Thursday, October 16

08:30 - 09:00

Registration

09:00 - 09:15

Opening & Welcome Word

Viorel Serban, UPT Rector

09:15 - 10:00

Guest Speaker - Dr. Nicolae Joni

10:00 - 10:45

Guest Speaker - Dr. Valentin Mureşan

10:45 - 11:00

Coffee Break

11:00 - 12:15

Robot Control

11:00 ***Method for Estimating Combined Controller, Joint and Link Stiffnesses of an Industrial Robot***

Ilya Tyapin (University of Agder, Norway), Geir Hovland (University of Agder, Norway) and Torgny Brogårdh (ABB Robotics, Sweden)

In this paper a new combined local/global approach for estimating the combined stiffnesses of joints in anthropomorphic robots is presented. The stiffness of each joint is a combination of several effects: i) stiffness of the links, ii) stiffness of joint bearings and gears and iii) stiffness of the position control loops given by the individual axis controller gains in the controller software. Experimental results are presented for an ABB IRB6600 industrial robot using measurements from a FARO Xi laser tracker and an ATI Omega160 force/torque sensor. The results show that there is a significant variation in stiffness among the individual joints of the robot and that the stiffnesses of the main axes (1-3) are significantly higher than the stiffnesses of the wrist axes (4-6). The measured forces and estimated stiffness are used in SimulationX modeling software to validate the proposed method, where the model includes both the kinematics and joint stiffness. The results presented in this paper are valid in the home position of the robot, but the method can be modified and used for any robot position. The method requires much less experimental data compared to a global approach.

11:25 ***Development and Control of a Bowden-Cable Actuated Exoskeleton for Upper-Limb Rehabilitation***

Qingcong Wu (Southeast University, P.R. China), Xingsong Wang (Southeast University, P.R. China), Fengpo Du (Southeast University, P.R. China) and Jigang Xu (Southeast University, P.R. China)

This paper deals with the development and control of an upper limb exoskeleton used for the robotic rehabilitation of stroke patients. Bowden-cable actuators with a high power-weight ratio are applied in the robot system to provide remote power transmission and simplify the mechanical design. The kinematics model of the exoskeleton is analyzed and optimized to eliminate singularities from the desired workplace and achieve natural human-robot interaction. A real-time control system is established in xPC target environment and used to process the feedback signals from the force sensor

and potentiometers and execute the control algorithm. An impedance control scheme is developed to provide interactive therapy training to the patients with different disability levels. Preliminary experiments have been carried out in two different training modes to evaluate the performance of the proposed exoskeleton and control approach.

11:50 ***Fuzzy Sliding Mode Control of a Riderless Bicycle with a Gyroscopic Balancer***

Ming-Hung Hsieh (National Taiwan University, Taiwan), Yen-Ting Chen (National Taiwan University, Taiwan), Cheng Hung Chi (University of National Taiwan, Taiwan) and Jui Jen Chou (National Taiwan University, Taiwan)

In this paper, we developed a riderless bicycle with a gyroscopic balancer controlled by fuzzy sliding mode control (FSMC). The riderless bicycle with the gyroscopic balancer and FSMC controller has the advantages of fast system response and relatively high robustness to disturbances. Even if hit by a bottle, filled with two liters of water, suspended 50 cm away from a pivot like a pendulum, and swung 90 degrees from its equilibrium position, the bicycle is still highly stabilized. The gyroscopic balancer is the balancer with the least mass ratio of balancer to bicycle among various bicycle balancers, and it can effectively produce a moment to prevent the bicycle from falling down. Moreover, the bicycle with the gyroscopic balancer controlled by FSMC can outperform the one with PID under highly uncertain environment. The FSMC intuitively comprehended by human operators is suitable for bicycle manipulation. It can significantly reduce the design complexity of a controller for the riderless bicycle. The design idea of FSMC is creating a sliding surface served as a balancing index which incorporates three factors, the lean angle of the bicycle, the rate of lean angle of the bicycle, and the rotation angle of the gyroscopic balancer. The bicycle dynamics model with the gyroscopic balancer is proposed to simulate and validate the design concept on the balancing performance of the bicycle with FSMC. Finally, experiments are designed to demonstrate that the riderless bicycle system remains upright and stationary under impact disturbances even when the bicycle doesn't move forward. Furthermore, since the results of experiments are consistent with the ones of the simulation, it validates the derived bicycle dynamics model with the gyroscopic balancer and proves its robustness.

12:15 - 13:30

Lunch

13:30 - 15:35

Path Planning & Robot Navigation

13:30 ***A time-optimal isotropic Cartesian Trajectory Generator with limited Acceleration Magnitude***

Mirko Kunze (KIT & IAR, Germany)

In this paper we present an algorithm to compute the time-optimal trajectory from one point in multi-dimensional Cartesian space to another with arbitrary start and target velocity vectors and with limited acceleration norm. Based on Pontryagin's minimum principle, we devise the conditions that have to be fulfilled and formulate a cost function for the time-optimal solution. The resulting boundary value problem is an optimization problem, which is exemplarily solved using the Nelder-Mead method. Exemplary curves are compared against cubic polynomials and trajectories generated by the Reflexxes Motion Libraries.

13:55 ***Knowledge-based Direction Prediction to Optimize the Null-space Parameter of a Redundant Robot in a Telemanipulation Scenario***

Jessica Hutzl (KIT Karlsruhe, Germany), David Oertel (Karlsruhe Institute of Technology, Germany) and Heinz Wörn (Karlsruhe Institute of Technology (KIT), Germany)

This paper shows an approach of a knowledge-based path-guidance for minimally invasive robotic surgery. For an accurate path-guidance it is important to know or estimate the direction of the tool tip's motion. Therefor it is necessary to predict the future direction. In this work, the predicted direction is based on clustering applied to typical trajectory sets, combined with building first and second order Markov models which represent cluster transitions. A coarse prediction is obtained by cluster transitions. For improvement, this is refined by projecting the cluster points distribution on a (unit) sphere surrounding the current tool tip position. For the latter step, a discrete procedure is proposed that takes into account the most likely consecutive cluster(s). The resulting predicted direction can be used to guide the robot's movement, especially by controlling the joint angles of a redundant robot in order to avoid joint limits. The main focus of this work is on the actual prediction of direction which is evaluated using a synthetic test scenario.

14:20 ***Human Arm Motion Imitation by a Humanoid Robot***

Sylvain Filiatrault (Université du Québec en Outaouais, Canada) and Ana-Maria Cretu (Université du Québec en Outaouais, Canada)

The objective of this work is the development of a system capable to control the arm movement of a robot by mimicking the gestures of an actor captured by a markerless vision sensor. The Kinect for Xbox is used to recuperate angle information at the level of the actor's arm and an interaction module transforms it into a usable format for real-time robot arm control. To avoid self-collisions, the distance between the two arms is computed in real-time and the motion is not executed if this distance becomes smaller the twice the diameter of the member. The interfacing issues are discussed and a software architecture is proposed and implemented for this purpose. The feasibility of our approach is demonstrated on a NAO robot.

14:45 ***Safer Hybrid Workspace Using Human-Robot Interaction While Sharing Production Activities***

Ramy Meziane (University of Quebec at Chicoutimi, Canada), Ping Li (University of Quebec at Chicoutimi, Canada), Martin Otis (University of Quebec at Chicoutimi, Canada), Hassan Ezzaidi (Universite of Quebec at Chicoutimi, Canada) and Philippe Cardou (Laboratoire de Robotique, Departement de Genie Mecanique, Universite Laval, Canada)

In a near future, human and industrial manipulator will work together sharing a common workspace and production activities leading to a potential increase of accident. The research project concerns the adaptation of industrial robot already installed in a flexible manufacturing system in order to make it more interactive with human. The aim concerns the reduction of potential risk of injuries while working with an industrial robot. This paper presents a new inexpensive, non-intrusive, non-invasive, and non-vision-based system, for human detection and collision avoidance. One method investigated for improving safety concerns planning of safe path. This system recognizes human activities and locates operator's position in real time through an instrumented safety helmet. This safety helmet includes an IMU (Inertial Measurement Unit) and an indoor localization system such as RSSI (Received Signal Strength Indication) using industrial wireless equipment. A hybrid workspace including a flexible manufacturing system has been designed in order to practice experiments in an industrial-like environment.

15:10 ***Remote-sensing based adaptive path planning for an aquatic platform to monitor water quality***

Fadi Halal (UQO, Canada), Pablo Pedrocca (Université du Québec en Outaouais, Canada), Thomas Hirose (Noetix Research Ltd, Canada), Ana-Maria Cretu (Université du Québec en Outaouais, Canada) and Marek Zaremba (UQO, Canada)

This paper addresses issues inherent to the design of navigation planning and control systems required for adaptive monitoring of pollutants in inland waters. It proposes a new system for estimating water quality, in particular the chlorophyll-A concentration, by using satellite remote sensing data. The aim is to develop an intelligent model based on supervised learning, with the goal of improving the precision of the evaluation of chlorophyll-A concentration. To achieve this, we use an intelligent system based on statistical learning to classify the waters a priori, before estimating the chlorophyll-A concentration with neural network models. We therefore develop several models for the same surface of water, based on the spectral signature of the samples acquired in-situ. A control architecture is proposed to guide the trajectory of an aquatic platform to collect in-situ measurements. It uses a multi-model classification/regression system to determine and forecast the spatial distribution of chlorophyll-A. At the same time, the proposed architecture features a cost optimizing path planner. Experimental results are presented to validate our approach using data collected on Lake Winnipeg in Canada.

15:35 - 15:50

Coffee Break

15:50 - 17:30

Intelligent Sensing

15:50 ***Joint Localization and Fingerprinting of Sound Sources for Auditory Scene Analysis***

Alex Doboli (SUNY Stony Brook, USA), Anurag Umbarkar (State University of New York at Stony Brook, USA) and Scott B Kaghazgaran (State University of New York at Stony Brook, USA)

In the field of scene understanding, researchers have mainly focused on using video/images to extract different elements in a scene. The computational as well as monetary cost associated with such implementations is high. This paper proposes a low-cost system which uses sound-based techniques in order to jointly perform localization as well as fingerprinting of the sound sources. A network of embedded nodes is used to sense the sound inputs. Phase-based sound localization and Support- Vector Machine classification are used to locate and classify elements of the scene, respectively. The fusion of all this data presents a complete "picture" of the scene. The proposed concepts are applied to a vehicular-traffic case study. Experiments show that the system has a fingerprinting accuracy of up to 97.5%, localization error less than 4 degrees and scene prediction accuracy of 100%.

16:15 ***A Smart Safety Helmet using IMU and EEG sensors for worker fatigue detection***

Ping Li (University of Quebec at Chicoutimi, Canada), Ramy Meziane (University of Quebec at Chicoutimi, Canada), Martin Otis (University of Quebec at Chicoutimi, Canada), Hassan Ezzaidi (Universite of Quebec at Chicoutimi, Canada) and Philippe Cardou (Laboratoire de Robotique, Departement de Genie Mecanique, Universite Laval, Canada)

It is known that head gesture and brain activity can reflect some human behaviors related to a risk of accident when using machine-tools. The research presented in this paper aims at reducing the risk of injury and thus increase worker safety. Instead of using camera, this paper presents a Smart Safety Helmet (SSH) in order to track the head gestures and the brain activity of the worker to recognize anomalous behavior. Information extracted from SSH is used for computing risk of an accident (a safety level) for preventing and reducing injuries or accidents. The SSH system is an inexpensive, non-

intrusive, non-invasive, and non-vision-based system, which consists of an Inertial Measurement Unit (IMU) and dry EEG electrodes. A haptic device, such as vibrotactile motor, is integrated to the helmet in order to alert the operator when computed risk level (fatigue, high stress or error) reaches a threshold. Once the risk level of accident breaks the threshold, a signal will be sent wirelessly to stop the relevant machine tool or process.

16:40 ***Risk Evaluation of Ground Surface Using Multichannel Foot Sensors for Biped Robots***

Futoshi Asano (Kogakuin University, Japan), Hideki Asoh (National Institute of Advanced Industrial Science and Technology, Japan), Mitsuharu Morisawa (AIST, Japan), Shuuji Kajita (AIST, Japan) and Kazuhito Yokoi (AIST, Japan)

In this paper, a method to calculate a risk index for the walking of biped robots in uneven terrain using the information of foot sensors is proposed. First, a feature for detecting unexpected large disturbances is extracted from the foot sensor observations using the 4th order moment. Next, the extracted multichannel features are mapped into a single risk index using the logistic regression model. In the experiment, the proposed index showed a high value indicating risk before the robot fell and when an equivalent large force was observed.

17:05 ***Instrumented Compliant Wrist for Dexterous Robotic Interaction***

Pascal Laferriere (University of Ottawa, Canada), Pierre Payeur (University of Ottawa, Canada) and Rafael Toledo (University of Ottawa, Canada)

The design, assembly and implementation of a custom fabricated instrumented wrist aimed at supporting dexterous robotic interaction with live proximity and contact feedback is presented in this paper. Although comparable platforms have been conceived in the past, efforts have been made to reduce the complexity of the overall system with a focus on weight and cost reduction and the addition of a proximity detection feature. Design considerations are explored and compared to similar existing compliant wrists. An experimental characterization of the prototype is reported in the context of an integrated vision-guided robotic system. An evaluation of other possible applications, namely for mobile robotics, is also presented.

17:30 - 20:30

ROSE 2014 Dinner

Friday, October 17

08:30 - 09:00

Registration

09:00 - 10:40

Robot Vision & Distributed Sensing

09:00 ***Robotic Intelligent Vision and Control for Tunnel Inspection and Evaluation - The ROBINSPECT EC Project***

Konstantinos Loupos (Institute of Communication and Computer Systems, Greece), Angelos Amditis (Institute of Communication and Computer SYstems, Greece), Christos Stentoumis (National Technical University of Athens (NTUA) & Institute of Communications and Computer Systems (ICCS), Greece), Philippe Chrobocinski (Cassidian FR, France), Juan Victores (Universidad Carlos III De Madrid, Spain), Max Wietek (VSH Hagerbach Test Gallery Ltd, Switzerland), Panagiotis Panetsos (EGNATIA Odos AE, Greece), Alberto Roncaglia (Institute of Microelectronics and Microsystems, Italy), Stephanos Camarinopoulos (RISA Sicherheitsanalysen GmbH & ERRA, Greece), Vassilis Kallidromitis (Tecnic spa, Italy), Dimitris Bairaktaris (D. Bairaktaris & Associates Ltd, Greece), Nikos Komodakis (Ecole Nationale Des Ponts Et Chaussees, France) and Rafa Lopez (Robotnik Automation Sll, Spain)

This publication will present ROBINSPECT as an EC research project (FP7 - ICT - 611145) driven by the tunnel inspection industry, that adapts and integrates recent research results in intelligent control in robotics, computer vision and active continuous learning and sensing, in an innovative, integrated, robotic system that automatically scans the intrados of tunnels for potential defects on the surface while at the same time inspects and measures radial deformation in the cross-section, distance between parallel cracks, cracks and open joints that impact tunnel stability, with mm accuracies. This

integrated solution allows a one pass, inspection and structural assessment of tunnels.

09:25 ***Integration of vision/force robot control for transporting different shaped/colored objects from moving circular conveyor***

Michael Jokesch (Chemnitz University of Technology, Germany), Mohamad Bdiwi (Fraunhofer Institute for Machine Tools and Forming Technology IWU, Germany) and Jozef Suchý (Chemnitz University of Technology, Germany)

This paper will propose algorithms for transporting different objects from moving circular conveyor with the help of vision/force robot control. Poses and speeds of the objects are calculated from sequential images captured by 3D-camera mounted on the hand of the robot. In the conveyor there are 4 slots which contain four differently formed and coloured objects. The cross sections of these objects are the square, the rectangle, the triangle and the circle. The required object will be segmented and then recognized with the help of fast image processing algorithm depending on its colour and shape. Furthermore, this paper will improve algorithm for grasping and pulling-out the required object from slot with tight clearance. For this task two different kinds of simple force control have been developed. The objects will be grasped by a 6-DoF robot with a primitive two-finger-gripper as end-effector. In the first experiment the proposed system will follow the required object until the movement of the conveyor stops. After that it will start to pull-out the object. In more complicated case, the robot will pull-out the object while the conveyor is moving. In other words, the movement of the robot will be synchronized with the movement of the object and it should grasp it at a convenient time and pose without any prior knowledge about its velocity. This paper will be supported with real experiments presenting promising results which illustrate the capability of grasping a stuck moving object with the help of vision/force robot control.

09:50 ***Low-Level Communication Time Analysis in Real-Time Wireless Sensor Networks***

Valentin Stangaciu (Politehnica University of Timisoara, Romania), Mihai V. Micea (Politehnica University of Timisoara, Romania) and Vladimir Cretu (POLITEHNICA University of Timisoara, Romania)

Studying the time components and delays introduced by the lower level communication protocols in realtime wireless sensor networks, as well as taking them into consideration at the design phase of such protocols, still remains an open issue in the field. This paper addresses this problem through a detailed analysis of the communication times and their implications in providing a predictable low-level support for realtime sensor networks. A measurement framework is proposed specifically on this purpose and then used in an extensive set of experiments to validate this timing analysis.

10:15 ***GINGER: a minimizing-effects reprogramming paradigm for distributed sensor networks***

Anna Antola (Politecnico di Milano, Italy), Lorenzo Mezzalira (Politecnico di Milano, Italy) and Manuel Roveri (Politecnico di Milano, Italy)

Reprogramming the applicative behaviour of distributed sensor networks is becoming a more and more important ability in real-working monitoring applications to include new functionalities or modify the existing ones. Several approaches for reprogramming have been presented in the literature suggesting efficient reprogramming mechanisms. The aim of this paper is to address a problem that received less attention in the scientific community: minimizing the reprogramming effects on the applications running at the networks nodes. This issue is of paramount importance in complex distributed monitoring systems, where the network's behaviour is characterized by several (possibly concurrent) applications running at nodes. This paper suggests a novel reprogramming paradigm, called GINGER, designed to minimize the reprogramming effects on the nodes of distributed sensor networks. Critical aspects, advantages and open points are deeply described and critically commented.

10:40 - 11:00

Coffee Break

11:00 - 11:50

Mobile Robots

11:00 ***Mobile Manipulator Is Coming To Aerospace Manufacturing Industry***

Kai Zhou (Profactor GmbH, Austria), Gerhard Ebenhofer (PROFACTOR GmbH, Austria), José Saenz (Fraunhofer IFF, Germany) and Christoph Walter (Fraunhofer IFF, Germany)

Industrial robots, which are designed to carry out operations fast, repeatedly and accurately, usually have been fixed to one physical location and manipulate passing objects on the assembly line. However, for several industrial applications, particularly for the applications involving large part manufacturing such as aerospace industry or shipbuilding industry, large parts are worked on in a stationary production cell. In such a production environment, specialized, stationary robotic systems are not economical and a mobile manipulator is desirable. In this paper, we present the systematic architecture designed for a mobile manipulator working together with human co-workers in an unstructured environment. We detail hardware specification of robot as well as structures of various software sub-architectures under consideration of safety, efficiency and load balance issues for industrial robotics, in particular for the aerospace manufacturing industry. A configurable graphical user interface has also been presented to test and validate our system design. Two commonly existing exemplary tasks in aerospace manufacturing industry - sealant applying and visual inspection, have been

discussed within this systematic architecture.

11:25 ***Technical Evaluation of the Carolo-Cup 2014 - A Competition for Self-Driving Miniature Cars***

Sebastian Zug (Otto-von-Guericke-Universität Magdeburg, Germany), Christoph Steup (Otto-von-Guericke-Universität Magdeburg, Germany), Julian Scholle (Otto-von-Guericke-Universität Magdeburg, Germany), Christian Berger (University of Gothenburg, Germany), Olaf Landsiedel (Chalmers University of Technology, Sweden), Fabian Schuldt (Technische Universität Braunschweig, Germany), Jens Rieken (Technische Universität Braunschweig, Germany), Richard Matthaei (Technische Universität Braunschweig & Institute of Control Engineering, Germany) and Thomas Form (Technische Universität Braunschweig, Germany)

The Carolo-Cup competition conducted for the eighth time this year, is an international student competition focusing on autonomous driving scenarios implemented on 1:10 scale car models. Three practical sub-competitions have to be realized in this context and represent a complex, interdisciplinary challenge. Hence, students have to cope with all core topics like mechanical development, electronic design, and programming as addressed usually by robotic applications. In this paper we introduce the competition challenges in detail and evaluate the results of all 13 participating teams from the 2014 competition. For this purpose, we analyze technical as well as non-technical configurations of each student group and derive best practices, lessons' learnt, and criteria as a precondition for a successful participation. Due to the comprehensive orientation of the Carolo-Cup, this knowledge can be applied on comparable projects and related competitions as well.

11:50 - 13:10

Lunch

13:10 - 14:50

Robot Programming & Optimization

13:10 ***Experimental Study on the Influence of Controller Firmware on Multirotor Actuator Dynamics***

Øyvind Magnussen (University of Agder, Norway), Geir Hovland (University of Agder, Norway), Morten Ottestad (University of Agder, Norway) and Simon Kirby (Hostway Canada, Inc, Canada)

In this paper the dynamic response of a propeller actuator commonly used in hobby unmanned aerial vehicles is studied experimentally. It is shown that the choice of electronic speed controller firmware has a significant effect on the overall actuator dynamics. Six different scenarios are tested: 1+2) Rising/falling step response with the standard firmware of the Hobbyking F30a, 3+4) Rising/falling step response with firmware from Simon Kirby/GitHub and 5+6) Rising/falling step response with firmware from Simon Kirby/GitHub including complementary Pulse-Width-Modulation (PWM) switching. Experimental results show a significant difference in actuator dynamics depending on the chosen firmware. By using firmware with complementary PWM switching, the rising and falling step responses are very similar. Such model symmetry is an advantage for control systems development, both in terms of robustness and performance.

13:35 ***Robotized Tasks Time Scheduling and Optimization Based on Genetic Algorithms for non redundant Industrial Manipulators***

Khelifa Baizid (University of Cassino and Southern Lazio, Italy), Amal Meddahi (University of Cassino and Southern Lazio, Italy), Ali Yousnadj (Polytechnics Military School, Algeria), Ryad Chellali (Italian Institute of Technology, Italy), Hamza Khan (Istituto Italiano di Tecnologia, Italy) and Jamshed Iqbal (COMSATS Institute of Information Technology, Pakistan)

Industrial robot manipulators must work as fast as possible in order to increase the productivity. This goal could be achieved by increasing robots speed or/and optimizing the trajectories followed by robots while performing assembly, welding or similar tasks. In our contribution, we focus on the second aspect and we target the shortening of paths between task-points. In other words, the goal is to find the shorter traveled distance between different configurations in the coordinate space. In addition to the short distance goal, we aim as well to impose both IKM (Inverse Kinematic Model) and the relative position and orientation of the manipulator regarding the task-points. To this end, we propose an optimization method based on Genetics Algorithms. The proposed approach is validated via numerical and graphical simulation, where, results show that the total cycle time required to perform a spot-welding task of an industrial car-body by a 6-DOFs (Degree Of Freedoms) industrial manipulator was drastically reduced.

14:00 ***Energy Profiling of FPGA Designs***

Cosmin Cernazanu (Politehnica University of Timisoara, Romania), Stefan Fedeac

(Politehnica University of Timisoara, Romania), Alexandru Amaricai-Boncalo (Politehnica University of Timisoara, Romania) and Marius Marcu (Politehnica University of Timisoara & Lasting Software Timisoara, Romania)

This paper investigates the possibility of energy profiling for FPGA based designs by means of direct board based measurement. We aim to determine how different design parameters and FPGA components usage affect the overall power and energy consumption of the device. The power and energy measurements have been performed on a Digilent Atlys board with Xilinx Spartan-6 device. We have varied the following parameters: the usage of slice-based resources, the usage of DSP block, the usage of BRAM memory modules and the clock frequency. Our goal is represented by the development of an accurate energy profiling methodology which will enable to estimate the power consumption of FPGA designs.

14:25 ***Hard Real-Time Execution Environment Extension for FreeRTOS***

Cristina Stangaciu (Politehnica University of Timisoara, Romania), Mihai V. Micea (Politehnica University of Timisoara, Romania) and Vladimir Cretu (POLITEHNICA University of Timisoara, Romania)

In this paper, a hard real-time execution environment extension is proposed for an open source real-time operating system, FreeRTOS, in order to support a special case of hard real-time tasks, called ModXs. The goal is to obtain a real-time system which has both the capabilities offered by a dynamic, preemptive, priority based scheduling and execution environment and the determinism and predictability of a hard real time execution environment. This paper also presents an implementation of the system which was tested and validated on a hardware platform EFM32-G8900-STK.

14:50 - 15:10

Best Paper Awards & Closing Remarks