COVER PAGE

2020 The 6th International Conference on

Mechatronics and Robotics Engineering

(ICMRE 2020)

2020 The 8th International Conference on

System Modeling and Optimization

(ICSMO 2020)

Barcelona, Spain | February 12-15, 2020

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WELCOME

Dear distinguished delegates,

We are pleased to welcome you to the 2020 6th International Conference on Mechatronics and Robotics Engineering (ICMRE 2020) and the 2020 8th International Conference on System Modeling and Optimization (ICSMO 2020) which are held in Barcelona, Spain during February 12-15, 2020.

The objective of the conference is to bring together interested academics and industry experts in the field of Mechatronics and Robotics Engineering and System Modeling and Optimization to a common forum. The evaluation of all the papers was performed based on the reports from anonymous reviewers, who are qualified in their field. As a result of their hard work, we are pleased to have accepted 60 presentations coming from universities, research institutes, and industries. The presentations are divided 6 parallel sessions with topics including Mobile Robots and Path Planning, Intelligent Robot Design and Development, Control Theory and Control System, Mechanical and Electrical Engineering, System Modeling Method and Algorithm Optimization, Signal Analysis and Data Processing.

We'd like to express our sincere gratitude to everyone who has contributed to this conference as its success could have only been achieved through a team effort. A word of special welcome is given to our keynote and invited speakers who are pleased to make contributions to our conference and share their new research ideas with us. They are Prof. Ian Walker from Clemson University, USA, Prof. Norbert Krüger from University of Southern Denmark, Denmark and Prof. David E. Breen from Drexel University, USA. Additionally, our special thanks go to all committee members for their excellent work in reviewing the papers and their other academic support efforts.

Barcelona is one of Spain's well-known tourist destinations, and is known as the “Pearl of the Iberian Peninsula”. Not only does it have the architecture of Gaudí and the paintings of Picasso, but also the bustling Las Ramblas and the Boqueria market. The home ground of the Spanish League giants FC Barcelona is here at Camp Nou, and is also destination for fans to come party. With its sunny beaches and festive bars and a perfect combination of art and life, perhaps it is its down-to-earth yet unique character that gives a hundred people a hundred different reasons to fall in love with Barcelona. Hope you enjoy your time here!

We believe that by this excellent conference, you can get more opportunity for further communication with researchers and practitioners with the common interest in this field. We are dedicated to higher and better international conference experiences. We will sincerely listen to any suggestion and comment. Wish you will enjoy this conference, contribute effectively toward it and take back with your knowledge, experiences, contacts and happy memories of these days.

We look forward to meeting you again next time!

Yours sincerely,

Conference Chair

Prof. Ian Walker, IEEE Fellow, Clemson University, USA

Program Committee Chair

Prof. Norbert Krüger, University of Southern Denmark, Denmark

AGENDA OVERVIEW

February 12, 2020 (Wednesday)		
10:00-17:00	Registration & Conference Kits Collection	Lobby
February 13, 2020 (Thursday)		
09:30-09:40	Opening Remarks Prof. Ian Walker, Clemson University, USA	Marbella & St. Sebastia
09:40-10:20	Keynote Speech I - Prof. Ian Walker	Marbella & St. Sebastia
10:20-10:50	 Group Photo & Coffee Break 	
10:50-11:20	Invited Speech I - Prof. Norbert Krüger	Marbella & St.Sebastia
11:20-11:50	Invited Speech II - Prof. David E. Breen	Marbella & St. Sebastia
12:00-13:30	Lunch	Foyer
13:30-16:00	Session 1 – Intelligent Robot Design and Development	Marbella
13:30-16:00	Session 2 – Mechanical and Electrical Engineering	St. Sebastia
16:00-16:15	 Coffee Break	
16:15-18:45	Session 3 – System Modeling Method and Algorithm Optimization	Marbella
16:15-18:45	Session 4 – Signal Analysis and Data Processing	St. Sebastia
18:45-20:00	Dinner	Restaurant
February 14, 2020 (Friday)		
09:30-12:00	Session 5 – Mobile Robots and Path Planning	Marbella
09:30-12:00	Session 6 – Control Theory and Control System	St. Sebastia
12:00-13:30	Lunch	Restaurant
February 15, 2020 (Saturday)		
08:30-17:00	Social Program	Plaza Catalunya

VENUE

Conference Venue

SB ICARIA BARCELONA

Add: Av. Icaria, 195 · 08005 Barcelona, Spain

(In Google Map, 95VX+FQ)

ⓘ Getting Here

Josep Tarradellas Barcelona-El Prat Airport, (30 min drive about 18.1 km)
Barcelona Sants Railway Station, (22 min drive about 6.9 km)

Metro+ **Walking**---- around 1 hr 10 min

Josep Tarradellas Barcelona-El Prat Airport, Terminal C

Take the **A2 line**
(Non-stop,20min)
↓
Transfer at **Pl. Espanya - FGC**
↓
Take the **H16 line**
(Ride 17 stops,36min)
↓
Get off at **Av Icària - Av Bogatell**
↓
Walk about 2 min, 100 m

GUIDELINE

Oral Presentation Guideline

- Get your presentation PPT files prepared. Please copy your slide files to the conference laptop before the session start. The size of PPT is 16:9.
- Regular oral presentation: 15 minutes (including Q&A).
- Laptop, projector & screen, laser sticks will be provided by the conference organizer.
- Certificate of Presentation will be awarded by the session chair at the end of each session.
- One Best Presentation will be selected from each parallel session and the author of best presentation will be awarded at the end of each session.

DETAILED AGENDA

[February 12, 2020 (Wednesday)]

10:00-17:00

Registration & Materials Collection

SB ICARIA BARCELONA (Lobby)

Give your **Paper ID** to the staff.

↓

Sign your name in the attendance list and check the paper information.

↓

Check your **conference kit**, which includes conference bag, name tag, lunch & dinner coupon, conference program, the receipt of the payment, the USB of paper collection.

Tips for Participants

- ✧ Your punctual arrival and active involvement in each session will be highly appreciated.
- ✧ The listeners are welcome to register at any working time during the conference. Certificate of Listener can be collected at the registration counter.
- ✧ Please kindly keep your Paper ID in mind so that the staff can quickly locate your registration information onsite.
- ✧ Wearing your name tag when you enter the meeting room. Name tag is not allowed to borrow to irrelevant persons.
- ✧ Do not bring irrelevant persons into the meeting room.
- ✧ Please keep all your belongings at any time, the organizer is not responsible for the loss of participants.

DETAILED AGENDA

[February 13, 2020 (Thursday)] Morning
Opening & Keynote/Invited Speeches
Marbella & St. Sebastia

09:30-09:40	**Opening Remarks**	**Prof. Ian Walker** Clemson University, USA
09:40-10:20	**Keynote Speech I**	
10:20-10:50	**Group Photo & Coffee Break**	
10:50-11:20	**Invited Speech I**	**Prof. Norbert Krüger** University of Southern Denmark, Denmark
11:20-11:50	**Invited Speech II**	**Prof. David E. Breen** Drexel University, USA
Lunch @ Foyer **<12:00-13:30>**		

DETAILED AGENDA

[February 13, 2020 (Thursday)] Afternoon

Authors' Parallel Presentations

Marbella	
13:30~16:00	**Session 1 – Intelligent Robot Design and Development** **Chaired by** **Prof. Sylvie Pesty** **Univ. Grenoble Alpes, France**
	10 Presentations CE1-0005, CE1-0023, CE1-0041, CE1-0036, CE1-0022 CE1-0025-A, CE1-0024, CE1-0070, CE1-0057, CE1-0001
16:00~16:15	**Coffee Break**
16:15~18:45	**Session 3 – System Modeling Method and Algorithm Optimization** **Chaired by** **Prof. Temur Chilachava** **Sokhumi State University, Georgia**
	10 Presentations CE2-1005, CE2-0014, CE2-0015, CE2-0018, CE1-0015 CE2-0008, CE2-0007, CE2-0013-A, CE1-0055, CE2-0023-A
St. Sebastia	
13:30~16:00	**Session 2 – Mechanical and Electrical Engineering** **Chaired by** **Prof. Thomas Schlechter** **University of Applied Sciences Upper Austria, Austria**
	10 Presentations CE1-0043, CE1-1001, CE1-0004-A, CE1-0003, CE2-0011 CE1-0066, CE1-0039, CE1-0061, CE2-0020, CE1-0072
16:00~16:15	**Coffee Break**
16:15~18:45	**Session 4 – Signal Analysis and Data Processing** **Chaired by** **Assoc. Prof. Mario Farrugia** **Univ. of Malta, Malta**
	10 Presentations CE1-0035, CE2-0004, CE2-0006, CE1-0040, CE1-0044 CE1-0010, CE1-0037-A, CE1-0045, CE2-1001, CE1-0073
<18:45-20:00> Dinner @ Restaurant	

DETAILED AGENDA

[February 14, 2020 (Friday)] Morning

Authors' Parallel Presentations

Marbella	
09:30-12:00	**Session 5 – Mobile Robots and Path Planning** **Chaired by** **Assoc. Prof. Teeranoot Chanthasopeephan** **King Mongkut's University of Technology Thonburi, Thailand**
	10 Presentations CE1-0050, CE1-0038, CE1-0033, CE1-0006, CE1-0063 CE1-0029, CE1-0009, CE1-0067, CE1-0062, CE1-0030
St. Sebastia	
09:30-12:00	**Session 6 – Control Theory and Control System** **Chaired by** **Prof. Dong-Hee Lee, Kyungsung University, South Korea** **Co-chaired by** **Dr. Hisham Elsherif, German University in Cairo, Egypt**
	10 Presentations CE1-0028, CE1-0018, CE1-0060, CE1-1004, CE1-0027 CE1-0069, CE1-0068, CE1-0042, CE1-0048, CE1-0065
Lunch @ Restaurant **<12:00-13:30>**	

DETAILED AGENDA

[February 15, 2020 (Saturday)]

Social Program

Duration Time: 08:30AM-05:00PM

❇**Assembly Time**: 08:30 AM

❇**Assembly Point:** Plaza Catalunya (Add: Plaça de Catalunya, 21, 08002 Barcelona, Spain)

❇**Return Location:** Plaza Catalunya (Add: Plaça de Catalunya, 21, 08002 Barcelona, Spain)

Overview	
Plaza Catalunya → Lloret de Mar → Tossa de Mar → Vila Vella → Plaza Catalunya	
	**Lloret de Mar** is the main touristic village of Costa Brava. Walking through its narrow streets, which still have reminiscence of its recent maritime past, we will find plenty of shops to suit all tastes: from the latest brands to the typical beach bazaars. In the middle of its most famous shopping street we will also be able to admire architectural jewels of great value such as Saint Roma church, with an exquisite modernism style, and inside the church, a 16th century altarpiece which is still so well preserved.
	**Tossa de Mar**. Beautiful ancient castle, magnificent sea level line, bicycles in the old town, leisurely and self-satisfied. During the sailing trip we will be able to enjoy the unique and characteristic landscape of Costa Brava: a procession of different huge cliffs which have been shaped in fanciful forms over the centuries by the strength of sea and wind.
	**Vila Vella** is considered “the pearl of Costa Brava” because in this small area we can find all those landscape and historic elements which have given it such well-deserved fame. Today, little is left from the original 13th-century structure and today’s ramparts are the result of several restorations undertaken throughout the years, especially that one dating from the late 14th-century. Over there, you will appreciate stunning views from the coastline.

❇ **Included**	❇ **Not Included**
- Transport by air-conditioned coach	- Meal cost
- English tourist guide	- Personal expenses such as souvenirs
- Boat tickets	

❇ **Note**

- This social program is optional and chargeable. (*These places are for references, and the final schedule should be adjusted to the actual notice.*)
- The guide will leave on time. Please arrive at the assembly point 5 minutes earlier.
- If you are interested, please give your feedback before February 05, 2020. If you miss this date, we can’t accept your request anymore.
- Please keep your belongings with you. The conference organizer and travel agency will not be responsible for the loss of your personal property.

KEYNOTE SPEAKER

Prof. Ian Walker (IEEE Fellow)
Clemson University, USA

Speech Title--- Robots: Adaptation by Growing

Speech Abstract--- This talk will discuss recent efforts to create robots which expand their bodies to "grow", sometimes called GrowBots. This research is motivated by the increasing need for robots to adapt and expand into unstructured, a priori unknown, dynamically changing environments. It is often inspired by observations of the abilities and behaviors of plants as they grow. Using a series of case studies focusing on (plant and robot) vines, the potential for, and challenges in creating growing robots will be discussed.

BIO: Professor Walker is a Fellow of the IEEE and a Senior Member of the AIAA. He has served as Vice President for Financial Activities for the IEEE Robotics and Automation Society, and as Chair of the AIAA Technical Committee on Space Automation and Robotics. He has also served on the Editorial Boards of the IEEE Transactions on Robotics, the IEEE Transactions on Robotics and Automation, the International Journal of Robotics and Automation, the IEEE Robotics and Automation Magazine, and the International Journal of Environmentally Conscious Design and Manufacturing. His research has been funded by DARPA, the National Science Foundation, NASA, NASA/EPSCoR, NSF/EPSCoR, the Office of Naval Research, the U.S. Department of Energy, South Carolina Commission of Higher Education, Sandia National Laboratories, and Westinghouse Hanford Company.

Professor Walker's research centers on robotics, particularly novel manipulators and manipulation. His group is conducting basic research in the construction, modeling, and application of biologically-inspired "trunk, tentacle, and worm" robots. Their work is strongly motivated by the dexterous appendages found in cephalopods, particularly the arms and suckers of octopus, and the arms and tentacles of squid. The ongoing investigation of these animals reveals interesting functional aspects of their structure and behavior. The arrangement and dynamic operation of muscles and connective tissue observed in the arms of a variety of octopus species motivate the underlying design approach for our soft manipulators. These artificial manipulators feature biomimetic actuators, including artificial muscles based on pneumatic (McKibben) muscles. They feature a “clean” continuous backbone design, redundant degrees of freedom, and exhibit significant compliance that provides novel operational capacities during environmental interaction and object manipulation. The unusual compliance and redundant degrees of freedom provide strong potential for application to delicate tasks in cluttered and/or unstructured environments. This work in turn leads to novel approaches to motion planning and operator interfaces for the robots. This work is currently funded by DARPA under the DSO BIODYNOTICS program, by NASA, and by NASA/EPSCoR Dr. Walker also conducts research in the area of fault tolerance and reliability of robots. New work focuses on the creation of animated environments. This work in Architectural Robotics, a fast-emerging area, exploits key aspects of engineering and architecture in exploring how our environments of the future could morph in real time. Applications being investigated by Walker's group focus on assisted living and aging in place.

INVITED SPEAKER

Prof. Norbert Krüger
University of Southern Denmark, Denmark

Speech Title--- The triangle AI, Computer Science and Robotics: A historical Perspective

Speech Abstract--- Artificial Intelligence (AI) is currently transforming our society. This transformation process is connected with utopias of wealthy societies where robots take over all inconvenient work as well as dystopias of huge poverty due to the masses of people that have been made redundant by the technological progress.

In this talk, a brief overview of the history of AI is given, which was heavily impacted by parallel advances in robotics and computer science. Actually, it is the whole triangle with its three corners AI, Computer Science and Robotics that is the basis of the current transformation processes. Constraints in one corner of the triangle have led to standstills in others while unforeseen developments in one area have boosted methods in other areas. Just one prominent example: Big data has led to a resurrection of Artificial Neural Networks and Deep Learning, both methods that had been put to a winter sleep in the last decade of the last century because of the unrealistic amounts of data and computational resources required for convergence.

The German philosopher Georg Wilhelm Friedrich Hegel once said: “We learn from history that we do not learn from history.”
Well, let’s give it a chance.

BIO: Norbert Krüger is Professor, Ph.D., Maersk Mc-Kinney Moller Institute for Production Technology, Technical Faculty at the University of Southern Denmark. He has been employed at the University of Southern Denmark since 2006 (first as an Associate Professor and then as a full Professor (MSO) since 2008). He is one of the two leaders of the Cognitive and Applied Robotics Group (CARO, caro.sdu.dk) in which currently 12 PhD students, two Assistant and two Associate Professor as well as 8 master students are working. Norbert Krüger's research focuses on Cognitive Vision, in particular vision based manipulation and learning. He has published 45 papers in journals and more than 80 papers at conferences covering the topics computer vision, robotics, neuroscience as well as cognitive systems. His H-index is 24. His group has developed the C++-software CoViS (Cognitive Vision Software) which is now used by a number of groups in national as well as European projects. He is currently involved in 2 European projects as well as 4 Danish projects.

INVITED SPEAKER

Prof. David E. Breen
Drexel University, United States

Speech Title--- Energy Constraints on Parameterized Models: Image Segmentation to Textile Modeling

Speech Abstract--- In 1987 Witkin, Fleischer and Barr published a paper at the SIGGRAPH Conference on a "simple but general approach to imposing and solving geometric constraints on parameterized models, (which is) applicable to animation and model construction." The constraints are formulated as an "energy" function on the model's parameter space. The function is specified in such a way that finding the variable values that produces a minimum function evaluation generates the desired result. Intuitively the energy constraints behave like forces that pull and/or deform the parts of the model into place. In general the constrained geometric solution is found by computing and following the energy function's gradient in the space of the varying parameters of the model. The intermediate model configurations may be used to produce animations of the model self-assembling or performing goal-oriented motions. This talk will present the formal description of the approach, a catalog of basic constraints and will describe several of its applications, including image segmentation, hierarchical model animation and geometric modeling of textiles.

BIO: David E. Breen is an Associate Professor of Computer Science at Drexel University. He has held research positions at the Max Planck Institute for the Physics of Complex Systems, the California Institute of Technology, the European Computer-Industry Research Centre, the Fraunhofer Institute for Computer Graphics, and the Rensselaer Design Research Center. His research interests include computer-aided design, biomedical image informatics, geometric modeling, and self-organization. Breen received a BA in Physics from Colgate University and MS and PhD degrees in Computer and Systems Engineering from Rensselaer Polytechnic Institute.

He is a recipient of the NSF CAREER Award. More information about Prof. Breen can be found at https://www.cs.drexel.edu/~david

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SESSION I

February 13, 2020
Session 1

Intelligent Robot Design and Development

13:30-16:00
Marbella

Chaired by

Prof. Sylvie Pesty

Univ. Grenoble Alpes, France

10 Presentations—

CE1-0005, CE1-0023, CE1-0041, CE1-0036, CE1-0022

CE1-0025-A, CE1-0024, CE1-0070, CE1-0057, CE1-0001

***Note**:

* Please arrive at the conference room 30 minutes before the session start.
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SESSION I

CE1-0005 **13:30-13:45**	Testing Social Robot Acceptance: What If You Could Be Assessed for Dementia by a Robot? A Pilot Study Lucie Cormons, Damien Pellier, Caroline Poulet, Humbert Fiorino and **Sylvie Pesty** Univ. Grenoble Alpes, France *Abstract*—It is beneficial to identify and begin treatment of neurocognitive disorders of the elderly as early as possible. In order to help diagnose these disorders, social assistive robots are promising technologies to assist psychologists. To be accepted by the elderly, the robot behaviours must be close enough to the fundamental competences of the psychologists in order not to confuse the patient. This pilot study aims (1) to design a social assistive robot capable of performing a memory evaluation test, (2) to gather opinions on the robot's acceptability with an innovative method (persona) and (3) to identify robot behavioural improvements. We used the "persona methodology" for this pilot study. A panel of students playing the role of a "persona" performed the memory test called RL/RI16, by interacting with the social robot Pepper and then were interviewed about their experience. The robot plays the psychologist role. The interviews and videos analysis showed that the robot is not yet well accepted but the analysis results gave interesting leads to continue.
CE1-0023 **13:45-14:00**	Fiber-Optic Sensors of Angular Position for Anthropomorphic Robot Grippers **Sergey Aleksandrovich Matyunin**, Orkhan Babaev Gadjibaba ogli and Maxim Vladimirovich Stepanov Samara National Research University, Russia *Abstract*—Currently, industrial and domestic anthropomorphic robots mainly use electronic sensors that register its state (tactile force, angular displacement, spatial orientation, etc.). A characteristic feature of commercially available sensors on a semiconductor element base is the sensitivity to external electromagnetic fields and radiation effects, large dimensions and weight. However, it is possible to develop fiber-optic sensors (FOS) with a number of advantages: fire and explosion safety, protection from contamination of the closed optical channel of the sensing element, protection from electromagnetic fields, high corrosion and radiation resistance, electrical insulation strength, a wide dynamic range of measurements, the ability to multiplex the sensing elements, small size and weight. This paper presents the results of the development of angular position FOS (FOS-AP) for phalanges of an anthropomorphic robot grippers based on macrobending of an optical fiber. The sensitive element of FOS-AP is a piece of optical fiber with a diameter of 0.25 mm.
CE1-0041 **14:00-14:15**	Combined Analysis of Energy Consumption and Expected Service Life of a Robotic System **Florian Stuhlenmiller**, Jens Jungblut, Debora Clever and Stephan Rinderknecht Technische Universität Darmstadt, Germany *Abstract*—Modern manufacturing benefits from the automa- tion capabilities and flexibility of robots. Consequently, arising ecological and economical costs depend on the individual use case. In this context, energy consumption is often viewed as an important

	factor regarding the resource efficiency. Extending corresponding models with load criteria for wear and fatigue occurring in the joint transmissions enables the additional consideration of the expected service life. Potential benefits and the impact of trajectory, motion time and payload are evaluated by a parametric study. Findings highlight the importance of accurate modeling for the service life prediction as well as a conflict of interest between minimal energy consumption and maximum lifetime. Hence, a combined analysis of energy consumption and expected service life provides a basis for an improved life cycle assessment and optimization of the ecological and economical efficiency.
CE1-0036 **14:15-14:30**	Investigation of the Resonant Effect in Carangiform Locomotion **Yanwen Liu**, Hongzhou Jiang and Weiwei Chen Harbin Institute of Technology, China *Abstract*—In view of the soft bodies and complex muscle activities, many fishes may utilize resonance to save the energy required for undulatory locomotion. To confirm this hypothesis, we develop a new model of fish swimming to investigate the swimming performance. The model, combing decoupled natural orthogonal complement matrices with the large-amplitude elongated-body theory, can be suitable to solve fish propulsion problems. Both simulations and experiments show that there does exist resonance phenomenon in carangiform locomotion when the driving torque is small. The impact factors for the resonant effect are also explored. The drag coefficient impact the resonant effect obviously while lift coefficient has almost no impact on the resonant effect. These properties can provide beneficial guides to design novel efficient biomimetic robotic fishes.
CE1-0022 **14:30-14:45**	Fiber-Optic Sensors of Tactile Force for Anthropomorphic Robot Grippers **Sergey Aleksandrovich Matyunin**, Orkhan Babaev Gadjibaba ogli and Maxim Vladimirovich Stepanov Samara National Research University, Russia *Abstract*—Currently, technologically advanced countries are conducting intensive research in the development of new types of sensors, especially for robotics. Fiber-optic sensors (FOS) with the closed optical channel witch insensitive to electromagnetic pickups, operating from cryogenic (minus 200 ºC) to high temperatures (+120 ºC) and in a principally explosion-proof design are of particular interest. Samara University has developed theory and made a report that discussed the features of the implementation of Tactile Force FOS (FOS-TF) of gripper phalanges of an anthropomorphic robot based on optical fiber macrobends. Experimental studies of FOS-TF prototypes of the gripper phalanges were carried out and the following characteristics were achieved: controlled tactile force is not less than 0 ... 10 N; the basic error of tactile force control is not worse than 1.0%; size of the contact patch of tactile force is at least 3x3 mm; resolution of the electronic transceiver is at least 10 bits; operating temperature is from minus 80 to plus 80 °C; relative air humidity is up to 100%; supply voltage of an electronic transceiver is 22-32 V, 0.1 A.

SESSION I

CE1-0025-A **14:45-15:00**	Navigation Modeling and Simulation of Magnetic Microrobots and Carrier Fluid Interactions using Magnetic Field Free Point (FFP) **Saqib Sharif**, Doyeon Bang, Chang-Sei Kim, Jong-Oh Park and Eunpyo Choi Chonnam National University, South Korea *Abstract*—Micro and nano scale robots can effectively convert magnetic energy into locomotion and force and are frequently referred as a future cargo system for targeted drug delivery. Recent advances in the design, fabrication and operation of micro/nanorobots have greatly enhanced their power, function, and versatility. However, navigating them within a complex colloidal vascular system is challenging. A higher environmental adaptability and an enhanced feedback-based hybrid control is required. A 3D simulation study of a new Electromagnetic Actuation (EMA) mode for drug delivery system is proposed. FFP has been used instead of conventional gradient field to navigate magnetic microrobots on the target path and location. The benefit of using an FFP gradient over the conventional field is its adoptability and feasibility with autonomous drug delivery system. It will also improve the hybrid navigation and imaging system which integrate EMA with magnetic particle imaging (MPI).
CE1-0024 **15:00-15:15**	Electronic Transceiver and Research Facility for Fiber-Optic Sensors of Anthropomorphic Robot Grippers **Orkhan Babaev Gadjibaba ogli**, Matyunin Sergey Aleksandrovich and Stepanov Maxim Vladimirovich Samara National Research University, Russia *Abstract*—Currently, intensive research is conducting in the development of new types of sensors for anthropomorphic robots. Fiber-optic sensors (FOS) with the closed optical channel witch insensitive to electromagnetic pickups, operating from cryogenic (minus 200 ºC) to high temperatures (+120 ºC) and in a principally explosion-proof design are of particular interest. Samara University has developed fiber-optic sensors of tactile force (FOS-TF) and angular position (FOS-AP) of gripper phalanges based on macrobending of optical fiber. The paper describes the features of the implementation of an electronic transceiver (ET), designed for interfacing FOS with microcontroller devices and FOS calibration. A special research facility based on the anthropomorphic robot gripper, designed to study the transfer characteristic and calibration of FOS using ET, is considered. According to the results of the research, ET were created that provide water measurements with a basic reduced error of not more than 0.86% and an additional reduced error of not more than 0.54%.
CE1-0070 **15:15-15:30**	Using the Feedback of Dynamic Active-Pixel Vision Sensor (Davis) to Prevent Slip in Real Time **Armin Masoumian**, Pezhman Kazemi, Mohammad Chehreghani Montazer, Hatem A. Rashwan and Domenec Puig Valls Universitat Rovira I Virgili Tarragona, Spain *Abstract*—The objective of this paper is to describe an approach to detect the slip and contact force in real-time feedback. In this novel approach DAVIS camera used as a vision

SESSION I

	tactile sensor due to its fast process speed and high resolution. Two hundred experiments were performed on four objects with different shape, size, weight and material to compare the accuracy and respond of Baxter robot grippers to avoid slipping. The advanced approach is validated by using a force-sensitive resistor (FSR402). The events captured with DAVIS camera are processed with specific algorithms to provide feedback to the Baxter robot aiding it to detect the slip.
CE1-0057 **15:30-15:45**	Improving Robots Swarm Aggregation Performance through the Minkowski Distance Function **Fouzi Harrou** and Belkacem Khaldi KAUST, Saudi Arabia *Abstract*—In this work, we study a simple collective behaviour, called aggregation, performed by a swarm of mobile robots system. We mainly proposed the Distance-Minkowski k-Nearest Neighbours (DM-KNN) as a new approach to the aggregation behaviour of simple robots swarm system. The method introduced the Minkowski distance function in computing distances between robots' neighbours. In this approach, the set k-nn members with which each robot will interact with is identified. Then an artificial viscoelastic mesh among the set members is built to perform the aggregation. When Analyzing experimental results based on ARGoS, a significant improvement in the aggregation performance of the swarm is shown compared to the classical distance-weighted k-NN aggregation approach.
CE1-0001 **15:45-16:00**	Studies on Electroosmotic Flow Through A Microchannel Between Two Parallel Plates Without the Debye–Huckel Approximation: An Analytical Approach Avisankha Dutta and **Sudip Simlandi** Jadavpur University, India *Abstract*—In this paper, a simple analytical method for obtaining solutions for the understanding of fundamental characteristics of electroosmotic flow through a parallel plate microchannel without the Debye–Huckle approximation is presented. Hence, Poisson–Boltzmann equation without the Debye–Huckle approximation for the electric potential distribution, the Navier-Stokes equation for the velocity profile and the energy equation for temperature distribution are averaged and solved analytically using homotopy perturbation method. Homotopy perturbation method (HPM) is simple, powerful, efficient and more accurate analysis is possible using it. The electric potential distribution, the velocity and temperature profiles are plotted and studied for a certain range of zeta potential.

16:00-16:15 Coffee Break

SESSION II

February 13, 2020
Session 2

Mechanical and Electrical Engineering

13:30-16:00

St. Sebastia

Chaired by

Prof. Thomas Schlechter

University of Applied Sciences Upper Austria, Austria

10 Presentations—

CE1-0043, CE1-1001, CE1-0004-A, CE1-0003, CE2-0011

CE1-0066, CE1-0039, CE1-0061, CE2-0020, CE1-0072

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SESSION II

CE1-0043 **13:30-13:45**	Environmental Condition Aware Data and Energy Economy Methodology in Distributed Systems **Thomas Schlechter** and Johannes Fischer University of Applied Sciences Upper Austria, Austria *Abstract*—Distributed (im-)mobile sensor nodes are becoming more and more widespread and increase dramatically in number. The ever occurring problem is the efficient power supply: minimize energy to be stored (i.e., small battery size) versus enhance life-time - those are conflicting requirements which call for efficient energy management algorithms. In this paper we provide an overview on recent research in that field. Based on this review, we propose an algorithm which is self-learning, adaptive to environmental conditions, and update-able during run-time. The implementation can be a solution to various real world problems.
CE1-1001 **13:45-14:00**	Real-Time Feedforward-Feedback Motion Tracking Control of a Laboratory Scale ROT Plate Using an EHAS Sohag Sutar and **Pranibesh Mandal** JadaVpur University, India *Abstract*—Electrohydraulic actuation systems (EHASs) with proportional valves and industry-grade cylinders have widespread use in many heavy duty applications due to their low cost and ease of maintenance. Designing proper controller with capability of taking care of non-linearity and uncertainties associated with such low cost system is of utmost priority. In steel industries, with the advancement of Ultra-Fast Cooling (UFC) technique EHAS can be an important part for controlling the motion of hot billet coming out of the furnace while getting cooled under cooling bay in a Run-Out Table (ROT). Proper motion control of the same is necessary for achieving different controlled cooling rates in order to produce a large variety of steel grades. The present experimental study focus on developing a feedforward-feedback controller for real-time motion tracking control of a reciprocating ROT tray coupled with the actuator of a low-cost industry grade EHAS.
CE1-0004-A **14:00-14:15**	Development of a Novel Electromagnetic-Actuator-Based 4-DOF Miniaturized Serial Mechanism **Buhyun Shin**, Nader A. Mansour, Youingshik Kim and Bong-jo Ryu Hanbat National University, South Korea *Abstract*—Recently, robots could substitute skilled operators in several medical applications due to its accurate performance. This paper presents a miniaturized 4-DOF serial robot based on electromagnetic actuators for medical applications. The end-effector of this robot can hold a syringe needle to deliver medicine by injection for patients in a professional way with an accurate inclination and it can hold a camera for laparoscopic surgeries. This 4-DOF robot consists of a pair of dual-axis electromagnetic modules of actuators 1. The rank of the robot's degrees of freedom can be further extended to the multiples of 2 which is the number of joints for each module. The proposed manipulator has a small size of 15 x 15 x 40 mm3 while the total mass is only 6 g. The position and orientation of the

	end-effector are changed by applying electric current to miniaturized voice-coils attached at each joint. Analyses of forward and inverse kinematics of the robot have been studied and the workspace has been obtained. A prototype of the system has been also developed to validate the simulation analyses. The developed prototype could prove the design concept and could move in different orientations, as shown in figure 1, by applying electric current in open loop conditions. Further work should be conducted to attach a syringe needle to the end effector and to apply a closed loop control system.
CE1-0003 **14:15-14:30**	Infrared Distance Sensors for Autonomous Model of Truck with Semi-trailer **Sebastian Rzydzik**, Adrian Saltarski, Marek Roziński and Krzysztof Psiuk Silesian University of Technology, Poland *Abstract*—The paper deals with problem of developing an autonomous model of truck with semi-trailer. Initially, the project was developed by students on classes, but now is being developed by a group of students as part of their own work outside of regular classes. The current works are related to the selection of infrared sensors parameters necessary to develop a security system allowing for the detection and monitoring of obstacles. Ultimately, these works will aim to develop a control system that allows autonomous driving of the truck with semi-trailer. The problem that arose at the present stage of developing of this system, is the selection of a set of distance sensors offering the best possible quality of obstacle detection in the required range. It was decided to use several popular types of distance sensors. This article presents the most important fragments of the report on the conducted research of a selected type of the distance sensor. Carried out tests allow us to state that the useful range of the distance sensor should take into account: the type of surface from which the infrared beam is reflected, the angle of incidence from which the infrared beam is reflected, sensor's own noise, and the need for several sensors to cover the required range of obstacle detection.
CE2-0011 **14:30-14:45**	Simulation of Three-sided Lid-driven Cavity **Abanoub G. Kamel**, Eman H. Haraz and Sarwat N. Hanna Alexandria University, Egypt *Abstract*—In this paper, an incompressible, two-dimensional (2D), time-dependent, and laminar Newtonian fluid flow in a square cavity is simulated in order to investigate vortex dynamics in cavities. Navier-Stokes equations in vorticity-stream function formulation are solved numerically using the finite difference method (FDM) and alternating direction implicit (ADI) technique as they are computationally effective. Two original, distinguished, and unexplored cases of the three-sided lid-driven cavity have been investigated. In case (1) the upper and lower walls are translated to the right whereas the left wall is translated upward and the right wall remains stationary. Furthermore, in case (2) the upper wall is translated to the right but the lower wall is translated to the left whereas the left wall is translated downward and the right wall remains stationary. Moreover, the speed magnitude is unity for all moving walls. However, a MATLAB© code is developed, used, and validated by studying the one-sided lid-driven cavity. The results were in a very good agreement. Besides, stream function and vorticity values in addition

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	to the location of primary and secondary vortices' centers inside the square cavity have been revealed at low and intermediate Reynolds numbers, typically (Re=100 to 2000). Moreover, as Reynolds number increases, more secondary vortices are generated near the cavity corners and the main primary vortex approaches the cavity center.
CE1-0066 **14:45-15:00**	Disign and Position Control of Rail Traction System with Parallel Brushless DC Motors Jongnam Bae, **JunHwi Park** and Dong-Hee Lee Kyungsung University, South Korea *Abstract*—Design and control scheme for the rail guided traction mover driven by two BLDC (Brushless DC) motors is investigated in this paper. The rollers to drive the mover are installed on the top surface of the rail to reduce the slip effect between the roller and the rail in the proposed design. Because of the rail suspending bar on the center of the rail top, the roller cannot be installed in a roll type. The wing type two direct roller connected to the BLDC motor are designed at each side of the mover. The mechanical stress of the designed system is analyzed by FEM (Finite Element Method). Differ from the single roller structure, the balance control between two rollers is very important in the proposed system. In order to reduce zig-zag moving by a non-linear disturbance loads of each motors, the instantaneous moving positions of two motors have to be balanced in the designed system. The instantaneous position balance control scheme is simply presented in this paper to reduce the zig-zag moving of the designed system. In the practical simulation and experiments, the proposed rail guided traction mover based on two BLDC motors are verified.
CE1-0039 **15:00-15:15**	Design of Underwater Humanoid Flexible Manipulator Motion Control System Based on Data Glove **Zhen Xu**, Canjun Yang, Weitao Wu and Qianxiao Wei Zhejiang University, China *Abstract*—The ocean is rich in resources. In order to facilitate the collection of marine resources, human beings have designed many robots to replace divers to overcome the harsh underwater conditions, most of which use motion rocker to control the movement of the rigid manipulator. It is difficult to accurately operate the underwater rigid manipulator with the moving rocker, and the rigid gripper and tools are also easy to damage and destroy the object being operated, which is not suitable for the work scene with high requirements for operation. Therefore, we design an underwater humanoid flexible manipulator motion control system (SMA controller) based on data glove, which can realize the precise control of complex actions, and reduce the destructive behaviors caused by improper operation.
CE1-0061 **15:15-15:30**	Optimal Design of a Novel Adaptive Gripper Giseong Kim and **Han Sung Kim** Kyungnam University, South Korea *Abstract*—In this paper, a novel adaptive gripper with under-actuation is presented, which can change its configuration to parallel or power grip mode according to object shapes. Differently from the commercial adaptive gripper by RobotiQ, the proposed gripper includes an actual parallelogram inside a five-bar mechanism, which allows the free

SESSION II

	selection of actuator locations. By changing the actuator locations, average actuation torque is reduced by 13.5%, and stroke is increased by 6.2%. Using the constrained optimization, the other design parameters are optimized, which yields the reduction of average actuation torque by 29.2% and the increase of stroke by 15.4% compared with RobotiQ. Based on the design results, the proposed gripper prototype has been developed and the parallel and power grips have been tested.
CE2-0020 **15:30-15:45**	Modeling of A Flexible Planar Manipulator with System Identification Method Levent Malgaca, **Şefika İpek Lök** and Mehmet Uyar Dokuz Eylul University, Turkey *Abstract*—System identification (SI) is a modeling method using experimental input-output signals without any physical properties of the system. In this study, a flexible planar manipulator is modeled with the SI method. The output is an acceleration signal of the tip point of the manipulator and the inputs are triangle and trapezoidal motion profiles. Motion parameters are set in order to reduce residual vibrations of the flexible manipulator. The transfer function of the system is estimated with the continuous-time SI method. Simulation results are obtained by using the mathematical model. The identification and validation data are successfully matched with the experimental results.
CE1-0072 **15:45-16:00**	On the Use of Vacuum Technology for Applied Robotic Systems **Emmanouil Papadakis**, Fredy Raptopoulos, Maria Koskinopoulou and Michail Maniadakis Foundation for Research and Technology Hellas, Greece *Abstract*—A variety of real-world robotic applications assume reliable grasping mechanisms to facilitate the effective manage- ment of objects. Vacuum technology has been frequently used for the development of end of arm tools for industrial robotic applications. Besides its effectiveness, the vacuum technology may occasionally face issues when the surface of the object to grasp is full of cavities or has an arbitrary non-flat shape. The present work studies the development of vacuum gripping mechanism for industrial environments, by assessing the importance of the vacuum generator technology, the use of shock absorber and the plasticity of the suction cup. The vacuum system is integrated in the end-effector of a delta-robot that is used for sorting recyclable wastes, thus providing the opportunity to assess vacuum performance on difficult and demanding situations. The obtained results show that the use of different vacuum generators has rather minimal effect on the performance of the composite system. On the opposite side, the use of the shock absorber and the plasticity of the suction cup may greatly affect system performance, especially for gripping objects with complex surfaces. To overcome the relevant issues, we have implemented a custom made suction cup that significantly facilitates gripping, even for dirty and oily objects. The composite system has been tested on a realistic recyclable waste sorting scenario with high success rates in gripping recyclable objects.

16:00-16:15 Coffee Break

SESSION III

February 13, 2020
Session 3

System Modeling Method and Algorithm Optimization

16:15-18:45
Marbella

Chaired by

Prof. Temur Chilachava

Sokhumi State University, Georgia

10 Presentations—

CE2-1005, CE2-0014, CE2-0015, CE2-0018, CE1-0015

CE2-0008, CE2-0007, CE2-0013-A, CE1-0055, CE2-0023-A

***Note**:

* Please arrive at the conference room 30 minutes before the session start.
* Certificate of Presentation will be awarded to each presenter by the session chair at the end of each session.
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* Please keep all your belongings at any time, the organizer is not responsible for the loss of participants.

SESSION III

CE2-1005 **16:15-16:30**	Mathematical and Computer Models of Settlements of Political Conflicts and Problems of Optimization of Resources **Temur Chilachava** and G. Pochkhua Sokhumi State University, Georgia *Abstract*—Nonlinear mathematical models of economic cooperation between two politically (non-military confrontation) mutually opposing sides (two countries or a country and its legal region) are proposed, which consider economic cooperation between parts of the population of the sides, aimed at rapprochement of the sides and peaceful settlement of conflicts. Mathematical models imply that the process of economic cooperation is free of political pressure, that is, the governments of opposing and external sides do not interfere in this process. With some dependencies between constant model coefficients, the first integrals and exact analytical solutions are found. A theorem has been proven to optimize (minimize) the financial resources at which economic cooperation can peacefully resolve political conflict (in the mathematical model we assume that the conflict is resolved if at the same time more than half of the population of both sides support the process of economic cooperation, which promotes political reconciliation). In general, with the variable coefficients of the mathematical model, a computer simulation in the MATLAB software environment was performed to numerically solve the Cauchy problem for a nonlinear dynamic system. Numerical solutions have been obtained, and appropriate graphs have been built. The minimum values of model coefficients (control parameters; optimization of financial resources) under which conflict resolution is possible have been found.
CE2-0014 **16:30-16:45**	Systems Dynamics and Activity-Based Modeling to Blueprint Generative Knowledge Management Systems **U. Schmitt** University of Stellenbosch Business School, South Africa *Abstract*—The predicted embracing of thriving knowledge societies is increasingly compromised by threatening perceptions of information overload and attention poverty, opportunity divides and career uncertainties. By integrating system dynamics, discrete-event, and agent-based modeling, this paper traces the roots of these symptoms back to their causes of information entropy and structural holes, invisible private and undiscoverable public knowledge which together characterize the sad state of our current knowledge management (KM) and creation practices. Looking forward, it proposes a decentralized generative KM approach that prioritizes the capacity development of autonomous individual knowledge workers not at the expense but as a viable means to foster a fruitful co-evolution with traditional organizational KM systems. As part of an ongoing design science research and prototyping project, this systems thinking and hybrid model perspective complements a succession of prior multi-disciplinary publications on the subject.

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CE2-0015 **16:45-17:00**	Low-Level Modeling for Routing and Scheduling Trains through Busy Railway Stations with Expandable Coupling/Decoupling Mechanism **Quoc Khanh Dang**, **Thomas** Bourdeaud'huy, Khaled Mesghouni, Arm and Toguy´eni Ecole Centrale de Lille, France *Abstract*—This paper studies train routing and scheduling problem for busy railway stations. The train routing problem is to assign each train to a route through the railway station and to a platform in the station. The train scheduling problem is to determine timing and ordering plans for all trains on the assigned train routes. Our objective is to allow trains to be routed in dense areas that are reaching saturation. Unlike traditional methods that allocate all resources to setup a route for a train until the route is freed, our work focuses on the use of resources as trains progress through the railway node. This technique allows a larger number of trains to be routed simultaneously in a railway node and thus reduces their current saturation. In this paper, we consider that trains can be coupled or decoupled and trains can pass through the railway station without stopping at any platform. To deal with this problem, this study proposes an abstract model and a mixed-integer linear programming formulation to solve it. The method is illustrated on a didactic example.
CE2-0018 **17:00-17:15**	Modeling Interstate War Combat Deaths **Vaughn H. Standley**, Frank G. Nuño and Jacob W. Sharpe National Defense University, United States of America *Abstract*—A prolonged campaign of peaceful interstate competition is an ideal strategic application of artificial intelligence. Monte Carlo simulation, based on validated war analytics, must be at the heart of this capability. Otherwise the system will not know how to assess the potential consequences of failed solutions, chief among them combat fatalities resulting from interstate war. Although the power law has been used since 1960 to model the statistical distribution of deaths resulting from violent conflict, it is not a valid candidate for use in Monte Carlo simulation because it is mathematically divergent for the case of interstate war. Probing Correlates of War Project data, investigators found that combat fatalities in interstate war follow log-gamma or log-normal distributions, depending on whether a state is attacking or defending. Both distributions are valid for use in Monte Carlo simulations. Moreover, they are strong quantitative evidence that war should be modeled as a zero-sum, non-cooperative, high-risk game.
CE1-0015 **17:15-17:30**	Design, Mathematical Modelling and Analysis of Externally Actuated Somersaulting Tensegrity Spine **Saitanay Naribole**, Renjith Kadeparambil Anil and Goutam Chakraborty IIT Kharagpur, India *Abstract*—The application of tensegrities in the field of robotics and space exploration is an upcoming field of study. Tensegrities are widely appreciated in the field of civil engineering, due to their mechanical versatility to handle various kinds of loads, while remaining as light as possible. This paper proposes to design the topology of a tensegrity spine, with an aim of achieving somersault motion, for traversing through unknown terrains. A simplified mathematical model is developed to approach the equations of

	motion. Generalised mathematical formulations for dynamic analysis of n-body tensegrity spine is generated. This formulation is implemented in the MATLAB environment and solved using Runge-Kutta methods to understand the static and dynamic response of the structure.
CE2-0008 **17:30-17:45**	Discrete Simulation on Elective Surgery Wait Line Using Arena Simulation Software **Xing Yee Leong**, Nethal K. Jajo and Shelton Peiris University of Sydney, Australia *Abstract*—Medical professionals and patients have struggled with long elective surgery waiting line for decades. Hospitals across the world, especially in countries with universal healthcare, struggle with balancing the heavy demand from elective surgery waiting line and allocating enough resources for emergency patients. Patients must rely on private hospitals or going abroad to get faster health care, but poorer patients do not have this privilege. During the recent election campaign in Australia, the incumbent Australian government received heavy backlash regarding the long elective surgery waiting line. Government statistics show that the number of patients added to elective surgery wait line has increased 9.1 percent in 2017-2018 compared to 2013-2014. However, the increase in the number of admissions is not reflected by a proportional increase in the number of surgeries completed within the same year. This duration also does not include the waiting time for patients to be referred to a specialist before they are admitted into the elective surgery waiting line. In New South Wales, the percentile of on-time surgery in 2017 - 2018 fell to 97.1 percent compared to 97.25 percent in 2013 - 2014. Although the percentage does not seem significant, patients were not treated within their recommended time frame. This increases the threat to their health if their condition worsens, and also causes great discomfort in the patients' everyday lives. In this research, we investigate whether moving surgeons across hospitals within a local health district can improve the elective surgery waiting line. For the scope of this research, only 3 types of surgeries, Urology, Ophthalmology, and Orthodontics, are considered. In order to implement the simulation process, 3000 dummy patients, 2000 old and 1000 new patients, were created for each urgency type in each surgery category. The data was fed into a new model in the Arena Simulation model as input. Poisson and Triangular distribution were applied in this model for assigning the surgery and observation duration. Since no real data was provided during this research, an estimated number of surgery resources was used in the control and experiment model. Our model scenario contains 2 large hospitals and 1 small hospital. In the experiment model, one surgeon was moved from both large hospitals to the designated small hospital, and we analyzed the 90^{th} percentile of the output. We noticed that the 90^{th} percentile duration in the waiting line decreased for both small and large hospitals after moving one surgeon from each large hospital. Therefore, we can conclude that temporarily transferring surgeons from one hospital to another can be beneficial to the elective surgery wait line. By moving surgeons instead of patients, patients can also choose a hospital nearer to their home for their elective surgery.

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CE2-0007 **17:45-18:00**	Roughness Grade Analysis on Fitness Landscape for Optimization Problem of Multi-Dimensional Function **Shihui WU** Air Force Engineering University, China *Abstract*—The roughness grade analysis on fitness landscape is helpful for obtaining the difficulty of the multi-dimensional function optimization problem, improving the optimization algorithms, and finding all local minima. Firstly, comparison studies are carried out on several commonly used indicators that depict the roughness of fitness landscape, such as autocorrelation function index, the improved fitness distance correlation (FDC) coefficient index, which are calculated using samples instead of differentiability of the function. A comprehensive index called roughness grade (RG) is constructed to measure the roughness of the fitness landscape by utilizing indices such as total variation of the function, rate of decline, FDC, etc. The advantages and disadvantages of the roughness indicators are summarized according to the results of experiments, which show that the improved FDC index and RG index are qualified for measuring different aspects of the roughness characteristics, and the improved FDC index has advantages over RG on fixed value range, less samples required, and simple calculation, thus can be used as main index, while RG index can be used as aided index for designing roughness grade based optimization algorithms of multi-dimensional function.
CE2-0013-A **18:00-18:15**	Secant Update Penalized Powell-Symmetric-Broyden **Nicolas Boutet**, Rob Haelterman and Joris Degroote Ghent University - Royal Military Academy, Belgium *Abstract*—One of the frequently used families of methods for the resolution of non-linear optimization problems are quasi-Newton methods. These methods differ from each other, among other things, by the way in which the estimation of the Hessian is built by imposing some properties to the created matrix. A simple example is Broyden's method where the satisfaction of the last secant equation is imposed, which is called Secant Update property. In order to create a more accurate estimate of the Hessian, one can try to maximize the use of available information. In addition to the Secant Update property, other information that can be used is the symmetry of the Hessian matrix or the previous steps on the optimization path (by satisfying multiple secant equations). The Powell-Symmetric-Broyden method (PSB) combines, for example, the secant update property, and the symmetry of the Hessian. On the other hand, Schnabel proved that it is impossible to combine this symmetry with the satisfaction of multiple secant equations. Developed originally in order to solve noisy problems, the Penalized PSB (pPSB) offers a way around the impossibility mentioned above by creating a symmetric Hessian and penalizing the non-satisfaction of multiple secant equations by using weight factors. In our study, we add to pPSB the secant update property. This gives us the Secant Update Penalized PSB (SUpPSB): the created estimate of the Hessian is symmetric, satisfies the last secant equation and penalizes the non-satisfaction of previous secant equations. While it is possible to approach the SUpPSB by using a very high first weight coefficient in pPSB, this new formula that we propose behaves differently. By avoiding a great

	difference in order of magnitude between the first coefficient and the following ones, it reduces the risk of rounding errors on those last ones during the calculation. The formula also avoids matrix inversions, which makes it easier to compute. Next to that, SUpPSB has been tested with multiple unconstrained optimization problems (Moré, Garbow Hillstrom). As shown on Fig. 1, the performance profiles for the best performing weight coefficient combination show that SUpPSB performs globally better compared to pPSB.
CE1-0055 **18:15-18:30**	Policy Gradient based Control of a Pneumatic Actuator Enhanced with Monte Carlo Tree Search Balint Kovari, **Adam Szabo**, Tamas Becsi and Szilard Aradi Budapest Univ. of Technology and Economics, Hungary *Abstract*—This paper presents a synergy of the Monte-Carlo tree search (MCTS) and a reinforcement learning (RL) based control strategy to achieve the position control of an electro-pneumatic gearbox actuator. Besides tracking the reference signal, there are qualitative requirements regarding the switching time and the overshoot, and there is also a necessity of reliable behavior in a wide range of operating conditions. By utilizing the domain-specific knowledge of a trained agent, the direction of the tree search can be controlled, hence the quality of the RL control can be further enhanced by the robustness of the MCTS algorithm.
CE2-0023-A **18:30-18:45**	Nonlinear delay dierential equations and its numerical approximation on an example of steel production **Natalia Czy_zewska** AGH University of Science and Technology in Krakow, Poland *Abstract*—In recent years it was observed that heterogeneous materials benet from the best features due to the mix of phases they are made of. Taking an advantage of heterogeneity is the main strengthening mechanism for modern multiphase steels, which are developed today. A detailed description of the complex microstructure features of these steels is required to investigate the correlation between the multiphase structure and the exploitation properties. The research deals with the solution of delay dierential equation describing evolution of dislocation density in metallic materials. Hardening, restoration,and recrystallization characterizing the evolution of dislocation populations provide the essential equation of the model. The last term transforms ordinary dierential equation into delay dierential equation with strong nonlinearity. Upper error bounds for the explicit Euler method will be shown,under the assumption that the right-hand side function is Holder continuous and monotone. Finally, the test the above results in simulations of real industrial process will be presented.

18:45-20:00 Dinner | Restaurant

SESSION IV

February 13, 2020
Session 4

Signal Analysis and Data Processing

16:15-18:45
St. Sebastia

Chaired by

Assoc. Prof. Mario Farrugia

Univ. of Malta, Malta

10 Presentations—

CE1-0035, CE2-0004, CE2-0006, CE1-0040, CE1-0044

CE1-0010, CE1-0037-A, CE1-0045, CE2-1001, CE1-0073

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SESSION IV

CE1-0035 **16:15-16:30**	Synchronization of Event Data Recorder (EDR) Data to Data from the CAN Bus and LabVIEW Miguel Tabone and **Mario Farrugia** Univ. of Malta, Malta *Abstract*—Research on the Event Data Recorder (EDR) and Crash Data Retrieval (CDR) at the University of Malta was extended to also cover a deployment event, i.e. a crash of enough severity that an airbag deployment is commanded. The experimental campaign was based on emulation of vehicle and engine parameters (wheel speeds, vehicle speeds, engine speed) such that experiments were performed in the laboratory while the Electronic Control Units (ECUs) sensed the vehicle as if being driven under various conditions. Over hundred non-deployment events were performed on a single Airbag Control Module (ACM). However, the deployment event freezes the ACM, i.e. the ACM cannot be reused. Data of the only one deployment event performed was captured by the EDR, LabVIEW and a CAN bus sniffer simultaneously. Synchronization of these three different data acquisition platforms was thus required and is discussed in this publication. The synchronization of EDR to CAN bus data was implemented by using an Inertial Measuring Unit transmitting onto the CAN bus. Synchronization of LabVIEW analog input data was synchronized by means of a circuit that silenced a purposely injected CAN message.
CE2-0004 **16:30-16:45**	Asymptotic VS. Bootstrap Confidence Estimations for Double Exponential Distribution: A Simulation for Comparing Performance **Melfi Alrasheedi** and Abdullah Alnefaie King Faisal Unversity, Saudi Arabia *Abstract*—The double exponential distribution is one of the symmetric continuous probability distributions indexed by location and scale parameters. In this paper, we compare the asymptotic confidence intervals for its location and scale parameters to the ones obtained through a bootstrap technique. In our simulation study, we observe that for the scale parameter, both methods provide coherent estimated coverage probabilities, while for the location parameter; the bootstrap pivot confidence interval performs better for a small sample size case. This makes the double exponential distribution a useful modelling tool in many applications for business and industry.
CE2-0006 **16:45-17:00**	CO-ARCH: Methodology for COllaborative ARCHitectures for Cross-organizational Data Analysis **B. D. van der Waaij**, E. Lazovik, T. Albers and M. R. Vonder The Netherlands Organization, The Netherlands *Abstract*—In modern data-driven analysis it becomes quite typical to process not only the datasets you own, but to collaborate with other organizations to receive data and analysis results from them as well. It is performed to achieve much more accurate analysis results, make better predictions, and be able to provide better decision-support mechanisms. However, to analyze data in a cross-organizational environment is not the same as to analyze your own data: there are many limitations and conditions from the collaborators to allow access to their data and/or analysis models. This paper presents a methodology

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	called CO-ARCH dealing with the process of choosing the suitable data-driven architectures for collaboration on data analysis between different organizations having their own conditions and limitations.
CE1-0040 **17:00-17:15**	Theoretical Study of Signal and Geometrical Properties of Two-dimensional UWB-based Indoor Positioning Systems using TDoA **Paolo Grasso** and Mauro Sebastian Innocente Coventry University, United Kingdom *Abstract*—This paper presents an introductory yet compre- hensive study of the combined signal and geometrical properties of Indoor Positioning Systems (IPSs) based on ultra-wideband (UWB) technology. These IPSs consist of a network of more than three transmitting anchors and a (tagged) single receiving object to be localised. The specific algorithm used in this paper is the Time Difference of Arrival (TDoA) with round-robin scheduling. The analysis is structured in a systematic manner in order to lay the foundations for the optimal number, location and orientation of anchors aiming for maximum precision, and also for maximum size of the working area with a desired prescribed precision.
CE1-0044 **17:15-17:30**	Camera-based Adaptive Trajectory Guidance via Neural Networks **Aditya Rajguru**, Christopher Collander and William Beksi University of Texas at Arlington, United States *Abstract*—In this paper, we introduce a novel method to capture visual trajectories for navigating an indoor robot in dynamic settings using streaming image data. First, an image processing pipeline is proposed to accurately segment trajec- tories from noisy backgrounds. Next, the captured trajectories are used to design, train, and compare two neural network ar- chitectures for predicting acceleration and steering commands for a line following robot over a continuous space in real time. Lastly, experimental results demonstrate the performance of the neural networks versus human teleoperation of the robot and the viability of the system in environments with occlusions and/or low-light conditions.
CE1-0010 **17:30-17:45**	Image Processing for the Detection and Monitoring of Toxic Gases in Confined Environments: An Approach Applied to Industries in Peru **Eduardo Nelson Chávez Gallegos**, Ricardo Sergio Adolfo Vidal Sánchez, Brigette Trevejo Marquez, Juan Herber Grados Gamarra and Adan Almircar Tejada Cabanillas Universidad Nacional del Callao, Perú *Abstract*—There are currently several industries, including the industries of maritime containers, gas, oil, among others, in these we find areas of difficult access, for example, confined environments, in these environments it is common that fatal accidents occur due to the presence of toxic gases, because they don't present a constant monitoring of the environment, to solve this, we propose a system that uses a local network that, with image processing, can detect toxic gases remotely. In this project, the reagents that adapt their properties and detection principles will be used to vary their color with respect to a specific gas, these colors will intensify according to the concentration of the gas in the

	environment, this will be captured by a chamber and processed in a microprocessor, which will allow the color of the reagent to be related to the percentage of the gas present in the environment.
CE1-0037-A **17:45-18:00**	Preliminary Study of Korean Electro-palatography (EPG) for Articulation Treatment of Persons with Communication Disorders **Seong Tak Woo**, Young Bin Park and Da Hee Oh Gyeongbuk Institute of IT Convergence Industry Technology, South Korea *Abstract*—Recently, the development of rehabilitation medical technology has increased the interest of speech therapy equipment. Among them, researches on articulation therapy for communication disorders are being actively conducted. The existing diagnosis and treatment of speech disorders had many limitations, such as traditional tactile perception tests and methods based on empirical judgment of speech therapists. Moreover, the position and tension of the tongue are key factors of speech disorders in articulation. This is a very important factor in the distinction of Korean characters such as lax, fortis, and aspirated consonants. In this paper, we proposed a Korean electro-palatography (EPG) system to easily measure, monitoring position, and tension of tongue in articulation treatment and diagnosis. In the proposed electro-palatography system, a sensor part was fabricated using AgCl electrode and biocompatible silicon. Also, the measured signal was analyzed by implementing the bio-signal processing module and monitoring program. In particular, the bio-signal was measured by inserting it into the palatal from an experimental control group. As a result, it was confirmed that it could be applied to clinical treatment for speech therapy.
CE1-0045 **18:00-18:15**	Assistive Parking Systems Knowledge Transfer to End-to-End Deep Learning for Autonomous Parking **Omar Gamal**, Mohamed Imran, Hubert Roth and Jürgen Wahrburg University of Siegen, Egypt *Abstract*—In numerous spots, parking a vehicle is challenging task and requires an experienced driver to maneuver and park the vehicle efficiently. With the advent of Automatic Parking Assist Systems (APAS), drivers can park their vehicles automatically and safely. These systems, however, still require driver intervention and constant attention while parking. The APAS system uses the onboard sensors to perceive the environment to identify the obstacles around and a proper parking space. The system then plans a collision-free trajectory and follows that trajectory to park the vehicle in the designated parking space. This paper presents an intelligent parking system for parking Unmanned Ground Vehicle (UGV) perpendicularly using Convolution Neural Networks (CNNs). To overcome the problem of dataset scarcity and quality APAS system is used to generate training data. The neural network model is trained to mimic the APAS system behavior captured in the generated dataset. The evaluation of the trained CNN model showed that the proposed intelligent parking system is able to park the vehicle perpendicularly with accurate orientation.

SESSION IV

CE2-1001 **18:15-18:30**	Design and Evaluation on Mobile Edge Caching Testbed Can Zhang, Mingyuan Zang and **Ying Yan** Technical University of Denmark, Denmark *Abstract*—Internet traffic is predicted to increase fast over the next years. A large portion of it will be generated by mobile video services. Such a data explosion puts higher requirements on the capacity of the mobile network. Deploying more bandwidth resources to increase the network capacity is one solution, but it also means high cost. Mobile Edge Caching (MEC) is a new solution put forward these years to deal with the drastic growth of video data by bringing the video resources close to users at the edge cache. Researches have been done on the design of MEC, and implementing it in an emulator is one of the ways to verify the design. An emulator can provide real-case protocol implementation and more credible results compared with simulator. This paper studies the LTE emulators available in the market and proposes an MEC testbed based on the OpenAirInterface platform. Two use cases of the testbed are demonstrated and their performances are evaluated separately.
CE1-0073 **18:30-18:45**	A Musculoskeletal Modeling Study of Lower-limb Kinematics and Muscle Activities during Level Walking in Patients with Knee Osteoarthritis **Wang Zesheng**, Chen W.M and Duo-Jin Wang University of Shanghai for Science and Technology, China *Abstract*—Background: Knee osteoarthritis (OA) is a common disease potentially limiting the locomotion capacity of the patients. The traditional diagnosis of knee OA could not obtain the accutate kinematics data from the affected joints during the gait cycle, which is essential for the optimal design of convervative treatment options, such as knee braces for these patients. Objective: The current study using a combined experimental and computational approach to the analysis of the joint kinematics and muscle pattern during the gait cycle in patients suffering from knee OA; and our approach should provide specific characteristics of the knee for the brace design of these patients. Method: Fifteen knee OA patients participated this experiment, in which the electromyography was used to acquire the activation of major lower limb muscles and the motion of the hip, knee and ankle was captured during gait cycle. The motion data was used to build the personalized musoskeletal model of individual and the joint kinematics were obtained and compared against those of the normal subjects. Results: During the gait cycle, the knee joints of the OA patients show an increased flexion motion upon the weight acceptance, but lack of extension motion during the mid-stance phase, and decreased swing speed at the early swing phase. The joint angle curve of hip and the ankle joints exhibit less rangeability. Knee OA patient's quadriceps and hamstring's muscles showed significantly longer activity duration during the gait cycle; at the beginning of stance phase the quadriceps and hamstring's muscles of patients performed more activation to stiff the knee joint and reduce the bending of knee. During the swing phase, the medial gastrocnemius of patients show much higher activation level compared with normal subjects.

18:45-20:00 Dinner | Restaurant

SESSION V

February 14, 2020
Session 5

Mobile Robots and Path Planning

09:30-12:00
Marbella

Chaired by

Assoc. Prof. Teeranoot Chanthasopeephan

King Mongkut's University of Technology Thonburi, Thailand

10 Presentations—

CE1-0050, CE1-0038, CE1-0033, CE1-0006, CE1-0063

CE1-0029, CE1-0009, CE1-0067, CE1-0062, CE1-0030

***Note**:

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SESSION V

CE1-0050 **09:30-09:45**	Mobile Robot Swarm Navigation and Communication using LoRaWan Thanakrit Maneekittichote and **Teeranoot Chanthasopeephan** King Mongkut's University of Technology Thonburi, Thailand *Abstract*—This work involves the development of an algorithm to control a group motion of mobile robots. A group of four mobile robots was developed while each of them was controlled to move by the microcontroller and electrical motors. The robots communicate through long range wide area network (LoRaWan). The information regarding the position of the robot were sent and received through the server while user can also obtain the information in real time through a user interface (web application). The locations of all four mobile robots were determined based on RFID reading while the RFID tags were also used as part of the route planning. Based on our experiment with different paths, the developed algorithm was capable of controlling the motion of the robots in the indoor designated area.
CE1-0038 **09:45-10:00**	Development and Control of a Humanoid Underwater Robot **Weitao Wu**, Canjun Yang, Zhen Xu, Xin Wu, Yuanchao Zhu and Qianxiao Wei Zhejiang University, China *Abstract*—With the deepening of ocean development, the tasks that underwater vehicles need to perform are more complex. Shared control provides a reliable scheme for robots to accomplish these tasks under teleoperation. At present, most of the underwater vehicles are equipped with traditional mechanical manipulator, which is challenging to realize the application of shared control. So, we developed a highly humanoid underwater robot for shared control. The robot is equipped with two humanoid arms. It can be remotely controlled by the operator through the full ocean depth optical fiber, and can also realize simple task planning based on its control system. We have realized and improved the auxiliary function in the operation room, such as motion capture, data fusion, etc. We built detailed modelling and simulation analysis of the robot, and used the sliding mode controller to achieve the stability control of the robot. Its reliability has been verified in the simulation and experiment. Finally, the robot completed the task autonomously in the offline state and showed a better control effect and stronger task completion ability under the shared control.
CE1-0033 **10:00-10:15**	A Motion Mapping System for Humanoids that Provide Immersive Teleprescence Experiences **Carlos Andres Girard**, Diego Calderon, Ali Arafat Lemus, Victor Ferman and Julio Enrique Fajardo Galileo University, Guatemala *Abstract*—Motion capture and mapping systems have been evolving to enhance the virtual immersion experience in a human-in-the-loop model. In this work, a motion mapping system composed by a 3D printed humanoid robot, built with low-cost materials, an IMU-based motion capture suit, a binaural microphone and a virtual reality headset is presented. The movements of the robot are limited by its reduced amount of degrees of freedom, particularly due to its shoulder con- figuration, which differs from the human's own

	biomechanics. Once the motion capture suit's information is extracted, a ROS- based architecture maps orientations from the user to obtain the generalized coordinates of the robot in order to imitate the operator's arm's motion. Additionally, the headset is used to project a stereo vision of the robot's surroundings and to map the operator's head motion. Furthermore, the microphones located on each ear provide the ability to capture 3D sound. This project intends to provide an interactive telepresence puppetry system to encourage the involvement of a targeted audience on engineering subjects. The system shows acceptable results with moderate time response.
CE1-0006 **10:15-10:30**	A Novel Frontier-Based Exploration Algorithm for Mobile Robots **Daniel Louback, Lubanco**, Markus Pichler-Scheder and Thomas Schlechter Linz Center of Mechatronics GmbH, Brazil *Abstract*—This paper aims to bring a novel approach to the exploration paradigm of mobile robots. Consequently, it uses the frontier-exploration method alongside a utility function in order to determine new goals to be achieved by the robot. The proposed approach was implemented using the Robot Operating System as the middleware, and makes use of several packages for, e.g., mapping and navigation. The algorithm implemented in this paper was motivated by the original work on frontier exploration developed by Yamauchi [1] as well as the more recent development, e.g., histogram-based frontier exploration. In addition, this paper aims to include additional parameters in order to enhance the decisions made by the exploration algorithm.
CE1-0063 **10:30-10:45**	Speed and Direction Control of Two In-Wheel BLDC Motors for the Self-Driving Surveillance Robot JongNam Bae, **KiWan Cho** and Dong-Hee Lee Kyungsung University, South Korea *Abstract*—This paper presents a design and control of the self-driving surveillance robot which is driven by two in-wheel BLDC(Brushless DC) motors. The detailed design of the self-driving surveillance robot and improved control scheme are presented in this paper. For the improved speed and motion control performance, the sensorless speed estimation is adopted for the actual speed detection. In the low-speed region, the continuous estimated speed can improve the speed control performance due to the extremely slow response of the actual feedback of hall sensor. The moving direction of the designed robot is calculated by the rotating positions of two in-wheel motors. Then, the direction is revised by the estimated direction by IMU (Inertial Measurement Unit) sensor. In order to compensate the heading angle error of the robot, the compensating term of moving angle based on the actual rotating positions of each in-wheel BLDC motor and the compensating term of angle error make revised speed reference to adjust the error. The proposed design and the control scheme are verified by the practical test of the manufactured robot, and shows the advanced control performance during self-driving.

SESSION V

CE1-0029 **10:45-11:00**	Path Planning Techniques for Mobile Robots - A Review **Sean Campbell**, Niall O'Mahony, Anderson Carvalho, Lenka Krpalkova, Daniel Riordan and Joseph Walsh Institute of Technology Tralee, Ireland *Abstract*—Mobile robots have become increasingly popular in recent years, offering a wide range of applications in areas such as industry, agriculture, search and rescue and much more. This has been achieved mainly as a result of extremely active research and development work on robotic and autonomous technology. We are still faced with many challenges however in order for a robot to navigate efficiently and reliably in an environment without any human assistance. The robot should be capable of extracting the necessary information from the environment and taking the necessary action required to plan a feasible path for collision free motion to reach its goal. In this paper, we review the most commonly used path planning methodologies that have been applied for mobile robot navigation in both static and dynamic environments. We look at both global and local path planning approaches as well as classical and heuristic based techniques.
CE1-0009 **11:00-11:15**	Integrated Development of Collaborative Mobile Robots and WSNs Supported by Cloud Service **Chimsom Isidore Chukwuemeka** and Maki K. Habib The American University in Cairo (AUC), Egypt *Abstract*—The integration of multiple mobile robots and WSNs in forming a collaborative system working in large operational environments has many benefits such as perception and coverage extension that facilitate wider exploration and surveillance area, efficiency in data routing, effective and reliable task environment management, etc. In this paper, a collaborative framework that integrates multiple mobile robots and WSNs, with cloud computing services is presented. The WSNs are comprised of zone sensor nodes (ZSNs) distributed at the zone level that collectively represents the operational task environment and a mobile robot assigned to each of these zones with the ability to navigate around the zone and equipped with mobile sensor node (MSN). Events detected by the ZSNs are routed through each zone's mobile robot to a base station (BS) while it navigates to the location of ZSN detecting the event using A* star path planning algorithm. At the BS, the events' data are visualized on graphic user interfaces and also uploaded to the ThingSpeak cloud platform for storage and analytics. The Simulation results show effective event detection, classification, visualization with the support of cloud analytics as a service.
CE1-0067 **11:15-11:30**	Space Qualification of an Embedded Hardware System for Multi-Sensor-Fusion **Marc Steven Krämer** and Klaus-Dieter Kuhnert University of Siegen, Germany *Abstract*—Qualification is an important step in the development of hardware for use in space. During this qualification, mission- specific requirements and environmental influences such as radiation, vacuum or vibrations are tested in special labora- tories. This paper describes this qualification step for an em- bedded hardware consisting of an FPGA

	and a module com- puter. This hardware is part of the AVIRO project, in which real-time multi-sensor-fusion is made.
CE1-0062 **11:30-11:45**	Instantaneous Position Control Scheme of HD-Camera for the Self-Driving Surveillance Robot **Dong-Hee Lee** and JangSik Park Kyungsung University, South Korea *Abstract*—In this paper, sensor and sensorless combined speed and position control scheme of permanent magnet (PM) DC motor with low-cost and low-resolution position sensor. Because, the resolution of the position sensor is not enough to detect the instantaneous actual speed, modified model reference adaptive system (MRAS) by the hall sensor is investigated. In order to improve the estimation performance, simple steady-state back EMF (electromotive force) calculation and the transient back EMF observer using estimated current error are proposed in this paper. For the advanced position control using low-resolution sensor, the instantaneous speed and position according to the operating time can be determined by the proposed position control method. In order to reduce the mechanical vibration, the operating time based on the speed reference and position error compensation are proposed in this paper. The proposed operating time based instantaneous speed reference is determined using acceleration and deceleration to satisfy the dynamic response and reduced mechanical vibration. In the proposed position control scheme, the final speed reference is determined by the instantaneous speed reference and the position error. The proposed control scheme is applied to the HD (high-definition) camera of the self-driving surveillance robot system. The HD-camera is installed in the vehicle type robot to detect the image information during operation. In order to get the high-quality image data during camera moving, the smooth operating is implemented by the proposed position control scheme. In the experiments, the proposed position control scheme shows the improved control performance of the HD-camera in the surveillance robot.
CE1-0030 **11:45-12:00**	Where am I? Localization techniques for Mobile Robots - A Review **Sean Campbell**, Niall O'Mahony, Anderson Carvalho, Lenka Krpalkova, Daniel Riordan and Joseph Walsh Institute of Technology Tralee, Ireland *Abstract*—Autonomous navigation is one of the most challenging competencies required of a mobile robot. In order to accomplish successful navigation, a mobile robot must be competent in the four main elements of autonomous navigation: perception- the robot must be capable of interpreting its sensors to configure useful data about its environment; localization- the robot must be capable of determining its state within that environment; cognition- the robot must be make meaningful decisions on its actions in order to achieve its goals; and motion control- the robot must be capable of modulating its motor outputs to accurately achieve its desired trajectory. Of these four elements, localization has received the most attention by researchers in recent years, and as a result, we are seeing tremendous advances being made. This paper will provide an overview of the most commonly used localization techniques for mobile robots. We highlight the advantages and challenges associated with each technique and also investigate the various sensor

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	fusion approaches that are being applied to enhance the overall accuracy and reliability of the localization system.

12:00-13:30 Lunch | Restaurant

SESSION VI

February 14, 2020
Session 6

Mobile Robots and Path Planning

09:30-11:45
St. Sebastia

Chaired by

Prof. Dong-Hee Lee, Kyungsung University, South Korea

Co-chaired by

Dr. Hisham Elsherif, German University in Cairo, Egypt

10 Presentations—

CE1-0028, CE1-0018, CE1-0060, CE1-1004, CE1-0027

CE1-0069, CE1-0068, CE1-0042, CE1-0048, CE1-0065

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SESSION VI

CE1-0028 **09:30-09:45**	Paper-Vehicle Control by Using Brain Signals Veronika Wissa, **Adam Mourad** and Hisham El Sherif German University in Cairo, Egypt *Abstract*—Car safety features have moved well beyond old standards, rapid advances have been made to automotive technologies, especially with respect to electronic sensing and control systems. This paper introduces a new feature that was implemented on an electric vehicle by using the EMOTIV EPOC sensing device which provides access to professional grade brain data; such an application captures the driver's brain signals. Machine learning was the main core of the research such that the implementation of some output parameters was very useful to control the car acceleration and steering. Different driver interactions were experimentally tested such as clenching the jaw and head movements. Other external factors like outliers that influence the brainwave signals were eliminated. The experimental outcome showed reliable results, which could be very useful for future implementations to help handicapped drivers.
CE1-0018 **09:45-10:00**	Performance Analysis of Active Suspension System for Half Car Model with Fuzzy Logic Controller **Narinder Singh Bhangal** National Institute of Technology, India *Abstract*—This work presents the MATLAB/Simulink simulations result of half car active suspension system controlled by the fuzzy logic controller. A mathematical model of 4 DOF active suspension systems is developed. The half car suspension model consists of one front and rear wheel. Fuzzy controller is designed based on the mathematical model. The purpose of this paper is to investigate the performance of active suspension system using fuzzy logic controller in comparison with passive suspension system. The results shows that fuzzy controller is more effective in controlling the front and rear suspension deflections, vertical and pitch accelerations of the body as compared to passive suspension system.
CE1-0060 **10:00-10:15**	Gradual Methodology for an Architectural Migration from a Centralized towards a Decentralized Control in Industrial Automated Guided Vehicle Systems **Matthias De Ryck**, Mark Versteyhe and Keivan Shariatmadar KU Leuven, Belgium *Abstract*—In this paper, a methodology is presented which aims at transforming an existing industrial Automated Guided Vehicle (AGV) control architecture from a centralized to a more decentralized architecture in a gradual way. Modern AGV control systems operate mainly in a centralized way. However, literature shows that centralized systems are not suitable to control a large AGV fleet, especially in future flexible manufacturing systems. Research towards a decentralized control of these systems is already very elaborated and industry shows a clear interest in this type of control for AGV systems. However, in literature, the proposed decentralized architectures are rather radical, causing the implementation of them being a real boundary for industrial manufacturers. Still today, the gap between academia and industry is very large which is the reason why

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	industrial AGV systems still work in a centralized fashion, despite the abundance on decentralized algorithms in literature. To overcome this issue, this paper proposes a methodology which facilitates the implementation of decentralized architectures for AGV control in practice. By separating the core AGV control tasks and modularize them by converting them to intelligent Task Agents, a gradual migration between the two architectures will be feasible in practice. This work can be beneficial for industrial R&D centers which are conducting research towards AGV control as well as for AGV manufacturers and consumers who want to decentralize their AGV fleet in a feasible and manageable way.
CE1-1004 **10:15-10:30**	An Experimental Study of a Fiber-Optic Ring Polarizer **Orkhan Babaev Gadjibaba ogli**, Sergey Aleksandrovich Matyunin and Maxim Vladimirovich Stepanov Samara National Research University, Russia *Abstract*—This paper describes the design of a fiber-optic ring polarizer (FORP) based on a single-mode telecommunication fiber, which can be used in fiber-optic sensors of various physical quantities instead of large and expensive prism polarizers or film polarizers that have significant limitations on operating conditions. A theoretical description of the physical processes existing today that causes the appearance of polarization in an optical fiber by bending in the form of a ring is presented. The design of an experimental bench for the FORP study is presented, which allows to fine tune the polarizer by precision changing the diameter of the FORP turn (with a step of 1.25 μm) and to observe in real time the corresponding dependence of the polarization degree of the FORP. The test results of polarizers of various diameters and two experimental samples with good repeatability of the polarization characteristics (the level of polarization of optical radiation of the order of 20 dB at a wavelength of 650 nm with a turn diameter of 7.5 mm) are presented.
CE1-0027 **10:30-10:45**	Pitch Tracking for an Airship with Moving Gondola Using Backstepping Control **Ali Mansur** and Eric Lanteigne University of Ottawa, Canada *Abstract*—This paper presented a backstepping approach for trajectory tracking control of an airship using a moving gondola as a control input. The gondola and thrusters can travel from the mid-rear of helium envelop to the front via a curved rail thereby altering the location of the center of gravity (CG) with respect to the center of volume (CV). The dynamic equation of airship is derived using the Newton–Euler method, and the model was implemented and simulated in Matlab/Simulink to illustrate the effectiveness of the designed controller for tracking pitch trajectories in the presence of uncertainty and wind disturbances. The global asymptotically stability is proved by Lyapunov stability analysis. The results show the effectiveness of the CG control for pitch and altitude tracking.
CE1-0069 **10:45-11:00**	Designing and Analyzing the PID and Fuzzy Control System for an Inverted Pendulum **Armin Masoumian**, Pezhman kazemi, Mohammad Chehreghani Montazer, Hatem A.

SESSION VI

	Rashwan and Domenec Puig Valls Universitat Rovira I Virgili Tarragona, Spain *Abstract*—The inverted pendulum is a non-linear unbalanced system that needs to be controlled using motors to achieve stability and equilibrium. The inverted pendulum is constructed with Lego and using the Lego Mindstorm NXT, which is a programmable robot capable of completing many different functions. In this paper, an initial design of the inverted pendulum is proposed and the performance of different sensors, which are compatible with the Lego Mindstorm NXT was studied. Furthermore, the ability of computer vision to achieve the stability required to maintain the system is also investigated. The inverted pendulum is a conventional cart which can be controlled using a Fuzzy Logic controller that produces a self-tuning PID control for the cart to move on. The fuzzy logic and PID are simulated in MATLAB and Simulink, and the program for the robot developed in the LabVIEW software.
CE1-0068 **11:00-11:15**	Design and Implementation of a Pattern Tracking System with Visual Control based on Images for An UAV in Indoor Environments. **Elvis Cordonez-Acosta**, Margarita Arroyo- Paredes, Milton Pérez-Gutierrez and David Rivas-Lalaleo Universidad De las Fuerzas Armadas Espe, Ecuador *Abstract*—For target tracking when UAV's operate in indoor environments, they present difficulties when using the GPS signal. One of the solutions to this type of problem is visual feedback through a camera on board the aircraft. In this work we developed two types of controllers a classic PID and a controller that uses the kinematic model of the UAV that allows to make the tracking of a defined pattern in space within indoor environments, both controllers receive a visual feedback through a camera on board the UAV that by means of a calibration estimates the distances of the UAV with respect to the pattern in each of its axes, finally a comparison of results is made and it is determined that the controller with kinematic model presents an error less than 5% for each axis in trajectories greater than one meter being the most optimal in this work.
CE1-0042 **11:15-11:30**	FeedForward Compressor Mass Flow Rate Control of the TurboCharger Hot Gas Test Stand Matthew Joseph Vella, Luke Spiteri, JeanPaul Azzopardi and **Mario Farrugia** Univ. of Malta, Malta *Abstract*—The performance of the Hot Gas Test Stand was further improved by electronically controlling the compressor flow using an Electronic Throttle Body (ETB). Control of the ETB was done at two different levels: a PID controller on an Arduino UNO was used to control the PWM required to open the throttle to the commanded angle; and a LabVIEW PID controller to calculate the required ETB angle for the set point air flow rate. For better control of the throttle plate movement, the control time of the microcontroller Arduino UNO board was reduced to 20 ms. On the other level, in LabVIEW, two control systems configurations were studied, 'PID Only control' and 'PID with Feedforward control'. It was found that linking the turbine flow rate to the compressor

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	flow rate made the test stand perform much better and easier to control. This is understandable as the turbine mass flow in an engine is always approximately equal to the mass flow of air coming in.
CE1-0048 **11:30-11:45**	Design and Fabrication of a Low-cost Human Body Lower Limb Exoskeleton Yunus Murtuza Pirjade, Anagha Uday Kotkar, Nihar Makarand Patwardhan, Divishad Ratnakar Londhe, Tushar Pandurang Shelke and **Shantipal Ohol** College of Engineering Pune, India *Abstract*—Recent developments in exoskeleton technology have assisted humans in performing strenuous and fatiguing tasks. However, these exoskeletons are unable to reach masses due to their high cost. In this paper, design, fabrication and validation of a low-cost human body lower limb hybrid exoskeleton is presented. The exoskeleton provides assistive torque at the hip and knee joints which prevents strain on the limbs of the user. The exoskeleton is designed to work with joint actuators made of electric dc motors coupled with back-drivable custom gearboxes. A prototype of the same is fabricated and tested. The joint angle data required to mimic a walking gait cycle was collected by filming subjects walking on a treadmill with the help of a camera whereas joint torque data was obtained by performing inverse dynamics on a musculoskeletal model. The exoskeleton model was simulated in MATLAB Simulink. The torque profiles produced by the joint actuators are plotted and compared with required torque profiles. Percentage torque assists at the hip and knee joints are calculated and discussed.
CE1-0065 **11:45-12:00**	Decentralized High Level Controller for Formation Flight Control of UAVs **Mark Bastourous**, François Guérin, Frédéric Guinand and Eric Lemains Normandie Univ. Unihavre, France *Abstract*—The main contribution of this paper is the design of a decentralized and tuning-less high level controller able to maintain without tracking errors a Leader-Follower (LF) configuration in case of lack or degraded communications (latencies, loss…) between the leader and followers UAVs. The high level controller only requires simple tunings and rests on a predictive filtering algorithm and a first order dynamic model to recover an estimation of the leader UAV velocities and avoid the tracking errors.

12:00-13:30 Lunch | Restaurant

MEMOS

MEMOS