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RACIR 2020

4th Robotix-Academy Conference on Industrial Robotics
July, 16th ZeMA, Germany

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Program

9h45 **10h**	**Welcome**	
10h **10h30**	*Soft finger modelling using a nonsmooth contact approach*	Olivier Devigne, Alejandro Cosimo and Olivier Brüls
10h30 **11h**	*INNOCISE: From Geckos to Robotics*	Dr.-Ing. Marc Schöneich
11h **11h30**	*Modified Feedback Linearization for Underactuated Cable Robot Control: Case studies*	Atal Anil Kumar, Jean-François Antoine, Vianney Papot, Patrick Zattarin and Prof. Dr. Gabriel Abba
11h30 **12h**	*A synchronized-HRC pick and place application using an intelligent vision system*	Prof. Dr.-Ing. Rainer Müller, Nishant Ketan Gajjar, Ahmad El Masri and Khansa Rekik
12h **12h30**	*Hybrid Workstations: A Simultaneous Planning Method for Economic-oriented Selection between Industrial and Collaborative Robots*	Christopher Schneider, Thomas Suchanek, Martina Hutter-Mironovova, Francisco Hernandez, Mohamad Bdiwi and Matthias Putz
12h30 **13h30**	**Lunch Break**	
13h30 **14h**	*Practically Oriented Investigation of Sensitive Robots Regarding the Execution of Force Controlled Applications*	Prof. Dr.-Ing. Rainer Müller, Ali Kanso and Marco Schneider
14h **14h30**	*External communication of the robot ABB YuMi via virtual machine with analysis of hybrid position-force control*	Wang Yiguo, Meryem Taghbalout, Jean-François Antoine and Prof. Dr. Gabriel Abba
14h30 **15h**	*Mobile Robot Lifting Mechanism Design for Manipulation and transportation task*	Bassem Hichri and Prof. Dr. Peter Plapper
15h **15h15**	**Coffee break**	
15h15 **15h45**	*Mobile Robots Target Reaching and Virtual Structure Navigation Based on Limit-Cycle Method*	Bassem Hichri and Prof. Dr. Peter Plapper
15h45 **16h15**	*Unconventional path planning for a serial kinematics robot with Reinforcement Learning using the example of the wire loop game*	Prof. Dr.-Ing. Rainer Müller, Ali Kanso and Stefan Marx
16h30	**End of the conference**	

Abstracts

Soft finger modeling using a nonsmooth contact approach

Olivier Devigne, Alejandro Cosimo and Olivier Brüls

In the frame of accurate grasping and safer humanrobot interactions, soft robots are an emerging and promising technology. Due to the fact that they do not rely on joints to produce a motion, but on deformation, they have a theoretically infinite number of degrees of freedom. This particularity calls for advanced numerical models to analyze them. Although some modeling tools have already been developed by other research teams, many open questions remain and should be addressed to accurately represent this kind of robots. Our work relies on the development of a research code for analyzing flexible multibody systems. This code is based on a Lie group formalism which is coupled with powerful nonsmooth algorithms for solving contact interactions. This numerical formulation opens the possibility to later consider more advanced models for describing the flexibility characterizing these problems, such as, for example, geometrically exact beam and shell elements. In this paper, a frictionless soft finger model able to interact with a sphere is introduced as a first prototype intended to test and present our code capabilities.

Keywords – soft robot, soft gripper, geometrically exact, nonsmooth, contact

Modified Feedback Linearization for Underactuated Cable Robot Control: Case studies

Atal Anil Kumar, Jean-François Antoine, Vianney Papot, Patrick Zattarin and Gabriel Abba

This paper presents the results of the simulations done to validate and analyze the performance of the modified feedback linearization control for an underactuated four Cable Driven Parallel Robot (CDPR). Different conditions are defined with varying payload, velocity and trajectory and the response of the system using the proposed control is presented. It is shown that the solution stabilizes the system behavior and performs efficiently under varying conditions.

Keywords – modified feedback linearization, underactuated, cable robot

A synchronized-HRC pick and place application using an intelligent vision system

Prof. Dr.-Ing. Rainer Müller, Nishant Ketan Gajjar, Ahmad El Masri and Khansa Rekik

In recent times, automation has been one of the most important aspects of industrial applications. Collaboration between the humans and robots has been a key factor for the development of industries of the future where mutually, humans and machines, can work and carry out important tasks together. The focus of this work is to create a method for Human Robot Collaboration (HRC) application, with the goal of setting up robots with certain safety measures in such a way that it actively supports a human completing it. The paper starts with an introduction to synchronized human-robot collaboration and the safety aspect of the system. It is then elaborated by an extensive study on image processing and application of computer vision used here in order to accomplish a given set of tasks.

Keywords – Synchronized-HRC, Safety, Pick and Place, Computer vision

Hybrid Workstations: A Simultaneous Planning Method for Economic-oriented Selection between Industrial and Collaborative Robots

Christopher Schneider, Thomas Suchanek, Martina Hutter-Mironovova, Francisco Hernandez, Mohamad Bdiwi and Matthias Putz

Current Human-Robot Interaction (HRI) planning methods focus firmly on the technical side while neglecting the economic complexity. Simple financial calculations are insufficient to counterbalance the occurring uncertainties. Furthermore, comparisons to fenceless industrial robots are ignored, which leads to incomprehensive solution space. Therefore, we present a planning tool to determine the economic-optimal fenceless robot-based system under consideration of all relevant factors.

Keywords – Collaborative Robots, Hybrid Workstations, Human-Robot-Collaboration, System Design, Cell Planning

Practically Oriented Investigation of Sensitive Robots Regarding the Execution of Force Controlled Applications

Prof. Dr.-Ing. Rainer Müller, Ali Kanso and Marco Schneider

The use of sensitive robots is of great importance, especially since the introduction of human-robot and robot-object interactions. In addition to ensuring safe cooperation between human and machine, sensitive robot systems also offer the possibility of identifying their environment with the aid of their intrinsic sensors. This sensor technology, in the form of force and torque sensors, and the closely related control strategy, differs partial between different robot manufacturers. Furthermore there are numerous external sensors that enable a conventional robot to interact with its environment. This paper deals with a practical oriented comparison between the KUKA LBR iiwa and the Universal Robots UR 10e regarding their ability to perform sensitive or force controlled applications.

Keywords – Sensitive Robotic, KUKA LBR iiwa, Universal Robots UR 10e, Force-torque-sensor, Force Accuracy

External communication of the robot ABB YuMi via virtual machine with analysis of hybrid position-force control

Wang Yiguo, Meryem Taghbalout, Jean-François Antoine and Gabriel Abba

In order to achieve real-time control and convenient debugging of the robot, it is necessary to establish a stable, smooth and convenient communication and connection between the robot and the server (ROS/Robotstudio). In this paper, we establish this king of communication through the virtual machine, where we can achieve ROS and Robotstudio running in the windows system at the same time. Besides, the latter part of the article introduces the process and result prediction of the hybrid position-force control.

Keywords – ABB YuMi, virtual machine, communication, virtual sensor, hybrid position-force control

Mobile Robot Lifting Mechanism Design for Manipulation and transportation task

Bassem Hichri and Peter Plapper

This article considers a design methodology for creating cooperative robots capable to manipulate and transport payloads. The strategy is based on tightening a payload between a set of similar mobile robots called m-bots. A lifting mechanism with two degrees of freedom mounted on each mobile robot allows then to lift the payload and put it on each m-bot top platform to be transported. Structural and dimensional analysis are detailed in order to develop the proposed mechanism based on the stability analysis of the payload on the top platforms of mobile robots. 3D multi-body dynamic software simulation results are presented to validate the proposed strategy.

Keywords – Cooperative mobile robots, Design of Lifting mechanisms, Object manipulation and transportation.

Mobile Robots Target Reaching and Virtual Structure Navigation Based on Limit-Cycle Method

Bassem Hichri and Peter Plapper

This paper addresses Target Reaching problem of mobile robots and obstacle avoidance based on Limit-Cycle Method. The Limit-Cycle method is also used for hidden Targets reaching around the payload. The chosen methodology to achieve optimal positioning and define the robot's targets around the payload to lift it and to transport it while maintaining a geometric multi-robot formation is presented. This appropriate configuration of the set of robots is obtained by combining constraints ensuring stable and safe lifting and transport of the payload. A suitable control law is then used to track a virtual structure in which each elementary robot has to keep its desired position with respect to the payload. Several simulation results validate our proposal.

Keywords – Cooperative mobile robots, Control architecture, Payload co-manipulation and co-transportation, Robots positioning, Navigation information, Virtual structure approach.

Unconventional path planning for a serial kinematics robot with Reinforcement Learning using the example of the wire loop game

Prof. Dr.-Ing. Rainer Müller, Ali Kanso and Stefan Marx

Modern customer-specific production systems in small and medium-sized enterprises are facing the challenges to have a high flexibility and adaptability and simultaneously be economically efficient. An automated, adaptive motion planning for industrial robot via reinforcement learning and simulation is necessary to fill this gap without expert persons. In this paper we represent motion planning method based on reinforcement learning which adapts to variations in the robot's environment, and therefore efficient when implementing new similar tasks. The Method is evaluated in use case wire loop game. The use case aims to move the industrial robot along metal wire without any contacts between the wire and the loop.

Keywords – Industrial robot, Motion planning, Reinforcement Learning, Q-learning, Wire loop game

Practical information

The conference takes place online via Webex

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