitor two important heart signals, namely the Electrocardiogram (ECG) and Phonocardiogram (PCG), concurrently and conveniently at home, and send the signals to medical professionals for consultation. Several wavelets were evaluated in this work and they were used for signal enhancement and segmentation. The same technique is also deployed to detect the QRS-peaks from the ECG, and S1 & S2 heart sounds from the PCG, to assist medical professionals in diagnosis of the heart condition. The device will benefit heart patients significantly in terms of reduction in travel time, with the convenience and comfort at home. It also helps the medical professionals in their diagnosis of heart condition as the signals are segmented with S1 and S2 marked accordingly. The hospitals will also gain through productivity improvement where non-critical heart patients could be evaluated without the need for them to visit hospitals for their regular check-ups.

14:45-15:00, Paper MoBT4.6 Add to My Program

Comparative Study of RGB-D Sensors Based on Controlled Displacements of a Ground-Truth Model

Anxionnat, Adrien — Université Grenoble Alpes

Voros, Sandrine — TIMC-IMAG Laboratory

Troccaz, Jocelyne — TIMC-IMAG Laboratory

Keywords: Perception systems, Biomedical instrumentation and applications

Abstract: In the context of developing a pedagogical tool for teaching anatomy, the need for a comparative study between two RGB-D cameras has emerged. This paper addresses the assessment of the accuracy and precision of two RGB-D sensors (Carmine Primesense and Persee Orbbec) through two different experiments. The evaluation not only provides comparative results on the sensors performances but also aims at determining in which conditions they are the most efficient. The first experiment evaluates the variability of the output depth map data. The second experiment focuses on analyzing the influence of the distance in the positioning accuracy of an object submitted to controlled displacements. The results are summarized in a set of error heat maps and a table; they provide clues for using one sensor rather than another by describing their robustness both in a static scene and in a motion capture scenario.

MoBT5 Invited Session, Ballroom 4111 Add to My Program

On Distributed Optimization, Games in Networked Systems and Their Applications

Chair: Ye, Maojiao — Nanjing University of Science and Technology

Co-Chair: Zhang, Duanjin — Zhengzhou University

Organizer: Ye, Maojiao — Nanjing University of Science and Technology

Organizer: Sun, Chao — Nanyang Technological University

13:30-13:45, Paper MoBT5.1 Add to My Program

Sensor Scheduling in Distributed Kalman Filter for Multi-Target Tracking (I)

Sun, Lucheng — Southeast University

Zhang, Ya — Southeast University

Keywords: Distributed estimation, Planning, scheduling and coordination, Sensor networks

Abstract: This paper studies the design of a distributed sensor scheduling policy for a sensor network, in which each dynamical target can only be measured by partial sensors due to the restriction of sensor resources while each sensor requires to monitor all targets. Consensus Kalman filtering algorithm and stochastic scheduling strategy are applied. Firstly, a necessary condition of the observation probabilities of the targets, which can guarantee the boundedness of the expected covariance of the network, is provided. Secondly, the marginal utility of the expected covariance with respect to the observation probability is proved. Then, an algorithm is proposed to compute the optimal probabilities, which requires less complex calculations. Numerical simulations are conducted to demonstrate the performance of the proposed algorithms.

13:45-14:00, Paper MoBT5.2 Add to My Program

Neural Network with Added Inertia for Linear Complementarity Problem (I)

He, Xing — Southwest University

Huang, Junjian — Chongqing University of Education

Li, Chaojie — Royal Melbourne Institute of Technology

Keywords: Energy management systems

Abstract: In this brief, considering the inertial term into first order neural networks(NNs), an inertial NN(INN) modeled by means of a differential inclusion is proposed for solving linear complementarity problem with P_{0} matrix. Compared with existing NNs, the presence of the inertial term allows us to overcome some drawbacks of many NNs, which are constructed based on the steepest descent method, and this model is more convenient for exploring different optimal solution. It is proved that the proposed NN is stable in the sense of Lyapunov and any equilibrium of our NN is the optimal solution of LCP with P_{0} matrix. Simulation results on two numerical examples show the effectiveness and performance of the proposed neural network.

14:00-14:15, Paper MoBT5.3 Add to My Program

Nash Equilibrium Seeking for Games in Hybrid Systems (I)

Ye, Maojiao — Nanjing University of Science and Technology

Keywords: Networked games, Consensus algorithms, Hybrid systems

Abstract: Nash equilibrium seeking for games in a class of hybrid systems is investigated in this paper. Different from the existing works, the players in the present game framework are composite of a set of continuous-time players and a

set of discrete-time players. Nash equilibrium seeking for such a hybrid game is challenging as some players update their actions in continuous time while the remainders update their actions in discrete time. To accommodate the hybrid games, we firstly consider a case in which the players update their actions according to the hybrid gradient play (i.e., the continuous-time players update their actions according to the continuous-time gradient play with sampled information flow while the discrete-time players update their actions according to the discrete-time gradient play). Then, we consider the case in which the players have restricted access into their opponents' actions. A hybrid consensus-based strategy is proposed for this case. The stability of the Nash equilibrium under the proposed hybrid seeking strategies is theoretically proven by utilizing Lyapunov stability analysis. Lastly, the hybrid seeking strategies are validated through a numerical example.

14:15-14:30, Paper MoBT5.4 Add to My Program

A Demand-Side Pricing Strategy Based on Bayesian Game (I)

Yang, Jie — Yanshan University
Tian, Zhenhua — Yanshan University
Ma, Kai — Yanshan University

Keywords: Smart grid, Energy management systems, Networked games

Abstract: Demand response can ensure the stability of power system and reduce the operation cost. This paper design a pricing scheme to balance the energy demand and supply based on demand response in smart grid. In the demand side, a Bayesian game is formulated to model the interaction of multiple consumers because each consumer's utility function is private. The utility company announces a regulation price which can change the Bayesian Nash equilibrium and the energy demand of consumers. We develop an algorithm to update the regulation price until the energy demand match the energy supply. Numerical results demonstrate that the algorithm make the regulation price converge to a stable state and balance the energy supply and demand.

14:30-14:45, Paper MoBT5.5 Add to My Program

H-Infinity Filtering for Delta Operator Networked Systems with Random Delays and Limited Communication

Zhang, Duanjin — Zhengzhou University
Zhang, Yinshuang — Zhengzhou University
Gao, Xiaobei — Zhengzhou University

Keywords: Networked control systems, Identification and estimation, Delay systems

Abstract: This paper is concerned with the problem of H-infinity filtering for networked control systems. A Bernoulli distributed is used to represent random time-delays and a switched sequence to illustrate limited communication in the considered system. Sufficient conditions that make the filtering error system to be exponentially stable with H-infinity performance, are proposed in terms of linear matrix inequalities (LMI) and Lyapunov-Krasovskii functional in delta domain. The parameters of the designed H-infinity filter are also developed. A numerical example is provided to show the effectiveness of the presented method.

14:45-15:00, Paper MoBT5.6 Add to My Program

Development of EtherCAT Slave Based on Multi-Core DSP

Park, Sung-Mun — Pusan National University
Kim, Hyoung-Woo — Pusan National University
Cho, Hyung Man — Pusan National University
Choi, Joon-Young — Pusan Natinal University

Keywords: Networked control systems, Network-based systems, Control applications

Abstract: We develop a hardware and software for EtherCAT slave based on multi-core DSP in order to apply to control applications. Beckhoff's ET1100 ASIC is employed as EtherCAT slave controller; EtherCAT slave stack and control application algorithm are processed by individually assigned DSP core; and data interexchange between the two DSP cores is carried out by using the Inter-Process Communication mechanism. Namely, we intentionally separate the EtherCAT communication stack process from control application process using multi-core DSP, which enables to achieve conducting complicated control application as well as high-speed communication cycle. The high performance of the developed EtherCAT slave are demonstrated by real experiments using EtherCAT network composed of the developed slave and IgH EtherCAT master for Linux.

MoBT6 Regular Session, Ballroom 4211 Add to My Program

Feature Extraction and Image Analysis (I)

Chair: Jiang, Hao — Fuzhou University

Co-Chair: Chi, Zheru — The Hong Kong Polytechnic University

13:30-13:45, Paper MoBT6.1 — Add to My Program

Efficient Human-Robot Interaction Using Deep Learning with Mask R-CNN: Localization, Tracking, Detection, Recognition and Segmentation

Le, Than — Bordeaux

Huynh, Dang — Axon Enterprise

Pham, Van Huy — AI Lab, Faculty of Information Technology, Ton Duc Thang Univers

Keywords: Face and Gesture., Feature extraction, grouping and segmentation, Localization, navigation and mapping

Abstract: We address social human-robot interaction problem by proposing an integration of deep neural network with mechanical robotic system to make it robust for human-robot interactive activities. Mask R-CNN, a neural network for object detection, can effectively help localize human faces which can be manipulated to instruct movement of the robot head. Our approach is not only suitable for detection and segmentation tasks but able to integrate as well with the mechanism of parallel mini-manipulator representing the 3D dimensions, in position and orientation of workspace. It can also solve the object segmentation problem which appears to be one of the most challenging issues in computer vision nowadays.

13:45-14:00, Paper MoBT6.2 — Add to My Program

A Multi-Face Challenging Dataset for Robust Face Recognition

Dubey, Shiv Ram — Indian Institute of Information Technology, Sri City

Mukherjee, Snehasis — IIIT SriCity

Keywords: Face and Gesture., Image/video analysis, Biometrics

Abstract: Face recognition in images is an active area of interest among the computer vision researchers. However, recognizing human face in an unconstrained environment, is a relatively less-explored area of research. Multiple face recognition in unconstrained environment is a challenging task, due to the variation of view-point, scale, pose, illumination and expression of the face images. Partial occlusion of faces makes the recognition task even more challenging. The contribution of this paper is two-folds: introducing a challenging multiface dataset (i.e., IIITS MFace Dataset) for face recognition in unconstrained environment and evaluating the performance of state-of-the-art hand-designed and deep learning based face descriptors on the dataset. The proposed IIITS MFace dataset contains faces with challenges like pose variation, occlusion, mask, spectacle, expressions, change of illumination, etc. We experiment with several state-of-the-art face descriptors, including recent deep learning based face descriptors like VGGFace, and compare with the existing benchmark face datasets. Results of the experiments clearly show that the difficulty level of the proposed dataset is much higher compared to the benchmark datasets.

14:00-14:15, Paper MoBT6.3 — Add to My Program

K3-Sparse Graph Convolutional Networks for Face Recognition

Wu, Renjie — Waseda University

Kamata, Sei-ichiro — Waseda University

Keywords: Face and Gesture., Object recognition, Feature extraction, grouping and segmentation

Abstract: In recent years, deep learning networks have substantially improved the performance of face recognition. Although deep learning networks have been very successful, there are limited to underlying Euclidean structure data. When dealing with complex signals such as medical imaging, genetics, social networks and computer vision, recently there has been a growing interest in trying to apply learning on non-Euclidean geometric data. Graph convolutional networks are a new deep learning architecture for analyzing non-Euclidean geometric data. In computer vision, a human face image is modeled as a graph in the irregular domain. A major technical challenge is how to optimize the structured face graph. Because, classification performance critically depends on the quality of the graph. In this paper, we explore an undirected graph convolutional network called k3-SGCNs (k3-sparse graph convolutional networks). The main idea is to use sparsity-constrained optimization that obtain connected sparse subgraphs. A sparse graph of face image is composed of connected sparse subgraphs. Experiments demonstrate that the learned sparse graph has better performance than mutual k-nearest neighbor graph and l1 graph.

14:15-14:30, Paper MoBT6.4 — Add to My Program

Enhanced Character Segmentation for Multi-Language Data Plate in Substation Transformer Based on Connected Component Analysis

Zheng, Jieling — Fuzhou University

Miao, Xiren — College of Electrical Engineering and Automation, Fuzhou Univers

Fang, Shih-hau Yuan Ze University
Chen, Jing College of Electrical Engineering and Automation, Fuzhou Univers
Jiang, Hao Fuzhou University

Keywords: Feature extraction, grouping and segmentation

Abstract: Intelligent inspection in the substation transformer using optical character recognizer has been developing rapidly. Character segmentation from the text line of data plate is an important step for localization and recognition of electrical equipment. However, on-site character segmentation is challenging if the data plate contains multiple languages, especially when the width between Chinese and non-Chinese character differs significantly and the complex environments cause the light reflection and fading. This paper proposes a new method, based on analyzing the connected component and Chinese character's structure, to segment characters from multi-language data plate of substations. The proposed method uses the combination of the HSV color space and multi-scale MSRCP to reduce the effect of illumination and complex background. The proposed method utilized the width of each kind character, the interval between characters and the relationship within the left-right structure Chinese character to improve the segmentation accuracy. Experimental results show that the text lines from the data plate in substation transformer, including Chinese, English, Roman numerals, Arabic numerals and symbols, can be segmented correctly. Results show that the proposed method outperforms two existing character segmentation methods and achieves 99.4%.

14:30-14:45, Paper MoBT6.5 Add to My Program

A Novel Structure of Convolutional Layers with a Higher Performance-Complexity Ratio for Semantic Segmentation

Jiang, Yalong The Hong Kong Polytechnic University
Chi, Zheru The Hong Kong Polytechnic University

Keywords: Feature extraction, grouping and segmentation, Image/video analysis, Activity/behavior recognition

Abstract: In this paper, we study an important factor that determines the capacity of a CNN model and propose a novel structure of convolutional layers with a higher performance-complexity ratio. Firstly, the relationship of the model capacity and the number of parameters versus segmentation performance is explored. Secondly, a mechanism is proposed to optimize the structure of a CNN model for a specific task. The mechanism also provides better convergence than current state-of-the-art methods for factorizing convolutional layers, such as MobileNet. Thirdly, we propose a measure based on the mutual information between hidden activations and inputs/outputs to compute the capacity of a CNN model. This measure is highly correlated with segmentation performance. Experimental results on the segmentation of the PASCAL Person Parts Dataset show that the linear dependency among convolutional kernels is an important factor determining the capacity of a CNN model. It is also demonstrated that our approach can successfully adjust the model capacity to best match to the complexity of a dataset. The optimized CNN model achieves the similar performance to Deeplab-V2 on the segmentation task with 100 less parameters, resulting in a significantly improved performance-complexity ratio.

14:45-15:00, Paper MoBT6.6 Add to My Program

Understanding Deformation Motion of Colloidal Nanosheets from CLSM Images Using Deep Learning-Based Approach

Fujioka, Hiroyuki Fukuoka Institute of Technology
Sawangphol, Jarupat Fukuoka Institute of Technology
Anraku, Shinya Fukuoka Institute of Technology
Miyamoto, Nobuyoshi Fukuoka Institute of Technology
Hidaka, Akinori Tokyo Denki University
Kano, Hiroyuki Tokyo Denki Univ

Keywords: Feature extraction, grouping and segmentation, Image/video analysis, Activity/behavior recognition

Abstract: This paper considers a problem of understanding deformation motion of colloidal nanosheets from a set of confocal laser scanning microscopy (CLSM) images corrupted by noises. First, we present a robust method for detecting nanosheet objects from noisy CLSM images by introducing the deep learning-based approach. Then, we develop a method for understanding motions of nanosheet objects in colloid liquid. Such a method is constituted by introducing the idea of the so-called gradient-based feature descriptor, in which the local and global deformation motions are effectively visualized. The performance is demonstrated by some experimental studies.

MoBT7 Regular Session, Ballroom 4212 Add to My Program

Intelligent Systems (I)

Chair: Jing, Wei IHPC and A*AI Programme, A*STAR

Co-Chair: Ranasinghe, Ravindra Sanath — University of Technology Sydney

13:30-13:45, Paper MoBT7.1 — Add to My Program

Online Semantic Segmentation and Manipulation of Objects in Task Intelligence for Service Robots

Llopart, Adrian — Technical University of Denmark
Ravn, Ole — Technical University of Denmark
Andersen, Nils A. — Tech. Univ. of Denmark
Kim, Jong-Hwan — Korea Advanced Institute of Science and Technology

Keywords: Intelligent automation, Feature extraction, grouping and segmentation, Neural networks

Abstract: Task Intelligence is the capacity of a robot to learn, reason and execute specific behaviours based on its environment. In this paper, the Task Intelligence problem formulated by the Robot Intelligence and Technology Laboratory at KAIST is researched further: specifically the proposed contribution is a brand new perceptual pipeline in which the recognition, detection, segmentation and grasping of objects is achieved assuming no prior knowledge of the environments arrangement nor the objects appearance. A Convolutional Neural Net (CNN) is used to detect, recognize and semantically label those objects that need to be interacted with. 3D point clouds, corresponding to the objects model, are extracted after several segmentation procedures and registered over time. Dimensional and positional information of the object is acquired. Additional grasping pose data is calculated. All of the collected knowledge is parsed so that the Task Intelligence system is able to deal with previously unknown objects in dynamic environments. This system is formed by an Episodic Memory (Deep-ART), an action sequence generator (FF-planner) and a trajectory warping module for pre-learnt behaviours. The proposed approach has been tested using the Webots simulator

13:45-14:00, Paper MoBT7.2 — Add to My Program

A Robotic Auto-Focus System Based on Deep Reinforcement Learning

Yu, Xiaofan — Peking University
Yu, Runze — Peking University
Yang, Jingsong — Peking University
Duan, Xiaohui — Peking University

Keywords: Intelligent automation, Intelligent systems, Robot control

Abstract: Considering its advantages in dealing with high-dimensional visual input and learning control policies in discrete domain, Deep Q Network (DQN) could be an alternative method of traditional auto-focus means in the future. In this paper, based on Deep Reinforcement Learning, we propose an end-to-end approach that can learn auto-focus policies from visual input and finish at a clear spot automatically. We demonstrate that our method - discretizing the action space with coarse to fine steps and applying DQN is not only a solution to auto-focus but also a general approach towards vision-based control problems. Separate phases of training in virtual and real environments are applied to obtain an effective model. Virtual experiments, which are carried out after the virtual training phase, indicates that our method could achieve a 100% accuracy on a certain view with different focus range. Further training on real robots could eliminate the deviation between the simulator and real scenario, leading to reliable performances in real applications.

14:00-14:15, Paper MoBT7.3 — Add to My Program

An Automated Irrigation System for Smart Agriculture Using the Internet of Things

V., Ramachandran — Kalasalingam Academy of Research and Education
R, Ramalakshmi — Kalasalingam Academy of Research and Education
Srinivasan, Seshadhri — Berekeley Education Alliance for Research in Singapore

Keywords: Intelligent automation, Internet of things

Abstract: Water is a vital and scarce resource in agriculture and its optimal management is emerging as a key challenge. This paper presents an automated irrigation system to reduce water utilization in agriculture by combining the Internet of Things (IoT), cloud computing and optimization tools. The automated irrigation system deploys low cost sensors to sense variables of interest such as soil moisture, pH, soil type, and weather conditions. The data is stored in Thingspeak cloud service for monitoring and data-storage. The field data is transmitted to the cloud using Wi-Fi modem and using GSM cellular networks. Then an optimization model is used to compute the optimal irrigation rate which are automated using a solenoid valve controlled using an ARM controller (WEMOS D1). The variables of interest are stored in the cloud and offered as a service to the farmers. The proposed approach is demonstrated on a pilot scale agricultural facility and our results demonstrate the reduction in water utilization, increase in data-availability, and visualization.

14:15-14:30, Paper MoBT7.4 — Add to My Program

A Learning-Based Approach for Error Compensation of Industrial Manipulator with Hybrid Model

Jing, Wei — IHPC and A*AI Programme, A*STAR
Zhou, Joey Tianyi — IHPC, A*STAR
Gao, Fei — Institute of High Performance Computing
Liu, Yong — A*STAR Institute of High Performance Computing
Tao, Pey Yuen — Singapore Institute of Manufacturing Technology, A*STAR
Yang, Guilin — Singapore Institute of Manufacturing Technology

Keywords: Intelligent automation, Modeling and identification, Intelligent systems

Abstract: The industrial robot usually has high repeatability but relatively lower accuracy. Therefore, error compensation plays a pivotal role in many industrial robotic applications with high accuracy requirement. In this paper, we present a novel computational method that utilizes a hybrid model that consists of Local Product-Of-Exponential (POE) and Gaussian Process Regression (GPR) to compensate the positioning errors of the industrial robotic manipulator for high accuracy industrial robotic applications. Specifically in the proposed method, the Local POE calibration method is first applied to calibrate the robot forward kinematic model to reduce the geometric error. Then the GPR is applied to learn the inverse kinematic model to further compensate the residual error in task space. We also demonstrate the robustness and effectiveness of our proposed method by showing the reduction of norm pose error by up to 37.2%, compared to the existing methods with multiple datasets.

14:30-14:45, Paper MoBT7.5 Add to My Program

A Hybrid Control Architecture for Autonomous Driving in Urban Environment

Jung, Chanyoung — KAIST
JUNG, SEOKWOO — KAIST
Shim, David Hyunchul — Korea Advanced Institute of Science and Technology

Keywords: Intelligent automation, Neural networks, Mobile robotics

Abstract: Autonomous driving in an urban environment is one of the most actively studied topics. To date, many studies on autonomous driving can be classified into two main approaches: 1.local perception-based approach 2.global path tracking-based approach. However, each approach has its own limitations for fully autonomous driving. In the case of perception-based approach, it is impossible to autonomously drive to the global destination because it only runs locally within the sensor range. On the other hand, the path tracking-based approach relies heavily on accurate navigation. For accurate navigation, there are many studies using expensive equipment or extremely precise and detailed maps, but they have not been resolved yet, and they are also not practical. In this paper, we address the problem of autonomous driving in an urban environment through the proposed hybrid control architecture. Proposed control architecture is designed to be complementary of local perception-based and global path tracking-based approaches. Especially, end-to-end deep learning based autonomous driving, which mimics human driving, is applied as a local perception-based approach. In addition, path tracking-based autonomous driving is performed in an environment where directional information to the destination is required, such as intersections. At the same time, our hybrid control architecture effectively compensates for the navigation error using ICP matching between the perception-based driven trajectory and the global path to the destination without any highly detailed prior map or expensive equipment. The performance of the proposed architecture on a full-scale autonomous vehicle is verified through experiments in the urban environment.

14:45-15:00, Paper MoBT7.6 Add to My Program

Calibration of a Rotating Laser Range Finder Using Intensity Features

Katuwandeniya, Kavindie — University of Moratuwa
Ranasinghe, Ravindra Sanath — University of Technology Sydney
Dantanarayana, Lakshitha — University of Technology Sydney
Dissanayake, Gamini — UTS
Liu, Dikai — University of Technology, Sydney

Keywords: Intelligent automation, Robot sensing and data fusion, Mechanism design and applications.

Abstract: This paper presents an algorithm for calibrating a ``3D range sensor'' constructed using a two-dimensional laser range finder (LRF), that is rotated about an axis using a motor to obtain a three-dimensional point cloud. The sensor assembly is modelled as a two degree of freedom open kinematic chain, with one joint corresponding to the axis of the internal mirror in the LRF and the other joint set along the axis of the motor used to rotate the body of the LRF. In the application described in this paper, the sensor unit is mounted on a robot arm used for infrastructure inspection. The objective of the calibration process is to obtain the coordinate transform required to compute the locations of the 3D points with respect to the robot coordinate frame. Proposed strategy uses observations of a set of markers arbitrarily placed in the environment. Distances between these markers are measured and a metric multidimensional scaling is used to obtain the coordinates of the markers with respect to a local coordinate frame. Intensity associated with each beam point of a laser scan is used to locate the reflective markers in the 3D point cloud and a least squares problem is

formulated to compute the relationship between the robot coordinate frame, LRF coordinate frame and the marker coordinate frame. Results from experiments using the robot, LRF combination to map a cavity inside a steel bridge structure are presented to demonstrate the effectiveness of the calibration process.

MoCT1 Invited Session, Lotus 4D

Add to My Program

Best Paper Award Finalist Presentations (Part 2) - Control and Automation

Chair: Wang, Danwei — Nanyang Tech. Univ

Co-Chair: Wen, Changyun — Nanyang Tech. Univ

15:30-15:45, Paper MoCT1.1

Add to My Program

Multi-Robot Motion-Formation Distributed Control with Sensor Self-Calibration: Experimental Validation

Garcia de Marina, Hector — University of Southern Denmark

Siemonsma, Johan — University of Groningen

Jayawardhana, Bayu — University of Groningen

Cao, Ming — University of Groningen

Keywords: multi-robot systems, Multi-agent systems, Distributed estimation

Abstract: In this paper, we present the design and implementation of a robust motion formation distributed control algorithm for a team of mobile robots. The primary task for the team is to form a geometric shape, which can be freely translated and rotated at the same time. This approach makes the robots to behave as a cohesive whole, which can be useful in tasks such as collaborative transportation. The robustness of the algorithm relies on the fact that each robot employs only local measurements from a laser sensor which does not need to be off-line calibrated. Furthermore, robots do not need to exchange any information with each other. Being free of sensor calibration and not requiring a communication channel helps the scaling of the overall system to a large number of robots. In addition, since the robots do not need any off-board localization system, but require only relative positions with respect to their neighbors, it can be aimed to have a full autonomous team that operates in environments where such localization systems are not available. The computational cost of the algorithm is inexpensive and the resources from a standard microcontroller will suffice. This fact makes the usage of our approach appealing as a support for other more demanding algorithms, e.g., processing images from onboard cameras. We validate the performance of the algorithm with a team of four mobile robots equipped with low-cost commercially available laser scanners.

15:45-16:00, Paper MoCT1.2

Add to My Program

Interactive Analysis and Visualization of Digital Twins in High-Dimensional State Spaces

Atorf, Linus — RWTH Aachen University

Roßmann, Jürgen — Lehrstuhl Und Institut Für Mensch-Maschine-Interaktion

Keywords: Data analytics., Cyber-physical systems, Factory modeling and simulation

Abstract: Digital Twins (DTs), an emerging concept from Industry 4.0, are virtual representations of real technical assets. Multi-domain 3D simulation systems can bring DTs to life, even before their physical counterparts are finished. A DT's internal state can be fed from its real twin or generated by simulation. Access to this high-dimensional state of a DT is the key for various analysis and visualization methods presented in this paper. We introduce a generic formalism of state space for DTs and utilize it in an application scenario for automated driving. Throughout this example, methods for state logging and replays, data analysis, and visualization within 3D simulation frameworks are presented. Clear definitions for state variables, vectors, trajectories, and time series help slicing the DTs' state spaces of enormous dimensionality. The presented methodology does not only support the development of intelligent algorithms for autonomous driving, but is also the basis for further use cases of DTs involving optimization, mental models, and decision support systems.

16:00-16:15, Paper MoCT1.3

Add to My Program

Building Prior Knowledge: A Markov Based Pedestrian Prediction Model Using Urban Environmental Data (I)

Vasishta, Pavan — Univ. Grenoble Alpes, Inria Grenoble

Vaufreydaz, Dominique — Univ. Grenoble Alpes, CNRS, Inria, Grenoble INP, LIG, 38000 Gren

Spalanzani, Anne — Inria - Grenoble Alpes University

Keywords: Activity/behavior recognition, Electric vehicles and intelligent transportation., Scene analysis

Abstract: Autonomous Vehicles navigating in urban areas have a need to understand and predict future pedestrian

behavior for safer navigation. This high level of situational awareness requires observing pedestrian behavior and extrapolating their positions to know future positions. While some work has been done in this field using Hidden Markov Models (HMMs), one of the few observed drawbacks of the method is the need for informed priors for learning behavior. In this work, an extension to the Growing Hidden Markov Model (GHMM) method is proposed to solve some of these drawbacks. This is achieved by building on existing work using potential cost maps and the principle of Natural Vision. As a consequence, the proposed model is able to predict pedestrian positions more precisely over a longer horizon compared to the state of the art. The method is tested over "legal" and "illegal" behavior of pedestrians, having trained the model with sparse observations and partial trajectories. The method, with no training data, is compared against a trained state of the art model. It is observed that the proposed method is robust even in new, previously unseen areas.

16:15-16:30, Paper MoCT1.4 Add to My Program

A Feature-Aware Online Learning Approach for Support Vector Machine Classification

FANG, LIU — Agency for Science, Technology and Research (A*STAR)
LEE, KEE JIN — Singapore Institute of Manufacturing Technology (SIMTech), Agenc
Hong, Jihoon — SIMTech

Keywords: Data analytics., Internet of things, Learning and Statistical methods

Abstract: Online machine learning algorithm has attracted increasing attention especially in the era of Industry 4.0. The reason is that traditional batch learning algorithm cannot deal with the streaming data produced by sensorized machines and make real-time decisions. In this paper, we propose a Feature-aware online learning approach of Support Vector Machine (FSVM) for classification problem. Usually, online learning algorithm has limited access to streaming data due to resource and computation constraints. In FSVM, we introduced a feature vector selection method to reduce the size of training dataset without losing key information and maintain an acceptable classification accuracy. Here, such small set of selected feature vectors is able to represent the original dataset. What is more, we can detect feature drifting by checking whether or not a new input data can be represented by the current feature vectors. We evaluate the performance of FSVM based on several real-world datasets. The results show that even train the SVM model with 10% data, an acceptable misclassification rate can be reached.

MoCT2 Regular Session, Lotus 4E Add to My Program

Robotic Control (II)

Chair: Lin, Hsien-Chung — University of California, Berkeley
Co-Chair: Huang, Qingjiu — Kogakuin University

15:30-15:45, Paper MoCT2.1 Add to My Program

Efficient Trajectory Optimization for Robot Motion Planning

Zhao, Yu — UC Berkeley
Lin, Hsien-Chung — University of California, Berkeley
Tomizuka, Masayoshi — UC Berkeley/NSF

Keywords: Robot control, Nonlinear systems, Control applications

Abstract: Motion planning for multi-jointed robots is challenging. Due to the inherent complexity of the problem, most existing works decompose motion planning as easier subproblems. However, because of the inconsistent performance metrics, only sub-optimal solution can be found by decomposition based approaches. This paper presents an optimal control based approach to address the path planning and trajectory planning subproblems simultaneously. Unlike similar works which either ignore robot dynamics or require long computation time, an efficient numerical method for trajectory optimization is presented in this paper for motion planning involving complicated robot dynamics. The efficiency and effectiveness of the proposed approach is shown by numerical results. Experimental results are used to show the feasibility of the presented planning algorithm.

15:45-16:00, Paper MoCT2.2 Add to My Program

The Obstacle-Restriction Method for Tele-Operation of Unmanned Aerial Vehicles with Restricted Motion

Duberg, Daniel — Royal Institute of Technology (KTH)
Jensfelt, Patric — Royal Institute of Technology (KTH)

Keywords: Mobile robotics, Tele-robotics

Abstract: This paper presents a collision avoidance method for tele-operated unmanned aerial vehicles (UAVs). The method is designed to assist the operator at all times, such that the operator can focus solely on the main objectives

instead of avoiding obstacles. We restrict the altitude to be fixed in a three dimensional environment to simplify the control and operation of the UAV. The method contributes a number of desired properties not found in other collision avoidance systems for tele-operated UAVs. Our method i) can handle situations where there is no input from the user by actively stopping and proceeding to avoid obstacles, ii) allows the operator to slide between prioritizing staying away from objects and getting close to them in a safe way when so required, and iii) provides for intuitive control by not deviating too far from the control input of the operator. We demonstrate the effectiveness of the method in real world experiments with a physical hexacopter in different indoor scenarios. We also present simulation results where we compare controlling the UAV with and without our method activated.

16:00-16:15, Paper MoCT2.3 Add to My Program

Control of Position, Attitude, Force, Moment of 6 Degree of Freedom Manipulator by Impedance Control

Hanafusa, Takuya Kogakuin University
Huang, Qingjiu Kogakuin University

Keywords: Robot control, Robot sensing and data fusion, Hybrid systems

Abstract: The work of the industrial robot is divided into two types that are contact work and no contact work between robot and external environment. Furthermore, force control of a robot applied to contact work is mainly divided into two types: torque control based force control (direct force control) and position control based force control (indirect force control). Hybrid control of position and force as a representative example of direct force control, and impedance control as a representative example of indirect force control. Torque control based force control can not be applied to industrial robots because the torque control of each joint to the industrial robot is not disclosed to the user. In contrast, position control based force control can be applied to industrial robots. Up to now, these two kinds of force control are effective for point contact work between robot and object, but are not effective for surface contact work. Therefore, in our laboratory, we proposed hybrid control of position, attitude, force and moment which is direct force control. This is a control that extracts the control of attitude and moment from the conventional position and force hybrid control, and it was confirmed that it is effective for surface contacting work. However, since hybrid control of position, attitude, force and moment by this torque control base force control is a torque command, it lacked general versatility to a general robot receiving a position command. In this paper, considering versatility for industrial robots, we proposed control of position, attitude, force and moment by impedance control based on position control of robot hand. Furthermore, using the proposed method of this study, simulation was performed on MATLAB / Simulink to automatically match the face of the hand of the PUMA type six degree of freedom robot arm with the wall whose slope is unknown. Based on the results, we clarified the effectiveness of our proposed method.

16:15-16:30, Paper MoCT2.4 Add to My Program

Detection and Following of Moving Targets by an Indoor Mobile Robot Using Microsoft Kinect and 2D Lidar Data

Popov, Vasil Technical University of Sofia, Plovdiv Branch
Ahmed, Sevil Technical University of Sofia, Plovdiv Branch
Shakev, Nikola Georgiev Technical University Sofia, Campus in Plovdiv
Topalov, Andon Venelinov Technical University Sofia, Campus in Plovdiv

Keywords: Mobile robotics, Robot sensing and data fusion, Robot control

Abstract: The mobile robot following behavior is frequently considered as an important pre-requisite while developing autonomous service robots intended to co-exist with humans in a shared environment. It can also simplify the development of autonomous navigation and obstacle avoidance behavior as well as the robot ability to operate within multi-agent formations. In this investigation, an approach is proposed that allows a KUKA youBot omnidirectional mobile platform to detect and follow people carrying different objects, such as suitcases, in a shared indoor environment. Using a Kinect sensor, the mobile robot can recognize standing human with a suitcase and will begin to consider him as a potential dynamic target. The 2D lidar of the mobile platform can further detect when the above target starts to move and will begin to track it. Meanwhile, the robot will start following the human by controlling its own velocity while maintaining a pre-specified orientation and distance.

16:30-16:45, Paper MoCT2.5 Add to My Program

Learning to Run with Potential-Based Reward Shaping and Demonstrations from Video Data

Malysheva, Aleksandra JetBrains Research
Kudenko, Daniel JetBrains Research
Shpilman, Aleksei JetBrains Research

Keywords: Neural networks, Intelligent systems, Adaptive control

Abstract: Learning to produce efficient movement behaviour for humanoid robots from scratch is a hard problem, as has been illustrated by the ”Learning to run” competition at NIPS 2017. The goal of this competition was to train a two-legged

model of a humanoid body to run in a simulated race course with maximum speed. All submissions took a tabula rasa approach to reinforcement learning (RL) and were able to produce relatively fast, but not optimal running behaviour. In this paper, we demonstrate how data from videos of human running (e.g. taken from YouTube) can be used to shape the reward of the humanoid learning agent to speed up the learning and produce a better result. Specifically, we are using the positions of key body parts at regular time intervals to define a potential function for potential-based reward shaping (PBRS). Since PBRS does not change the optimal policy, this approach allows the RL agent to overcome sub-optimalities in the human movements that are shown in the videos. We present experiments in which we combine selected techniques from the top ten approaches from the NIPS competition with further optimizations to create an high-performing agent as a baseline. We then demonstrate how video-based reward shaping improves the performance further, resulting in an RL agent that runs twice as fast as the baseline in 12 hours of training. We furthermore show that our approach can overcome sub-optimal running behaviour in videos, with the learned policy significantly outperforming that of the running agent from the video.

MoCT3 Invited Session, Ballroom 4010AB

Add to My Program

Advances in Complex Autonomous Robot Systems

Chair: Li, Zhibin	University of Edinburgh
Co-Chair: Yau, Wei Yun	Institute for Infocomm Research
Organizer: Tsagarakis, Nikos	Italian Institute of Technology
Organizer: Li, Zhibin	University of Edinburgh
Organizer: Yau, Wei Yun	Institute for Infocomm Research

15:30-15:45, Paper MoCT3.1

Add to My Program

An Improved Frontier-Based Approach for Autonomous Exploration (I)

Gao, Wenchao	Institute for Infocomm Research
Booker, Matthew Robert Kilgour	University of California, Irvine
Adiwahono, Albertus Hendrawan	Institute for Infocomm Research
Yuan, Miaolong	Institute for Infocomm Research
Wang, Jiadong	Zhejiang University
Yau, Wei Yun	Institute for Infocomm Research

Keywords: Localization, navigation and mapping

Abstract: A new approach for autonomous exploration in an unknown scenario based on the concept of frontiers is proposed in this paper. Exploration frontiers introduced by [4], are the regions on the boundary between open space and unexplored space. A mobile robot is able to construct its map by adding new space and moving to unvisited frontiers until the entire environment has been explored. However, the original frontier strategy, suffering from local minima, only considers the distance and size of unknown spaces, resulting in low exploration efficiency in complex environments. By making use of the robot heading information using wheel odometry and coarse graph representation of the environment, the modified exploration method is able to balance the mapping coverage and time expenditure to a greater extent. The proposed method is experimentally verified on a mobile platform, exploring a real-world office environment cluttered with a variety of obstacles.

15:45-16:00, Paper MoCT3.2

Add to My Program

Bi-Manual Articulated Robot Teleoperation Using an External RGB-D Range Sensor (I)

Rolley-Parnell, Emily-Jane	University of Plymouth
Kanoulas, Dimitrios	Istituto Italiano Di Tecnologia
Laurenzi, Arturo	Istituto Italiano Di Tecnologia
Delhaisse, Brian	Istituto Italiano Di Tecnologia
Rozo, Leonel	Istituto Italiano Di Tecnologia
Caldwell, Darwin	Istituto Italiano Di Tecnologia
Tsagarakis, Nikos	Italian Institute of Technology

Keywords: Tele-robotics, Human centered systems, Perception systems

Abstract: In this paper, we present an implementation of a bi-manual teleoperation system, controlled by a human through three-dimensional (3D) skeleton extraction. The input data is given from a cheap RGB-D range sensor, such as the ASUS Xtion PRO. To achieve this, we have implemented a 3D version of the impressive OpenPose package, which was recently developed. The first stage of our method contains the execution of the OpenPose Convolutional Neural

Network (CNN), using a sequence of RGB images as input. The extracted human skeleton pose localisation in two-dimensions (2D) is followed by the mapping of the extracted joint location estimations into their 3D pose in the camera frame. The output of this process is then used as input to drive the end-pose of the robotic hands relative to the human hand movements, through a whole-body inverse kinematics process in the Cartesian space. Finally, we implement the method as a ROS wrapper package and we test it on the centaur-like CENTAURO robot. Our demonstrated task is of a box and lever manipulation in real-time, as a result of a human task demonstration.

16:00-16:15, Paper MoCT3.3 Add to My Program

An Innovative Robotics Stowing Strategy for Inventory Replenishment in Automated Storage and Retrieval System (I)

Chong, Zheng-Hao — Nanyang Technological University
Luxman, Ramamoorthy — Nanyang Technological University
Pang, Wee-Ching — Nanyang Technological University
Zhao, Yi — Nanyang Technological University
Ren, Meixuan — Nanyang Technological University
HENDRA, SURATNO TJU — NTU
Causo, Albert — Nanyang Technological University
Chen, I-Ming — Nanyang Technological University

Keywords: Mechanism design and applications., Mobile robotics, Dexterous manipulation

Abstract: Modern automated warehouses are equipped with one or many expensive and sophisticated equipment, such as palletizing robots, automated guided vehicles as well as an automated storage and retrieval system (AS/RS). These equipment are operated manually at many levels. These manual interruptions are accompanied by disadvantages of slow storage and retrieval speed, high operating costs and high frequency of errors in the operations. This paper presents an approach for efficient robotic stowing of items for inventory replenishment in a storage system. The objective is to enable a robotic arm system to stow items into a storage bin system and automatically generate a file to indicate which bin each object is stowed to. This would require a robust object recognition imbued with recognition history such that a previously recognized object is remembered as being stowed, even if it has been obscured by other objects subsequently during the task. A feature confidence aggregation strategy has been implemented to analyze a sequence of images containing a number of objects that are added to the storage system sequentially. The strategy is based on a weighted aggregation of ranked machine-learned classification scores and feature-matching recognition scores. This method is able to produce a high recognition rate and has been applied in the Amazon Robotic Challenge 2017 by Team Nanyang.

16:15-16:30, Paper MoCT3.4 Add to My Program

Recurrent Deterministic Policy Gradient Method for Bipedal Locomotion on Rough Terrain Challenge (I)

Song, Doo Re — J.P. Morgan Cazenove
Yang, Chuanyu — University of Edinburgh
McGreavy, Christopher — University of Edinburgh
Li, Zhibin — University of Edinburgh

Keywords: Intelligent systems, Neural networks, Robot control

Abstract: This paper presents a deep learning framework that is capable of solving partially observable locomotion tasks based on our novel interpretation of Recurrent Deterministic Policy Gradient (RDPG). We study on bias of sampled error measure and its variance induced by the partial observability of environment and subtrajectory sampling, respectively. Three major improvements are introduced in our RDPG based learning framework: tail-step bootstrap of temporal difference, initialisation of hidden state using past subtrajectory, truncation of temporal backpropagation, and injection of external experiences learned by other agents. The proposed learning framework was implemented to solve the Bipedal-Walker challenge in OpenAI's gym simulation environment where only partial state information is available. Our simulation study shows that the autonomous behaviors generated by the RDPG agent are highly adaptive to a variety of obstacles and enables the agent to effectively traverse rugged terrains for long distance with higher success rate than leading contenders.

16:30-16:45, Paper MoCT3.5 Add to My Program

Transparent Integration of Humanoid Robot System for Performing Various Tasks (I)

Kakiuchi, Yohei — The University of Tokyo
Okada, Kei — The University of Tokyo
Inaba, Masayuki — The University of Tokyo

Keywords: Robot control, Human centered systems, Mechanism design and applications.

Abstract: An integrated humanoid robot system, including from low-level hardware to high-level intelligence software and user interfaces, is required to build humanoid robot system meeting the expectation that robots work in the real environment such as disaster response. For creating such an integrated system, it is important that it has sustainable development potential, partially re-usability, and transparency to any type of robot. When creating a new robot, the conventional system is desired to use just by changing a robot hardware. In order to realize such a system, it is necessary to ensure that a software system is transparent to a robot hardware. On the other hand, sustainable development and partially reusability contribute robustness of the system and quickly building a complex system. In this paper, we describe the methodology to create an integrated humanoid robot system through actual humanoid robot system we have developed. Our system achieved to have sustainable development, partially re-usability, and transparency to any type of robot.

MoCT4 Regular Session, Ballroom 4011 Add to My Program

Electrical Vehicles and Intelligent Transportation

Chair: HADJ-ABDELKADER, Hicham University of Evry - Paris Saclay

Co-Chair: Tangade, Shrikant REVA Institute of Technology and Management

15:30-15:45, Paper MoCT4.1 Add to My Program

CBTM: Cryptography Based Trust Management Scheme for Secure Vehicular Communications

Tangade, Shrikant REVA Institute of Technology and Management

Manvi, Sunilkumar REVA University

Keywords: Electric vehicles and intelligent transportation.

Abstract: Vehicular Ad hoc Networks (VANETs) are used to improve traffic management and reduce the number of road accidents by providing safety applications. However, VANETs are susceptible to a number of security attacks from malicious entities. To secure the network against these attacks, most of the researchers have proposed various security schemes based on cryptography and trust management. While both cryptography and trust management are effective to some extent, each scheme has some flaw to fully secure the network. In this paper, we propose a cryptography based trust management scheme (CBTM) to secure VANET to a larger extent. The scheme employs Hashed Message Authentication Code (HMAC) and digital signature along with the Trust Value of the vehicle. The Road Side Unit (RSU) as a trusted entity performs evaluation of trust for each vehicle based on the trust value of neighboring vehicles and reward points for type of alert in the safety message. The results are gained with extensive simulations to validate the proposed scheme. The simulation results show that many security requirements are met by the proposed scheme and its performance is improved in comparison with existing scheme.

15:45-16:00, Paper MoCT4.2 Add to My Program

A Hybrid Methodology for Optimal Fleet Management in an Electric Vehicle Based Flexible Bus Service

Perera, Thilina Nanyang Technological University

Prakash, Alok Nanyang Technological University

Srikanthan, Thambipillai Nanyang Technological University

Keywords: Electric vehicles and intelligent transportation.

Abstract: The ever-increasing traffic congestion and green house gas emission caused by rapid urbanization, calls for smarter and energy efficient transit services. Conventional public transit lacks the ability to meet these diversified needs. As a result, intelligent transit systems, influenced by the digital revolution have created a profound impact by enhancing the user-experience of transit services. Consequently, demand responsive transit (DRT) services, which operate with flexible routes and schedules have become a common option among commuters. Thus, in this work we propose an electric vehicle (EV) based flexible bus service, a variant of DRT, that satisfies passenger demand in a given geographical zone. Next, we present a hybrid methodology to optimally manage the EV fleet minimizing the total vehicle miles travelled (VMT). Experimental results with a real map show that the proposed hybrid method achieves near-optimal results with 120x improvement in computation time. Further, the flexible bus service reduces VMT by over 70% in comparison to single occupancy vehicles, thus reducing both traffic congestion and green house gas emissions.

16:00-16:15, Paper MoCT4.3 Add to My Program

Multi-Period Pickup and Delivery Problem with Time Windows and Paired Demands

AL CHAMI, Zaher Univ. Bourgogne Franche-Comté FEMTO-ST Institute/CNRS

MANIER, Hervé Univ. Bourgogne Franche-Comté FEMTO-ST Institute/CNRS

MANIER, MARIE-ANGE University of Technology Belfort-Montbeliard, France

Keywords: Electric vehicles and intelligent transportation., Complex systems

Abstract: This paper addresses the Multi-Period Pickup and Delivery Problem with Time Windows and Paired Demands (Mu-PDPTWPD). A first strategy consists in dealing with the problem as a whole. A second one is to consider the studied problem as a sequence of mono-period selective PDPTWPDs. The Mu-PDPTWPD is an extension of well-known pick up and delivery problem where vehicles must satisfy a set of transportation requests under many constraints. The Multi- Period aspect is added to the problem to match real-world applications where sites must be visited one time during a set of periods. In this paper, we propose several methods to solve this problem. The efficiency of our approaches is validated by tests on two sets of new generated instances. A comparison between all proposed approaches is done in order to trace the advantages and drawbacks for each of them.

16:15-16:30, Paper MoCT4.4 Add to My Program

An Intelligent Torque Vectoring Performance Evaluation Comparison for Electric Vehicles

Parra, Alberto — Tecnalia Research & Innovation
Zubizarreta, Asier — University of the Basque Country
Pérez Rastelli, Joshué — Tecnalia Research & Innovation

Keywords: Electric vehicles and intelligent transportation., Fuzzy systems, Intelligent systems

Abstract: Nowadays, intelligent transportation systems (ITS) have become one of the main research areas, being electric vehicles (EVs) and automated vehicles key topics. To guarantee safety and comfort and maximize their efficiency, proper vehicle dynamics control systems such as Torque Vectoring (TV) are mandatory. This work proposes an intelligent TV approach for EVs which considers the vertical force distribution among the tractive wheels. This approach allows to maximize vehicle cornering capacity and also its efficiency. In order to demonstrate its effectiveness, its performance is compared using Dynacar High Fidelity vehicle simulator with three traditional approaches found in the literature: PID, Second Order Sliding Mode Control (SOSMC) and Fuzzy Control. Results show that all evaluated controllers improve the handling of the vehicle and the efficiency with respect to the baseline vehicle. However, the proposed intelligent TV system provides better overall results.

16:30-16:45, Paper MoCT4.5 Add to My Program

Inverse Perspective Mapping Roll Angle Estimation for Motorcycles

Damon, Pierre-Marie — University of Evry Val D'Essonne
HADJ-ABDELKADER, Hicham — University of Evry - Paris Saclay
Arioui, Hichem — IBISC Laboratory, University D'Evry
Youcef-Toumi, Kamal — Massachusetts Inst. of Tech

Keywords: Electric vehicles and intelligent transportation., Identification and estimation, Image/video analysis

Abstract: This paper presents an image-based approach to estimate the motorcycle roll angle. The algorithm estimates directly the absolute roll to the road plane by means of a basic monocular camera. This means that the estimated roll angle is not affected by the road bank which is often a problem for vehicle observation and control purposes. For each captured image, the algorithm uses a numeric roll loop based on some simple knowledge of the road geometry. For each iteration, a bird-eye-view of the road is generated with the inverse perspective mapping technique. Then, a road marker filter associated with the well-known clothoid model are used respectively to track the road separation lanes and approximate them with mathematical functions. Finally, the algorithm computes two distinct areas between the two-road separation lanes. Its performances are tested by means of the motorcycle simulator BikeSim. This approach is very promising since it does not require any vehicle or tire model and is free of restrictive assumptions on the dynamics.

16:45-17:00, Paper MoCT4.6 Add to My Program

Powered Two-Wheeled Vehicles Steering Behavior Study: Vision-Based Approach

Damon, Pierre-Marie — University of Evry Val D'Essonne
HADJ-ABDELKADER, Hicham — University of Evry - Paris Saclay
Arioui, Hichem — IBISC Laboratory, University D'Evry
Youcef-Toumi, Kamal — Massachusetts Inst. of Tech

Keywords: Electric vehicles and intelligent transportation., Perception systems, Image/video analysis

Abstract: This paper presents a vision-based approach to prevent dangerous steering situations when riding a motorcycle in turn. In other words, the proposed algorithm is capable of detecting under, neutral or over-steering behavior using only a conventional camera and an inertial measurement unit. The inverse perspective mapping technique is used to reconstruct a bird-eye-view of the road image. Then, filters are applied to keep only the road markers which are, afterwards, approximated with the well-known clothoid model. That allows to predict the road geometry such that the curvature ahead of the motorcycle. Finally, from the predicted road curvature, the measures of the Euler angles and the vehicle speed, the proposed algorithm is able to characterize the steering behavior. To that end,

we propose to estimate the steering ratio and we introduce new pertinent indicators such that the vehicle relative position dynamics to the road. The method is validated on the advanced simulator BikeSim during a steady turn.

MoCT5 Invited Session, Ballroom 4111 Add to My Program

Advanced Vehicle Control Techniques for Enhanced Robustness and Safety

Chair: Wang, Wei — Beihang University

Co-Chair: He, Renjie — Nanyang Technological University

Organizer: Wang, Wei — Beihang University

15:30-15:45, Paper MoCT5.1 Add to My Program

Adaptive Asymptotically Tracking Control for Uncertain Strict-Feedback Nonlinear Systems with Input Quantization (I)

Long, Jiang — Beihang University

Wang, Wei — Beihang University

Zhou, Jing — University of Agder

Keywords: Adaptive control, Networked control systems, Nonlinear systems

Abstract: In this paper, we investigate the output tracking control problem for a class of uncertain nonlinear systems in parametric strict feedback form with quantized input. A novel backstepping based adaptive quantized control scheme is proposed. Different from the existing results, the true quantization parameters are allowed to be unknown in the design of adaptive controller. It is shown that with the proposed control scheme, the system output can track the desired trajectory asymptotically and all the closed-loop signals are globally uniformly bounded.

15:45-16:00, Paper MoCT5.2 Add to My Program

Weighted Pseudo-Inverse Based Control Allocation of Heterogeneous Redundant Operating Mechanisms for DPC Aircraft (I)

Wang, Zhihui — Beihang University

Zhang, Jing — Beihang University

Yang, Lingyu — Beihang Unviersity

Guo, Xiaoming — Beihang University

Keywords: Control applications

Abstract: Distributed propulsion configuration (DPC) usually have heterogeneous redundant operating mechanisms including redundant control surfaces and thrust vector actuators, thus producing strong and complex control coupling between flight and propulsion systems. Then control allocation of heterogeneous redundant actuators is certainly required to realize integrated control. First, the formulation of this specific control allocation problem is given, and then the Moore-Penrose pseudo-inverse method and weighted pseudo-inverse method are introduced to improve control accuracy and coordinate the complex relationship between different types of actuators. Simulation results reveal that the weighted pseudo-inverse method has higher accuracy in allocation result, and it is suitable for the specific control allocation problem for DPC aircraft.

16:00-16:15, Paper MoCT5.3 Add to My Program

Reciprocal Collision Avoidance for Nonholonomic Mobile Robots (I)

Wang, Lei — Nanyang Technological University

Li, Zhengguo — Institute for Infocomm Research, A*STAR

Wen, Changyun — Nanyang Tech. Univ

He, Renjie — Nanyang Technological University

Guo, Fanghong — ASTAR

Keywords: Mobile robotics, Nonlinear systems

Abstract: In this paper, reciprocal collision avoidance is studied for nonholonomic mobile robots to achieve an efficient navigation. Two strategies are proposed to respectively adjust the linear and angular velocities so that a collision-free navigation can be achieved. By characterizing the collision-free navigation as a set of changing ratios for linear velocities, it is shown that collision can be avoided if the changing ratio of linear velocities is inside this set. Moreover, the strategy of the adjusting angular velocities is established following TTC-based method. With the combination of

these two strategies, a simulation is done for four robots crossing the intersection, which shows the effectiveness of the proposed method.

16:15-16:30, Paper MoCT5.4 Add to My Program

Fractional Order Flight Control of Quadrotor UAS: An OS4 Benchmark Environment and a Case Study (I)

Shang, Bo — Northeastern University, Shenyang
Zhang, Yunzhou — Northeastern University
Wu, Chengdong — Northeastern University
Chen, YangQuan — University of California, Merced

Keywords: Robust control, Control applications, Precision motion control

Abstract: The OS4 quadrotor is a classic quadrotor simulation platform. So far, many different kinds of controllers have been designed based on its plant model. Most of the research only provided a numerical simulation to verify their designed controllers. Only a few researches have put the proposed controllers back to OS4 quadrotor to verify, but they didn't share the project folder to let others continue their work. More open-source and well-documented codes are needed to accelerate the application of fractional order controllers in industry. This paper updated the OS4 folder for the latest MATLAB version. A case of study demonstrated the workflow to design a fractional order proportional derivative controller for the simulated drone. Comparisons showed that fractional order controllers perform better in a nonlinear system like OS4 than integer order PID controllers. An impulse disturbance scenario is also used as a testbed. Project folder can be accessed from: https://ww2.mathworks.cn/matlabcentral/fileexchange/67882-o s4-foc. Related videos can be found from this link: https://youtu.be/heuz4tFqf64.

16:30-16:45, Paper MoCT5.5 Add to My Program

Synthesis of Point Memory-Based Adaptive Gain Robust Controllers with Guaranteed L2 Gain Performance for a Class of Uncertain Time-Delay Systems

OYA, Hidetoshi — Tokyo City University
Nagai, Shunya — The University of Tokushima
Matsuki, Tsuyoshi — Niihama National College of Technology
Hoshi, Yoshikatsu — Tokyo City University

Keywords: Robust control

Abstract: This paper proposes a point memory-based adaptive gain robust controller with L2 gain performance for a class of uncertain linear systems with state delays. The point memory adaptive gain robust controller presented in this paper consists of a fixed gain controller and a adaptive gain one. In this paper, we show that LMI-based sufficient conditions for the existence of the proposed adaptive gain robust controller are presented. Finally, a simple illustrative example is included to show the effectiveness of the proposed robust control system.

16:45-17:00, Paper MoCT5.6 Add to My Program

Design of a Data-Driven Two-Degree-Of-Freedom Control System Considering Robustness

Sakaki, Ayumu — Hiroshima University
Kinoshita, Takuya — Hiroshima University
Yamamoto, Toru — Hiroshima University

Keywords: Robust control

Abstract: Virtual Reference Feedback Tuning (VRFT) and Fictitious Reference Iterative Tuning (FRIT) are the data-driven tuning schemes for directly designing feedback controllers. These schemes have been extended to the two-degree-of-freedom (2DOF) control systems in recent years. The conventional design schemes of 2DOF controllers need a complicated two-stage tuning scheme. This paper provides a one-stage tuning scheme for a 2DOF control system using the fictitious exogenous signal based on a data-driven method. In the proposed scheme, 2DOF controllers are designed with one criterion, and the least squares method can be applied to find the optimal set of 2DOF controller parameters. According to the proposed scheme, the reference models are determined based on the stability margin that is quantified by the sensitivity function. It is also possible to design a control system considering robustness. Finally, the effectiveness of the proposed scheme is numerically verified by using a simulation example.

MoCT6 Regular Session, Ballroom 4211 Add to My Program

Feature Extraction and Image Analysis (II)

Chair: Liu, Yanhong — Zhengzhou University

Co-Chair: Xie, Shoulie — Institute for Infocomm Research

15:30-15:45, Paper MoCT6.1 — Add to My Program

SceneEDNet: A Deep Learning Approach for Scene Flow Estimation

Thakur, Ravi Kumar — Indian Institute of Information Technology SriCity
Mukherjee, Snehasis — IIIT SriCity

Keywords: Stereo and Structure from motion, Vision for robots, Image/video analysis

Abstract: Estimating scene flow in RGB-D videos is attracting much interest of the computer vision researchers, due to its potential applications in robotics. The state-of-the-art techniques for scene flow estimation, typically rely on the knowledge of scene structure of the frame and the correspondence between frames. However, with the increasing amount of RGB-D data captured from sophisticated sensors like Microsoft kinect, and the recent advances in the area of sophisticated deep learning techniques, introduction of an efficient deep learning technique for scene flow estimation, is becoming important. This paper introduces a first effort to apply a deep learning method for scene flow estimation by presenting a fully convolutional neural network with an encoder-decoder (ED) architecture. The proposed network SceneECNet involves estimation of three dimensional motion vectors of all the scene points from sequence of stereo images. The training for direct estimation of scene flow is done using consecutive pairs of stereo images and corresponding scene flow ground truth. The proposed architecture is applied on a huge dataset and providing meaningful results.

15:45-16:00, Paper MoCT6.2 — Add to My Program

Improving Semantic Segmentation in Urban Scenes with a Cartographic Information

Ioukkal, abdelhak — Renault S.A.S / Sorbonnes Universités Université De Technologie
Fremont, Vincent — Ecole Centrale De Nantes, CNRS, LS2N, UMR 6004
Grandvalet, Yves — CNRS/UTC
LI, You — RENAULT S.A.S

Keywords: Feature extraction, grouping and segmentation, Neural networks, Perception systems

Abstract: This paper presents three different approaches to inject a location information in semantic segmentation Convolutional Neural Networks (CNN) applied to urban scenes. The assumption that a location information would improve semantic segmentation performance emerges from the idea that some elements of urban scenes are located in a predictable manner. This assumption is confronted to realistic data on the CARLA autonomous driving simulator, which is used to create our own synthetic dataset with images, depth maps and bird-eye-view cartographic images. Simulators circumvent the difficulties due to the scarcity of publicly available synchronous labeled images and location information. We encode the location information as a cartographic image to process it as a camera image. We assess the relevance of injecting the cartographic information in three different manners: as a Conditional Random Field potential, as an additional task and as an additional encoder input of a CNN. The three methods are evaluated and compared with a state of the art CNN with regards to the pixel-wise accuracy, mean intersection over union and intersection over union of some important classes. The best approach developed in this paper improves the intersection over union of the pedestrians, vehicles and traffic signs classes by respectively 4%, 1.6% and 9 %.

16:00-16:15, Paper MoCT6.3 — Add to My Program

Recognition of Multi-Scale Multi-Angle Gestures Based on HOG-LBP Feature

Zhou, Shuai — Zhengzhou Univeisity
Liu, Yanhong — Zhengzhou University
Li, Keqiang — Zhengzhou University

Keywords: Feature extraction, grouping and segmentation, Object recognition, Face and Gesture.

Abstract: Gesture rotation and zooming have significant impact on the gesture recognition system and can greatly reduce the recognition rate. In this paper, we propose a novel recognition method for the multi-scale multi-angle gestures in skin-like noise backgrounds based on HOG-LBP feature extraction. The proposed gesture recognition system consists of pretreatment, feature extraction and classification. First, the single Gaussian model (SGM) and K-means algorithm was used to extract gesture images from a skin-like noise background region. Then, a HOG-LBP feature descriptor is proposed to represent multi-scale multi-angle gesture information. The HOG component provides the gesture edge gradient information and the LBP component provides the texture feature information, which can compensate for the lack of rotation invariance of a single feature and improve the recognition rate of gestures at multiple scales and multiple angles. Finally, the SVM classifier is utilized to realize the gesture classification. Experiment results on the home-made data sets show that the proposed method can achieve 99.01% recognition rate. Experiments on the NUS database and the MUGD database also demonstrate the performance of the proposed method.

16:15-16:30, Paper MoCT6.4 — Add to My Program

QL-Net: Quantized-By-LookUp CNN

Abdiyeva, Kamila — Nanyang Technological University
Yap, Kim Hui — Nanyang Technological University
Wang, Gang — Alibaba
Ahuja, Narendra — Advanced Digital Sciences Center (ADSC), Illinois at Singapore P
Lukac, Martin — Nazarbayev University

Keywords: Learning and Statistical methods, Feature extraction, grouping and segmentation, Image/video analysis

Abstract: Convolutional Neural Networks (CNNs) have achieved a state-of-the-art performance in the different computer vision tasks. However, CNN algorithms are computationally and power intensive, which makes them difficult to run on wearable and embedded systems. One way to address this constraint is to reduce the number of computational operations performed. Recently, several approaches addressed the problem of the computational complexity in the CNNs. Most of these methods, however, require a dedicated hardware. We propose a new method for the computation reduction in CNNs that substitutes Multiply and Accumulate (MAC) operations with a codebook lookup and can be executed on the generic hardware. The proposed method called QL-Net combines several concepts: (i) a codebook construction, (ii) a layer-wise retraining strategy, and (iii) a substitution of the MAC operations with the lookup of the convolution responses at inference time. The proposed QL-Net achieves a 98.6% accuracy on the MNIST dataset with a 5.8x reduction in runtime, when compared to MAC-based CNN model that achieved a 99.2% accuracy.

16:30-16:45, Paper MoCT6.5 Add to My Program

A Wavelet Frame Energy-Based Segmentation Method for Biomedical Images

Xie, Shoulie — Institute for Infocomm Research
huang, Weimin — Institute for Infocomm Research
lu, Zhongkang — Institute for Infocomm Research
huang, Su — Institute for Infocomm Research

Keywords: Medical Image Analysis, Feature extraction, grouping and segmentation

Abstract: This paper presents a new medical image segmentation method by using wavelet frame energy distribution, which is the sum of squares of the wavelet frame coefficients at each pixel. This work shows that the wavelet frame energy distribution contains the fine texture information extracted from images with low intensity contrast and complex structures using wavelet frame transform. Thus it is employed to enhance the segmentation quality under some challenge conditions such as low intensity contrast, weak/ambiguous boundaries, intensity inhomogeneity and heavy noise. Furthermore, this paper adopts convex relaxation approach to solve the corresponding optimization problem instead of classical level-set method, so the leading numerical computation is efficient and robust to initialization values. Experimental results also illustrate the efficiency of the proposed segmentation method for biomedical images under these extreme imaging conditions.

16:45-17:00, Paper MoCT6.6 Add to My Program

Multi-Population Differential Evolution for Retinal Blood Vessel Segmentation

Mistry, Kamlesh — Northumbria University
Issac, Biju — Northumbria University
Jacob, Seibu Mary — Teesside University
Jasekar, Jyoti — Northumbria Healthcare NHS Stokesley
Zhang, Li — Northumbria University

Keywords: Feature extraction, grouping and segmentation, Medical Image Analysis, Intelligent systems

Abstract: The retinal blood vessel segmentation plays a significant role in the automatic or computer-assisted diagnosis of retinopathy. Manual blood vessel segmentation is very time-consuming and requires a great amount of domain knowledge. In addition, the blood vessels are only a few pixels wide and cover the entire fundus image. This further hinders the recent systems from automating the retinal blood vessel segmentation efficiently. In this paper, we propose a modified differential evolution (DE) algorithm to carry out automatic retinal blood vessel segmentation. The modified DE employs cross-communication among multiple populations to select three types of features i.e. thick blood vessels, thin blood vessels and non-blood vessels. Multiple classifiers such as neural networks (NN), Support vector machines (SVM), NN based and SVM based ensembles are used to further measure the performance of segmentation. The proposed algorithm is evaluated on three publicly available retinal image datasets like DRIVE, STARE and HRF. It outperformed the state-of-the-art with a high average accuracy of 98.5% along with high sensitivity and specificity.

MoCT7 Regular Session, Ballroom 4212 Add to My Program

Intelligent Systems (II)

Chair: Nguyen, Minh Sang — Singapore Institut of Manufacturing Technology

Co-Chair: Shan, Jiayuan — Beijing Institute of Technology

15:30-15:45, Paper MoCT7.1 — Add to My Program

A Learning Method Based on Bisimulation in the Inconsistent Knowledge Systems

Nguyen Thi Hong, Khanh — University of Engineering and Technology, VNU

Keywords: Intelligent systems

Abstract: Inconsistencies may naturally occur in the considered application domains in Artificial Intelligence, for example as a result of data mining works in distributed sources. In order to solve inconsistent knowledge, several paraconsistent description logics have been proposed. In this paper, we face the problem of concept learning for an inconsistent knowledge base system based on bisimulation. This algorithm allows learning a concept from a training information system in a paraconsistent descriptive logic system with a set of positive items, negative items, and inconsistent items. Here, we present a system for learning concept in an inconsistent knowledge base and discuss preliminary experimental results obtained in the electronic application domain.

15:45-16:00, Paper MoCT7.2 — Add to My Program

Stable Gait Optimization for Small-Sized Humanoid Robot Using CFO

Anh, Ho Pham Huy — Ho Chi Minh City University of Technology, VNU-HCM

Tran Thien, Huan — Ho Chi Minh City University of Technology and Education (HCM-UTE

Khuu Bach, Thy — Faculty of Electrical and Electronics Engineering (FEEE), Ho Chi

Nguyen Ho Hieu, Trung — Faculty of Electrical and Electronics Engineering (FEEE), Ho Chi

Keywords: Intelligent systems, Modeling and identification, Robot control

Abstract: This paper proposes a new way to optimize the gait design for human robots that allows stable stepping with preset foot-lifting magnitude. The novel Central Force Optimization (CFO) algorithm is used to optimize the gait parameters to help humanoid robot walk steadily. The efficiency of the proposed method is compared with the GA-Genetic Algorithm, PSO-Particle Swarm Optimization and improved differential evolution algorithm (MDE-Modified Differential Evolution). The simulated and experimental results applied on the small-sized humanoid robot show that the newly proposed algorithm offers an efficient and stable gait for humanoid robots with accurate foot-lifting magnitude.

16:00-16:15, Paper MoCT7.3 — Add to My Program

Intelligent and Adaptive System Based on a Non-Monotonic Logic for an Autonomous Motor-Glider

VILCHIS MEDINA, José Luis — Aix-Marseille Univ, Université De Toulon, CNRS, LIS

Siegel, Pierre — LIS

Doncescu, Andrei — Laboratory of Architecture and Analysis of Systems CNRS

Keywords: Intelligent systems, Space and underwater robots, Electric vehicles and intelligent transportation.

Abstract: This article we present an intelligent and adaptive system for an autonomous motor-glider based on non-monotonic logic. Piloting is an activity with many constraints. It could have conflicting situations and an uncertain environment. When a pilot faces such kind of situations, he enters into reasoning under uncertainty. Because maybe there are rules with incomplete and contradictory informations, e.g. legislation rules, tower control orders, security rules... Despite the fact that decisions have to be taken at all times regarding different objectives. Default logic is used to find fixed points from ambiguous and conflicting informations. The model proposed here embeds a knowledge of the world based on a set of situations, objectives and actions. After computation of plausible solutions, decision-making is expressed thanks to a non-probabilistic model. On the other hand, we also study the property of resilience which allows to absorb and modify to overcome disturbances. The core of this property is based on the interaction of the possible solutions and the connectivity of its states. Including the resilience in our model allows to carry out the convergence of one or several goals. Eventually, we present some preliminary results of the implementation.

16:15-16:30, Paper MoCT7.4 — Add to My Program

Quadrotors' Low-Cost Vision-Based Autonomous Landing Architecture on a Moving Platform

Jiang, Jiaqi — Beijing Institute of Technology

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Keywords: Intelligent systems, Visual servoing, Robot control

Abstract: In this paper, a low-cost vision-based autonomous landing architecture for an unmanned aerial vehicle (UAV) on a moving platform is presented. First, a novel landing pad was designed for a monocular camera to robustly detect the pad in both high and low altitudes. In order to solve mirror effect and occasional misidentification, a 3D points cluster algorithm for relative position estimation is presented. Second, the dynamics of the quadrotor is simplified for this lading task and a PD controller is designed based on the estimated relative position. Finally, the low-cost system architecture of the quadrotor and the experiment results are both presented to show the effectiveness of the proposed method.

16:30-16:45, Paper MoCT7.5 Add to My Program

Dispatching of Multiple Autonomous Intelligent Vehicles Considering Stochastic Travel Times by Genetic Algorithm

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Hong, Jihoon SIMTech
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Keywords: Discrete event systems, Event-triggered and self-triggered control, Planning, scheduling and coordination

Abstract: An assumption on deterministic travel times of the vehicles might not be realistic for the dispatching problem of multiple Autonomous Intelligent Vehicles (AIVs). Thus, this paper presents a more accurate approach to solve this problem by considering stochastic travel times of the vehicles. The problem is modeled as a stochastic combinatorial optimization (SCO) problem that aims to minimize the total travel time and balance the utilization time of AIVs. Genetic Algorithm (GA) is then used to provide near-optimal solutions for the SCO. The obtained near-optimal results are then compared with the ones using conventional ruled-based approaches. The results showed that the GA solver could outperform the conventional ruled-based approaches in both deterministic and stochastic testing scenarios.

16:45-17:00, Paper MoCT7.6 Add to My Program

Gait Analysis Using RGBD Sensors

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Rodrigo, Ranga University of Moratuwa

Keywords: Biomedical instrumentation and applications

Abstract: Human gait analysis, the study of human locomotion, is possible with low-cost RGBD sensors such as the Kinect sensor. However, due to the inherent depth sensing accuracy limitations of these sensors as the distance from the sensor increases, the distance range of gait analysis too becomes small and inefficient for clinical use. We present a system that uses two independent Kinects in a data fusion framework that increases the distance range of gait analysis from 2.5 m to 4 m with three gait cycles. Our gait parameters are reasonably accurate and comparable with existing systems with 4 % error in length measurements and 5-degree error in flexion measurements. The system is extensible to have several Kinects.