BUDAPEST

2024 12th International Conference on Mechatronics and Control Engineering

2024 10th International Conference on Manufacturing and Industrial Technologies

January 25-27, 2024 | Budapest, Hungary

www.icmce.org

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Venue

The Institute for Computer Science and Control (SZTAKI)

Address: Hungary, H-1111 Budapest, Kende u. 13-17

The Institute for Computer Science and Control (SZTAKI), founded in 1964 as a member of the state-owned chain of institutions, has nearly 300 full-time employees, including about 80 with Ph.D. The Institute gained a worldwide reputation in computer science, systems- and control theory, engineering and business intelligence, machine perception and human-computer interaction. SZTAKI has applied results for the vehicle industry and transport, production informatics and logistics, energy and sustainable development, security and surveillance, Big Data analytics, networks, distributed computing and the Future Internet. The institute is Centre of Excellence in Information Technology, Computer Science and Control of the European Union since 2001. As the first institute from the Central Eastern European region, ERCIM (European Research Consortium of Informatics and Mathematics) granted full membership to SZTAKI in 1994. Since 2010, SZTAKI hosts the Fraunhofer-SZTAKI Project Centre for Production Management and Informatics (PMI). SZTAKI is the founding leader of the Artificial Intelligence National Laboratory, the Autonomous Systems National Laboratory, the Hungarian node of the Research Data Alliance (HRDA), and the ELKH Cloud research infrastructure.

Technical Tour

Technical Tour to Innovation and Demonstration Space at SZTAKI

In the Innovation and Demo Space (IDS) at HUN-REN SZTAKI (https://sztaki.hun-ren.hu/en) researchers, students and industrial partners can meet with machines, methods, and innovation. The demonstrations are related to autonomous vehicles, aerial vehicles, and mobile robots as well as components of production systems. All the demonstrations are developed in cooperation with universities, or industrial actors. IDS can make a meaningful and practice-oriented contribution to facilitate the transfer of advanced technologies and the cooperation between academic and industrial sectors. IDS is also an innovation and demonstration space of the National Laboratory for Autonomous Systems (https://autonom.nemzetilabor.hu).

Three institutions - HUN-REN SZTAKI, Budapest University of Technology and Economics and the Széchenyi István University - with excellent research capacity and research teams are joined together by theNational Laboratory for Autonomous Systems. In addition to their research and development effectiveness, they also have an outstanding performance in training the upcoming research generation. The triple objective of the National Laboratory is sustainable and high-level research, exploitable results, and a developing research network in the fields of autonomous road vehicles, aircrafts, drones and mobile robotics.

Welcome

Dear distinguished delegates,

On behalf of the conference Committee, we warmly welcome you to 2024 12th International Conference on Mechatronics and Control Engineering (ICMCE 2024), and 2024 10th International Conference on Manufacturing and Industrial Technologies (ICMIT 2024). Our conferences were scheduled to be held on January 25-27, 2024 in Budapest, Hungary.

The conference is addressed to academics, researchers and professionals with a particular interest related to the conference topic. It brings together academics, researchers and professionals in the field of Mechatronics and Control Engineering, Manufacturing and Industrial Technologies making the conference a perfect platform to share experience, foster collaborations across industry and academia, and evaluate emerging technologies across the globe. The evaluation of all the papers was performed based on the reports from anonymous reviewers, who are qualified in their field. All the presentations are divided into 3 oral parallel sessions with the following topics: Image based system measurement and signal detection, Functional Material Analysis and Manufacturing Technology, Advanced Control Methods for Autonomous Vehicles.

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: Ahmed CHEMORI, Hamid Reza Karimi, John Mo, John J. Martinez, Mehmet Emir Koksal, Dmitry Ivanov and Mainul Islam.

Additionally, our special thanks go to our Advisory Chair, Conference Chair, Program Chairs, and all the other committee members for their excellent work in securing a substantial input of papers from all around the world and in encouraging participation.

With the strong support from all of you, ICMCE 2024 and ICMIT 2024 conference is more distinctive. We wish that all guests can gain benefits from this conference and improve their academic performance. Thank each of you for your efforts to make this conference successful.

We wish all of you will have an unforgettable experience in the conference.

Yours sincerely,
Conference Committee

Committee

International Advisory Committee

Graziano Chesi, The University of Hong Kong, Hong Kong
József Bokor, Institute for Computer Science and Control (SZTAKI), Hungary
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Sergei Alexandrov, RUDN University, Moscow, Russian Federation

Onsite Guideline

Oral Presentations Onsite

- Timing: a maximum of 15 minutes in total, including speaking time and discussion. Please make sure your presentation is well timed and arrive at the designated conference room 15 minutes earlier.
- You can use USB flash drive (memory stick) and make sure you scanned viruses in your own computer. Each speaker is required to meet her / his session chair in the corresponding session rooms 10 minutes before the session starts and copy the slide file (PPT or PDF) to the computer.
- It is suggested that you email a copy of your presentation to your personal inbox as a backup. If for some reason the files can't be accessed from your flash drive, you will be able to download them to the computer from your email.
- Please note that each session room will be equipped with a LCD projector, screen, point device, microphone, and a laptop with general presentation software such as Microsoft Power Point and Adobe Reader. Please make sure that your files are compatible and readable with our operation system by using commonly used fronts and symbols. If you plan to use your own computer, please try the connection and make sure it works before your presentation.
- Videos: If your Power Point files contain videos, please make sure that they are well formatted and connected to the main files.

Voice Control Rules during the Presentation

- The host will mute all participants while entering the meeting.
- The host will unmute the speakers' microphone when it is turn for his or her presentation.
- Q&A goes after each speech, the participant can raise hand for questions, the host will unmute the questioner.
- After Q&A, the host will mute all participants and welcome next speaker.

Online Guideline

Before the conference

Time Zone
Budapest Standard Time (GMT+1)
You're suggested to set up the time on your computer in advance.

Platform: ZOOM
* You can download Zoom Platform before.
Zoom ID: 883 3686 2154
Zoom Link:
https://us02web.zoom.us/j/88336862154

Equipment Needed
- A computer with internet connection and camera
- Headphones

Environment Needed
- A quiet place
- Stable internet connection
- Proper lighting and background

Test Your Presentation
Date: Thursday, January 25, 2024
Prior to the formal meeting, presenters shall join the test room to ensure everything is on the right track. Please check your test time on this program.
Every presenter or listener enter the ZOOM, please rename as SESSION NUMBER + PAPER ID + YOUR NAME.

*For example:
Presenter: S1+ CE1101+David
Delegate: D001+David

During the conference

Voice Control Rules
- The host will mute all participants while entering the meeting.
- Speakers can unmute microphone when it is turn for his or her presentation.
- Q&A goes after each speaker, the participant can raise questions.

Oral Presentation
- Timing: a maximum of 15 minutes in total, including 2-3 minutes for Q&A. Please make sure your presentation is well timed.
- Please join the meeting room 10 minutes in advance.
- ICMCE & ICMIT encourages all presenters to make live oral presentations. For technical problems such as network instability, we suggest you email a record video/slide to conference secretary as backup before on **January 20. 2024**.

Conference Recording
- The whole Speaker's speeches will be recorded. We appreciate you proper behavior and appearance.
- The recording will be used for conference program and paper publication requirements. The video recording will be destroyed after the conference and it cannot be distributed to or shared with anyone else, and it shall not be used for commercial nor illegal purpose. It will only be recorded by the staff and presenters have no rights to record. If you don't want to be recorded, please inform us ahead of time.

Detailed Agenda

Day 1: January 25, 2024 | Thursday | GMT+1

Onsite Sign in and Conference Materials Collection & Technical Tour - The Institute for Computer Science and Control (SZTAKI)		
12:00-14:30	Sign In	Kende Street Nagytanács Conference Room, Floor -1
15:00-17:00	Technical Tour	Innovation and Demonstration Space, Lagymanyosi Street Building, on Floor 6
Speakers' Test Session Zoom ID: 883 3686 2154 Zoom Link: https://us02web.zoom.us/j/88336862154		
Time	**Presenter**	
9:00-9:10	Assoc. Prof. Dmitry Ivanov, University of Bristol, UK	
9:10-9:20	Assoc. Prof. Mainul Islam, University of Southern Queensland, Australia	
9:20-9:30	Prof. Mehmet Emir Koksal,Ondokuz Mayis University, Turkey	

Day 2: January 26, 2024 | Friday | GMT+1

Opening & Keynote Speeches & Invited Speech Room: Kende Nagytanács (Floor -1) Chaired By: Prof. Ricardo Ambrocio Ramirez-Mendoza, Tecnológico de Monterrey (ITESM), Mexico Zoom ID: 883 3686 2154 Zoom Link: https://us02web.zoom.us/j/88336862154	
Time	**Presenter**
9:00-9:10	**Opening Remarks** Prof. Olivier Sename, Grenoble Institute of Technology, France
9:10-9:50	**Keynote Speech I** Ahmed CHEMORI, CNRS Senior Researcher, IEEE Senior member LIRMM, University of Montpellier, CNRS, Montpellier, France *Speech Title: Assistive Control of Rehabilitation Exoskeletons: From Concept to Real-Time*

	Experiments
9:50-10:30	**Keynote Speech II** Prof. Hamid Reza Karimi, Politecnico di Milano, Italy *Speech Title: Deep Information Fusion for Fault Diagnosis*
10:30-10:50	**Coffee Break& Group Photo**
10:50-11:30	**Keynote Speech Ⅲ** Prof. John Mo, RMIT University, Australia *Speech Title: Engineering Systems Fault Prediction*
11:30-11:55	**Invited Speech I** Assoc. Prof. Mainul Islam, University of Southern Queensland, Australia *Speech Title: Building the Future: Innovation in Green Sandwich Structures for Construction Excellence*
11:55-12:20	**Invited Speech II** John J. Martinez, Grenoble INP - Ense3, Université Grenoble Alpes. Control Systems Department, GIPSA-lab, France *Speech Title: Health-aware Control for Mechatronic Systems in Degradation*
12:20-13:30	**Lunch**
Invited Speeches & Parallel Sessions **Zoom ID: 883 3686 2154** **Zoom Link: https://us02web.zoom.us/j/88336862154**	
Room: Kende Nagytanács (Floor -1)	
13:30-13:55	**Invited Speech Ⅲ** Assoc. Prof. Dmitry Ivanov, University of Bristol, UK *Speech Title: Manufacturing Approaches for Multi-Material Hybrid Composites*
13:55-14:20	**Invited Speech Ⅳ** Mehmet Emir Koksal,Ondokuz Mayis University, Turkey *Speech Title: Fractional Order Thinking and Modeling in Control Theory*
14:20-15:50	**Onsite Session 1: Image Based System Measurement and Signal Detection-First Half** CE303, CE304, CE333-A, JA514, CE305, CE335-A
15:50-16:10	**Coffee Break**
16:10-17:25	**Onsite Session 1: Image Based System Measurement and Signal Detection- Second Half** CE337, CE336, CE340, CE338, CE307, CE311, CE314, JA513, JA518-A
Session room: Kende Street Conference Room 507, Floor 5	
13:30-15:30	**Onsite Session 2: Functional Material Analysis and Manufacturing Technology** JA511-A, JA507, CE302, CE306, CE310, CE332, JA519, JA512
15:30-15:50	**Coffee Break**
15:50-18:20	**Onsite Session 3: Advanced Control Methods for Autonomous Vehicles** CE318, CE322, CE323, CE325, CE331-A, CE334, JA502-A, CE315, CE324, CE329
18:20-19:30	**Dinner**

Speakers

Senior CNRS researcher. Ahmed CHEMORI,
CNRS Senior Researcher, IEEE Senior member
LIRMM, University of Montpellier, CNRS, Montpellier, France

Keynote Speech I
Zoom ID: 883 3686 2154
Time: 09:10-09:50

Ahmed Chemori received his M.Sc. and Ph.D. degrees, both in automatic control from Polytechnic Institute of Grenoble, France, in 2001 and 2005 respectively. During the year 2004/2005 he has been a Research and Teaching assistant at Laboratoire de Signaux et Systèmes (LSS - Centrale Supelec) and University Paris 11. Then he joined Gipsa-Lab (Former LAG) as a CNRS postdoctoral researcher.

He is currently a senior CNRS researcher in Automatic control and Robotics for the French National Center for Scientific Research (CNRS), at the Montpellier Laboratory of Computer Science, Robotics and Microelectronics (LIRMM).

His research interests include nonlinear (adaptive and predictive) control and their real-time applications in different fields of robotics (underactuated robotics, parallel robotics, underwater robotics, humanoid robotics and wearable robotics).

Speech Title: Assistive Control of Rehabilitation Exoskeletons: From Concept to Real-Time Experiments

Abstract: Assisting disabled and elderly people in daily activities using wearable devices has gained a particular interest during last decades due to the highly increasing rate of dependent people. The rise in life expectancy is set to continue; combined with the decrease in birth rates, this should further accelerate the aging of the population. Consequently, this will certainly have a great impact on the development of assistive wearable devices.

Thanks to the latest advances in portable device technologies in terms of compact/miniaturized design, low cost and energy consumption, their wearability has known an significant progress.

Indeed, human wearable devices such as exoskeletons, wearable bio-sensors and wearable stimulators are no more considered as fiction science. Furthermore, this field is attracting more and more researchers from different communities (mechanical design, sensors, actuators, control design, etc).

In terms of data measurement, different sensing systems are often used in wearable devices, namely EMG (muscular activities), IMU (human posture), Force sensors (contact with the ground), etc. Commercial wearable products have already emerged, but they are expected to grow considerably in the few coming years within the context of network-connected objects. The enhancement of disabled/elderly people's abilities in their daily activities, based on this technology, is a key point stimulating design of these systems, with a tendency to low weight and high efficiency devices. These factors are closely related to the success of any wearable device and will have a straightforward impact on the comfort, security and autonomy of the user.

This talk will be focused on wearables robotics challenges, recent advances in this field, and some proposed control solutions for rehabilitation purposes. All the proposed control solutions will be illustrated through either numerical simulations, or real-time experiments.

Speakers

Prof. Hamid Reza Karimi, Department of Mechanical Engineering, Politecnico di Milano, Italy
Director, The International Institute of Acoustics and Vibration (IIAV)

Keynote Speech Ⅱ
Zoom ID: 963 2857 2637
Time: 09:50-10:30

Hamid Reza Karimi is currently Professor of Applied Mechanics with the Department of Mechanical Engineering, Politecnico di Milano, Milan, Italy. Karimi's original research and development achievements span a broad spectrum within the topic of automation/control systems, and intelligence systems with applications to complex systems such as wind turbines, vehicles, robotics and mechatronics. Karimi is an ordinary Member of Academia Europa (MAE), Distinguished Fellow of the International Institute of Acoustics and Vibration (IIAV), Fellow of The International Society for Condition Monitoring (ISCM), Fellow of the Asia-Pacific Artificial Intelligence Association (AAIA), Member of Agder Academy of Science and Letters and also a member of the IFAC Technical Committee on Mechatronic Systems, the IFAC Technical Committee on Robust Control, and the IFAC Technical Committee on Automotive Control. Karimi is the recipient of the 2021 BINDT CM Innovation Award, the 2016-2021 Web of Science Highly Cited Researcher in Engineering, the 2020 IEEE Transactions on Circuits and Systems Guillemin-Cauer Best Paper Award, August-Wilhelm-Scheer Visiting Professorship Award, JSPS (Japan Society for the Promotion of Science) Research Award, and Alexander-von-Humboldt-Stiftung research Award, for instance. Karimi is currently the Editor-in-Chief of the Journal of Cyber-Physical Systems, Subject Editor, Technical Editor or Associate Editor for some international journals and Book Series Editor for Springer, CRC Press and Elsevier. He has also participated as General Chair, keynote/plenary speaker, distinguished speaker or program chair for several international conferences in the areas of Control Systems, Robotics and Mechatronics.

Speech Title: Deep Information Fusion for Fault Diagnosis

Abstract: The objective of this speech is to address some challenges and recent results on fault diagnosis of mechanical systems, with a focus on advanced artificial intelligence algorithms developments. Specifically, different deep learning models such as deep supervised, unsupervised and reinforcement learning algorithms are examined to establish a trustworthy intelligence fault diagnosis model. The talk will be concluded with some results on the development of explainable intelligence fault diagnosis framework based on post-hoc visualization methods as well as multi-source information fusion with complementary transferability metric for mechanical fault diagnosis.

Speakers

Prof.John Mo,
RMIT University, Australia

Keynote Speech Ⅲ
Zoom ID: 883 3686 2154
Time: 10:50-11:30

Prof. John Mo is Professor of Manufacturing Engineering and formerly Head of Discipline of Manufacturing and Materials Engineering at RMIT University, Australia. The Discipline has 400 students, in which 150 students are postgraduate and PhD students. Prior to joining RMIT, he was Senior Principal Research Scientist in Commonwealth Scientific and Industrial Organisation (CSIRO), the Australian government research agency. He led research teams with 20 researchers working on many large scale government and industry sponsored projects including electricity market simulation, infrastructure protection, wireless communication, fault detection and operations scheduling. He has over 400 publications including three monographs, 150 journal articles and 220 refereed conferences papers, 15 book chapters, 12 public reports, 15 keynote speeches and undisclosed number of commercial consultancy reports.

Speech Title: Engineering Systems Fault Prediction

Abstract: Modern engineering systems are complex and sophisticated. Any minor issue can be escalated to complete system failure. With Industry 4.0, enormous amount of information can be collected from system processes online – the commonly knonw health monitoring paradigm. The idea is to maintain the system in good operating state. To achieve this goal, many researchers have contributed their efforts using digital signal processing. However, most researches are focused on recognition of fault conditions only. This means by the time when a fault is recognised, at least one problem has surfaced affecting performance of the system. This is not ideal for systems that requires absolute reliability in continuous operation mode.

One of the difficult issues in health monitoring is prevention of faults. Faults are abrupt deterioration of the machine's capabilities leaving the machine operator almost no time to take remedial action preventing rejects or causing damage to the machine. Detection of this type of machinery faults requires instantaneous machine signal discrimination. Therefore, health monitoring assumes that the system deteriorates over time (but still performing satisfactorily) so that continuous monitoring of certain operating parameters of the system will be able to detect problems before they occur. Therefore, the ability to continuously measure and process signals from the system to check its status is pre-requisite to health monitoring. A good example is monitoring wear and tear on cutting tools. The idea is to monitor certain conditions on the system by some indicative measures based on theoretical model of the operation so that decision to stop and repair can be made before the cutting tool malfunctions.

This paper reviews a range of methods of fault prognosis and explains the development of a new system health condition indicator, Sum Standard Deviation Frequency. This indicator is computed from a new computational process that segments raw data streams into time segments and the segments are synchrosqueezed continuous wavelet transformed. So long as sufficient data is available, the mothod does not link to any application context information of the raw signal data stream hence making it context independent. More importantly, the trend that the system is going into faulty state can be monitored so that while the performance is deteriorating and the system is still working within acceptable conditions, preparation for providing the right repair can be made and the system can be stopped before producing bad outcomes.

Speakers

Assoc. Prof. Mainul Islam,
University of Southern Queensland, Australia

Invited Speech Ⅰ
Zoom ID: 883 3686 2154
Time: 11:30-11:55
Speaker Local Time: 23:30-23:55

Dr Mainul Islam is an academic in Mechanical Engineering with specialisation in Composite Materials in the School of Mechanical and Electrical Engineering at the University of Southern Queensland (USQ), Australia. He also belongs to the Centre for Future Materials at USQ for conducting research. He completed his PhD in Mechanical Engineering at the University of Newcastle, Australia. He is a graduate and also former Assistant Professor in Mechanical Engineering of Khulna University of Engineering & Technology (KUET), Bangladesh. He got Master degree in Structural Engineering from Kyushu University, Japan. He has been with USQ since 2008 just after completing PhD. His current research interests are in the areas of smart and sustainable composites and shape memory polymeric materials especially for infrastructure and biomedical applications. He has over 150 research publications based on his research outcomes. He has been able to secure a total of over $1.5M research funding jointly and individually during his academic career so far.

Speech Title: Building the Future: Innovation in Green Sandwich Structures for Construction Excellence

Abstract: This study explores three sandwich structures utilizing Formica sheets and perlite/sodium silicate foam as the core, with or without a paper honeycomb. By employing three-point bending tests and Lee's thermal conductivity apparatus, we assessed flexural characteristics and thermal conductivity. The results showcased a remarkable enhancement in flexural properties, including core shear stress and energy absorption, with the incorporation of paper honeycomb reinforcement. Thermal conductivity and flexural properties of these structures proved highly compatible with existing building materials, as described in relevant literature. Failure analysis revealed premature core buckling in paper honeycomb-reinforced sandwiches, contrasting with the ability of foam-filled honeycomb core sandwiches to sustain higher loads, exhibiting core shear failure, skin rupture, and delamination. Foam-filled paper honeycomb structures emerged as capable of withstanding higher bending loads, presenting promising applications as eco-friendly materials for building thermal insulation.

Speakers

John J. Martinez, Grenoble INP - Ense3
Université Grenoble Alpes. Control Systems Department, GIPSA-lab.

Invited Speech II
Zoom ID: 883 3686 2154
Time: 11:55-12:20

John J. Martinez was born in Cali, Colombia. He received the B.Sc. degree in electrical engineering and the M.Sc. degree in automatic control from the Universidad del Valle, Cali, in 1997 and 2000, respectively, and the Ph.D. degree in automatic control from the Institut National Polytechnique de Grenoble, Grenoble, France, in 2005. He joined the Universidad Nacional de Colombia, Medellín, Colombia, as a Teacher Assistant, from 2001 to 2002. He was an Invited Visitor with the Centre for Complex Dynamic Systems and Control, The Newcastle University, Callaghan, NSW, Australia, in 2005, 2007, and 2009. He is currently Full Professor with the GIPSA Laboratory, Department of Control System, Institut National Polytechnique de Grenoble, Grenoble. His current research interests is related to modeling and robust control of mechatronic systems (e.g. Polytopic system modeling, Linear Parameter-Varying systems, Switching control and Invariant-Set Theory for Fault-Tolerant Control and Robust Disturbance Estimation/Rejection), mostly in the following applications: Automotive vehicle dynamics, Aerial vehicle dynamics, Wind turbines control, Physiologic-aware electric bikes and Anti-vibration systems.

Speech Title: Health-aware Control for Mechatronic Systems in Degradation

Abstract: In this talk we present a state-space approach for controlling the Remaining Useful Life (RUL) of deteriorating mechatronic systems. The proposed approach supposes the availability of a deterioration model that links the deterioration rate with some manipulable control inputs. Such a link can be a non-linear monotonic function between the deterioration-rate and the manipulable control inputs. We propose a method for designing both state observer and state feedback controller for RUL prediction and control. We consider that the manipulable inputs are affected by additive random disturbances and possible multiplicative unknown parameters. In addition, we assume that the control decisions can not be applied instantaneously on the system, which is modeled as a time-delay between control decisions and manipulable inputs of the deterioration dynamics. The proposed methodology is illustrated on several applications related to power transmission systems, friction drive systems, applications using Lithium-ion batteries, among others.

Speakers

Assoc. Prof. Dmitry Ivanov,
University of Bristol, UK

Invited Speech III
Zoom ID: 883 3686 2154
Time: 13:30-13:55
Speaker Local Time: 12:30-13:00

Dmitry Ivanov (Dr Dmitry Ivanov - Our People (bristol.ac.uk), Dmitry Ivanov-Google Scholar) is Associate Professor in Composites Manufacturing at the University of Bristol, Theme Lead in Manufacturing and Design at Bristol Composites Institute (Bristol Composites Institute | Bristol Composites Institute | University of Bristol). His research path started in KULeuven, Belgium in 2002 and spanned from multi-scale theories to applications in process modelling and innovative manufacturing. Dmitry works in Bristol since 2011 and led projects funded by industry, EU and UK research councils on additive manufacturing, multi-matrix composites, process analysis and control.

Speech Title: Manufacturing Approaches for Multi-Material Hybrid Composites

Abstract: Manufacturing of polymer composites is a field of incredible creativity. There is a wide range of processing solutions tailored to the requirements of performance, cost, and functionality. With the innovations in fibre deposition, steering, hybridisation, and forming the composite structures become increasingly more efficient and find new applications featuring challenging geometries and service conditions. In this talk we will discuss some of the new directions, where the composite properties can be boosted even further through emerging manufacturing concepts that bring together various materials in one interconnected system. Driven by the requirements of sustainability and efficiency, the concepts such as Multi-Matrix Continuously-Reinforced Composites (MMCRC) have been recently introduced. The concept allow designing and mapping the zones of different functions within one structure. The presentation will cover successful examples of MMCRC, examine implications of using these materials, and discuss their new features.

Speakers

Mehmet Emir Koksal
Ondokuz Mayis University, Department of Mathematics 55139
Atakum, Samsun, Turkey

Invited Speech IV
Zoom ID: 883 3686 2154
Time: 13:55-14:20
Speaker Local Time: 15:55-16:20

Mehmet Emir Koksal is a Professor of Mathematics at the Ondokuz Mayis University. His research interests are in systems and control theory, circuit and system theory, differential equations, and numerical analysis. The main focus is on the development and analysis of commutativity conditions of time-varying systems, feedback systems, decomposition and transitivity properties of commutativity, and applications of commutativity in physical systems using differential and difference equations. He also studies ordinary and partial differential equations, their numerical solution methods, and mathematical modeling and analysis of various engineering problems using differential equations. He has published many research papers in eligible international journals, and he has many proceedings presented at famous international conferences. His research has been mainly supported by the Scientific and Technological Research Council of Turkey.

Speech Title: Fractional Order Thinking and Modeling in Control Theory

Abstract: Fractional calculus has become very famous and popular subject in recent years. It is used as a powerful and important mathematical modelling tool, for defining, investigating, analyzing, solving, and discussing many different types of engineering, physical, chemical, statistical, and social problems in real life. In fact, fractional order (FO) dynamic models simulate characteristics of real dynamic systems better than the integer order models. In this lecture, I will introduce basic concepts of fractional calculus, present various applications in distinct areas of science and engineering, and predict possible future research trends on this topic. The content of my speech is more concisely expressed as follows.

After reviewing the important definitions of FO integration and differentiation, usefull continious and discrete approximation methods and their digital and analog implementations are elaborated. Integer order approximation is introduced as a frequent tool for approximating FO transfer functions (FOTF).

Most commenly used Matlab toolboxes which facilitate utilizing FO calculus in the control field and other areas are presented. Namely open reach toolboxes such as FIT, CRONE, FOMCON, FOTF, NINTEGER, Syquake-FOPID will be extracted.As for the most common uses, fractional order propotional-integral-derivartive (PID) controllers and lead-lag controllers (LLC) draw grate attention in the control engineering area. Many systems either themselves modelled by FO Dynamics (FOD) and/or controlled by FO controllers (FOC) apperrarded for tuning desired time-constant, gain and phase margins, gain crossover frequency, controller effort, whilst adjusting desired robustness and stability requirements and minimizing the error according to some performance criteria. In particular, stability boundary locus methods are described fort the best tuning of the controller parameters. Use of FO calculus and its interaction with genetic algorithms and fuzzy neural systems will be mentioned. Specially, to point out the application of the subject in a wide area, fractional order electrical filters and their circuit implementations, speed and torque control of different motors (DC, AC, permenant magnet, induction), power and power quality control systems, time-delay systems, biomedical applications, are some of the topics that will be covered in my talk.I will terminate my talk by mentioning doyens and masters who contributed FO calculus and its applications in social and basic sciences as well as in engineering; forward opinions about where the subject will go and which researches it will lead to in the future.

Author Parallel Session 1

Topic: Image Based System Measurement and Signal Detection

Time: 14:20-18:10, January 26 | Room: Kende Nagytanács (Floor -1)

Session Chair: Prof. Olivier Sename, Grenoble Institute of Technology, France

Session Chair: Prof.John Mo, RMIT University, Australia

CE303 **14:20-14:35**	Geometric Methods and Computational Tools for Switching Structured Linear Systems: A Survey and Some New Results Elena Zattoni, Anna Maria Perdon, Giuseppe Conte Presenter: Elena Zattoni, Alma Mater Studiorum Universita' di Bologna, Italy Abstract: This work presents the geometric methods and the computational tools which have been recently developed to solve control and observation problems involving switching structured linear systems —i.e., structured linear systems where the existing links between the state,input and output variables are not only unknown as to their numerical value but also subject to change according to an exogenous signal. In particular, the notions of invariance, controlled invariance and conditioned invariance are revised and their use in the derivation of solvability conditions for the disturbance decoupling problem and for the unknown-input state observation problem is discussed in a unified framework. Notions and results are explained by examples and illustrated by directed graphs.
CE304 **14:35-14:50**	Techniques for Fusing Multimodal Data in Predictive Scenarios using CNN Philpp Ruf, Massiwa Chabbi, Christoph Reich, Djafar Ould Abdeslam Presenter: Christoph Reich, Hochschule Furtwangen, Germany Abstract: In recent years, Convolutional neural networks (CNN) have demonstrated high performance (real-time) in image analysis, but often times, there is only structured data available regarding a specific problem. By representing structured data as images, CNNs can effectively learn and extract valuable insights from tabular data, leading to improved predictive accuracy and uncovering hidden patterns that may not be apparent in traditional structured data analysis. In applying a single neural network for analyzing multimodal data, e.g., both structured and unstructured information, significant advantages in terms of time complexity and energy efficiency can be achieved. In addition, the use of a single model for both types of information enables capturing of relations between the information that might otherwise be lost, thus improving the capabilities of the neural networks. Converting structured data into images and merging them with existing visual material offers a promising solution for applying CNN in multimodal datasets. By employing suitable preprocessing techniques, structured data is transformed into image representations, where the respective features are expressed as different formations of colors and shapes. In an additional step, these representations are fused with existing images for incorporating both types of information. This final image is finally analyzed using a CNN.
CE333-A **14:50-15:05**	Robot Finger Pressure Measurement and Analysis Through Optical Image Processing and Artificial Intelligence Algorithm Soohee Ha, Moojung Seo, Jaechern Yoo

	Presenter: Soohee Ha, Sungkyunkwan University, Republic of Korea Abstract:In the realm of robotics, precise control and understanding of tactile interactions are paramount for enhancing the capabilities of robotic systems. This study presents the measurement and analysis of robot finger pressure utilizing a novel approach that combines optical image processing and artificial intelligence algorithms. The proposed system leverages advanced imaging techniques to capture high-resolution images of the contact surface, enabling accurate representation of pressure distribution across the robot finger.
JA514 **15:05-15:20**	Warehouse Efficiency Improvement Model Applying Lean Manufacturing Methodology in a Textile Company Adrian Humberto Cuenca Bazan, Cesar Augusto Arrunategui Vasquez, José Antonio Taquía Gutiérrez Presenter: José Antonio Taquía Gutiérrez, Universidad de Lima, Peru Abstract: The storage process is one of the key points of success for more effi-cient management of all operations, so the focus of this article is to increase effi-ciency in the warehouse through the reduction of existing operating times. Through the Lean Manufacturing methodology, using the 5S tool and taking pro-cess times, for a pilot test in a delimited space of the storage area and the respec-tive validation with the use of the Arena simulator, an efficiency improvement of 54.72% is achieved concerning the amount of finished product arriving at the warehouse; likewise, a reduction in waiting times and total storage time of 82.80% and 66.71%, respectively, is achieved.
CE305 **15:20-15:35**	Path Tracking Control for Rover with Estimation of Slip Rate Using Echo State Network Jun takaki,Uchiyama Kenji, and Masuda Kai Presenter: Jun Takaki, Nihon University, Japan Abstract: This paper describes a planetary rover tracking control method by estimating the slip rate based on the echo state network (ESN). A rover is required to move on uneven terrain that varies depending on the location. Soft soils should be particularly avoided during planetary rover exploration. However, it is not easy to detect them with external sensors such as cameras and LiDAR. The rover would be stuck on soft soils because of the high slip rate if the thrust of the rover is determined without considering the slip rate. Therefore, estimating the slip rate at the current position is necessary to generate the appropriate thrust. We propose the method to estimate the slip rate that varies depending on the location with a few sensors. The proposed method uses the ESN to compensate for the effect of thrust loss caused by the slip rate. The ESN is one of the recurrent neural networks and can estimate some values quickly using time series data of IMU. The ESN is used to estimate the slip rate of the current rover position in real time. Results of the numerical simulation show the effectiveness of the proposed tracking control method for the exploration rover.
CE335-A **15:35-15:50**	ath Planning and Control Using an Integrated Robot Operating System and Matlab Environment Ákos Bokor, Dániel Losonczi, Szilárd Aradi, László Palkovics Presenter: Szilárd Aradi, Budapest University of Technology and Economics, Hungary

	Abstract: Integrating advanced software tools has become essential to enhance the capabilities of modern robotic systems and highly automated vehicles. Robot Operating System (ROS) has proven suitability in recent years in robotics research and industrial development. Its modularity, language independence, scalability, and code reusability are the key properties that make ROS stand out from other robotic frameworks. However, in control engineering, Mathworks Matlab/Simulink is the fundamental software tool in education and research. Matlab has had a ROS interface for a few years now. Our presentation introduces a framework for path planning and robot control by seamlessly integrating the ROS functionalities and MATLAB environment. Combining these two powerful frameworks offers a comprehensive solution for addressing the challenges of robot navigation. To demonstrate the practical implications of this integrated environment, we present a case study involving an Ackermann mobile robot. An artificial potential field-based route planning algorithm was developed, the result of which is followed by a pure pursuit controller. It demonstrates the collaboration of ROS and MATLAB, wherein ROS manages the robot's interaction with its surroundings while MATLAB executes path planning and control tasks. During the development process, testing took place in the Gazebo simulator, and then the final solution was transferred to a real robot. The case study substantiates this combined approach's advantages and provides valuable experience in fast prototyping. The presentation begins by clarifying the significance of path planning and robot control. It highlights the fundamental features of ROS and MATLAB, emphasizing their individual strengths in handling robot-related tasks. Subsequently, the proposed integration methodology is detailed, outlining the steps required to establish a stable environment covering the implementation issues. A critical aspect of the integrated approach is the seamless communication between ROS and MATLAB components. In conclusion, our presentation emphasizes the fusion of the Robot Operating System and MATLAB as a powerful tool to support fast prototyping in robotics. Furthermore, such a framework can also be suitable for a highly automated test vehicle. The integrated environment exploits the strengths of both frameworks, enabling seamless interaction between real-time control and an advanced robotic framework.
15:50-16:10	**Coffee Break**
CE337 **16:10-16:25**	Neurohumanities Lab: Physiological Signal Analysis Within an Educational Partially Immersive Environment Mauricio Adolfo Ramírez-Moreno Presenter: Mauricio Adolfo Ramírez-Moreno, Tecnologico de Monterrey, Mexico Abstract: The use of immersive virtual reality technologies in education has demonstrated an improvement in the learning process of professionallevel students; nevertheless, mostly limited to the fields of science and engineering. In this study, the Neurohumanities Lab was introduced as a semi-immersive space where, differences in physiological signals electroencephalography and heart rate, plus the statistical results from the ITC-SOPI presence questionnaire, were analyzed. These results were compared to those of a traditional class. Supervised Machine Learning algorithms were tested, and the engagement ratio plus

	the power extraction in the gamma band were the most significant features, with 92.34% accuracy on average. Heart rate variations were related to changes in the state of presence, also observed by the questionnaire responses' results. Concluding that the Neurohumanities Lab has the potential to be a completely immersive environment, enhance the learning experience in the humanities area, and evaluate learning in an objective way.
CE336 **16:25-16:40**	Vision System Based on Artificial Intelligence for Service Robots Juan Carlos Tudon-Martinez Presenter: Juan Carlos Tudon-Martinez, Tecnologico de Monterrey, Mexico Abstract: The vision system presented in this paper was originally developed to be integrated into a service robot called PiBot for the COVID-19 pandemic control, however, the bases of the system can be used as a main vision system of another nature, mainly for object detection. To develop a vision system based on artificial intelligence, ROS, and YOLO were employed, achieving quite solid results through a sampling of face mask detection and distance violation, being comparable with other recent vision systems, and an excellent option for service robots. Especially when the used experiments in the presented detection results have uncontrolled factors such as people's quantity passing by, the distance between people, the variant perspective of captured faces, etc.
CE340 **16:40-16:55**	Biomechanical Analysis of Dance Improvisation Based on Emotions Jorge de Jesus Lozoya-Santos Presenter: Jorge de Jesus Lozoya-Santos, Tecnologico de Monterrey, Mexico Abstract: This study examines the relationship between emotions and movements in contemporary dance, focusing on how emotions influence the biomechanics of dance improvisation. Motion capture, data analysis and biomechanical modeling are used to understand the impact of emotions on dancers' movements. The preliminary analysis shows differences in movement (joint acceleration) depending on the interpreted emotion, which was more evident for the immersive environment. The proposed methodology has the potential to improve performance aspects and wellbeing to practitioners in the dance community, benefiting trainers and health professionals, and contributing to the comprehensive development in the field of dance.
CE338 **16:55-17:10**	Design of a Physiological and Vehicle-oriented Data Acquisition Platform for Autonomous Vehicles Users Mauricio Adolfo Ramírez-Moreno Presenter: Mauricio Adolfo Ramírez-Moreno, Tecnologico de Monterrey, Mexico Abstract: This article presents the design of a platform capable of recording the physiological and biometric data of users in an autonomous vehicle. This includes biometric wearable and noninvasive devices used to acquire physiological data, while vehicle-orientated data is obtained from integrated and programmable sensors in the vehicle that output variables related to the driving cycle. In addition, it integrates the use of hardware and software components to conclude with raw data files that can be analysed in

	further work. Several tests were performed using the autonomous vehicle NEV Polaris Gem e6 with manual and autonomous driving modalities to acquire data of the users, for which the data was successfully stored. This work presents a method for the analysis of peripheral physiological data of the user during a route made by a vehicle.
CE307 **17:10-17:25**	Identification of Lateral Dynamics of an Autonomous Car Vehicle Daniel Pup, György Istenes, Ferenc Szauter, Jozsef Bokor Presenter: György Istenes, Szechenyi Istvan University, Hungary Abstract: In this paper, the ID (identification) of the lateral dynamics of a road vehicle is presented. The mathematical description of lateral dynamics is essential for the development of different autonomous functions. One of the most useful methods to define the mathematical model is the system ID based on measured data. The measurements were performed on straight track sections with an experimental test vehicle. This vehicle is capable of fully autonomous driving. During the measurements, the vehicle's steering servo was artificially excited while the autonomous function forced the vehicle to drive in a straight line. The input to the system was therefore the sum of the artificial excitation and the control signal from the autonomous function, and the output was the lateral accelerarion of the vehicle. The tests were carried out at different speeds.From these measurements, the lateral dynamic system was identified using linear ID methods.
CE311 **17:25-17:40**	Vision Based Driving Agent for Race Car Simulation Environments Gergely Bári, László Palkovics Presenter: Gergely Bári, Szechenyi Istvan University, Hungary Abstract: In recent years, autonomous driving has become a popular field of study. As control at tire grip limit is essential during emergency situations, algorithms developed for racecars are useful for road cars too. This paper examines the use of Deep Reinforcement Learning (DRL) to solve the problem of ”grip limit driving” in a simulated environment. Proximal Policy Optimization (PPO) method is used to train an agent to control the steering wheel and pedals of the vehicle, using only visual inputs to achieve professional human lap times. The paper outlines the formulation of the task of time optimal driving on a race track as a deep reinforcement learning problem, and explains the chosen observations, actions, and reward functions. The results demonstrate human-like learning and driving behavior that utilize maximum tire grip potential.
CE314 **17:40-17:55**	Theoretical Investigation and Simulation of a Brake-By-Wire Based Bicycle Wedge Brake Bence Nagy, Dénes Fodor Presenter: Bence Nagy, Szechenyi Istvan University, Hungary Abstract: In today's vehicle industry "X-by-wire" technologies gain significant importance, especially in full-electric vehicles. This paper demonstrates the first steps of an electromechanic bicycle wedge brake design that uses brake-by-wire technology. The paper discusses the importance of Anti-lock Brake Systems (ABS) and Brake-by-Wire (BBW) technologies in the bicycle industry and summarizes how the technologies improve rider safety. Then we do a technical investigation by establishing a Model-Based Design workflow for developing a first-principle ABS control for electronic wedge-brake

	applications. First, We establish a longitudinal model of a bicycle, allowing for a detailed investigation of wheel-lockups. After obtaining a baseline bicycle model we implement a control-algorithm to prevent wheel-lockup during braking. The effect of the control algorithm on the braking distance of the bicycle is also investigated. After concluding the effects of the ABS brake systems for bicycles we summarize the next steps for continuing the design process of the brake system development.
JA513 **17:40-17:55**	Driving Cycle Optimization based on Torque-Switching method Péter Kőrös, Zoltán Pusztai, Tamás Luspay Presenter: Zoltán Pusztai, Szechenyi Istvan University, Hungary Abstract: In this article, an optimization procedure is presented that provides a near-energy-optimal trajectory for a given track. The presented optimization method is an offline approach, which was designed to comply with the Shell Eco–marathon regulations. This method was employed by SZEnergy Team, the electric vehicle development team of Sz´echenyi Istv´an University, resulting in breaking the current world record in 2022 and in 2023. Measurement-based grey-box type modelling was used for describing the vehicle and the track to properly handle the extreme low resistance and slope forces. The optimization procedure was carried out by using a genetic algorithm, which determined the points of acceleration along the track in discrete points. The optimized torque value and the switching speed were added as additional variable to the decision vector, these parameters are used for implementing the torque switching method. The developed method can be easily implemented, while the comparison with other similar methods showed just negligible difference in energy consumption.
JA518-A **17:55-18:10**	System Design of a Mobile Robot Platform for Traffic Diversion Element Manipulation Norbert Boros, Dániel Eredits, János Hollósi, Richárd Vasvári, Rudolf Krecht, Áron Ballagi Presenter: Dániel Eredits, Széchenyi István University, Hungary Abstract: Autonomous systems have been provenly successful in solving dirty, dull, and dangerous tasks on various fields. The placement of temporary road signs or other traffic diversion elements can be unquestionably characterized by all the three mentioned characteristics: For example, the monotonous task of traffic cone placement often implies work in adverse weather conditions in the direct vicinity of high-speed motor vehicles. Furthermore, some specific tasks, such as racetrack or vehicle industry test track markings by traffic cone placement require centimeter-level precision. In order to provide a solution for the monotonous but precise task of traffic cone placement, we propose an autonomous mobile robot platform for this purpose. This mobile robot platform consists of a heavy-duty, skid-steer robot platform with an on-board robot manipulator. Localization is carried out by a Real-Time Kinematic Global Navigation Satellite System (GNSS-RTK), traffic cone detection is solved by cameras and a custom machine vision solution based on artificial intelligence. The platform also features a laser scanner for obstacle detection. The usage of the proposed robot platform is made possible by a custom web-based user interface. The user marks the desired position of the traffic cones on a digital map. After that, the robot initiates the iterative placement of the traffic cones based on GNSS

	coordinates. Similarly, the traffic cones can be collected as well, based on GNSS coordinates and input from the machine vision system.

Author Parallel Session 2

Topic: Functional Material Analysis and Manufacturing Technology
Time: 13:30-15:30, January 26 | Room: K507 (Kende Street -5th Floor)
Session Chair: Associate Prof.Thira Jearsiripongkul, Thammasat University, Thailand

JA511-A **13:30-13:45**	Modelling of Hot Rolling Texture Simulation of Aa1100 Aluminum Alloy Considering Crystal Plasticity And Rate Sensitivity Tzu-Shiuan Wang Presenter: Tzu-Shiuan Wang, National Cheng-Kung University, Taiwan Abstract: In the era of smart manufacturing, numerical simulation plays a crucial role, not only enhancing industrial value but also accelerating the speed of product development. In the manufacturing of aluminum alloys, the hot tandem rolling process is one of the key processes that significantly influences the microstructure and texture of the final products. Compared to the cold rolling process, the hot rolling process includes more complex deformation mechanisms. However, only few studies directly take the influence of thermal process parameters into account, which makes it difficult to simulate the texture accurately in hot rolling process. In this research, a Taylor-typed model with consideration of crystal plastic and rate sensitivity was built to simulate the texture evolution of AA1100 aluminum alloy under different thermomechanical parameters, including temperature, strain and strain rate. Extensive experimental and simulation data of hot rolling process were compared and linked. The hot rolling experimental results show that the S component of deformation texture and the RC component of recrystallization texture dominate during hot rolling process. For specific thermomechanical process parameters, the simulation results exhibit a high correlation with the experimental results, with an R2 value of 0.88 and the difference in volume fraction of texture components fall within the range of 1% to 5%. Moreover, the model has been successfully applied to multi-tandem hot rolling texture simulation, enhancing the predictive capability of texture component in the aluminum alloy industry to increase industrial added value.
JA507 **13:45-14:00**	Influence of Graphene Coating in Electrical Discharge Machining (EDM) with Graphite Electrode Israa Dheyaa Khalaf Alrubaye, Gualtiero Fantoni, Davide Melis, Massimo Arcioni, Dario Clori Presenter: Israa Dheyaa Khalaf Alrubaye, University of Pisa, Italy Abstract: Electrode wear plays a critical role in evaluating the performance of Electrical Discharge Machining (EDM) due to its impact on final shapes and total machining costs associated with electrode replacement. To address this issue, coating technology has emerged as a promising approach to reduce electrode wear and enhance the EDM process. This study investigates the effects of different coating types on the performance of graphite electrodes in EDM. Three electrodes were used: a non-coated graphite electrode, a graphite electrode coated with pure graphene, and a graphite electrode

	coated with a graphene/zirconium composite. Eleven experiments were conducted for each electrode for roughing and finishing EDM phases at various cutting depths. A comprehensive comparison was performed based on the total machining time, electrode wear, and surface roughness values of all machined surfaces. The findings have revealed that the use of a coated electrode, specifically with graphene/zirconium, yielded superior surface roughness results in finishing EDM phases. Additionally, the graphene/zirconium-coated electrode in most cases has shown a machining time reduction, compared with graphene-coated and uncoated electrodes. Furthermore, in some experiments concerning finishing phases, the use of coated electrodes has confirmed a wear reduction, a further benefit that enhances geometrical accuracy as well as reduces total costs. These results contribute to understanding the effects of coating technologies on EDM processes by providing valuable information making this technology increasingly competitive compared with other subtractive machining technologies.
CE302 **14:00-14:15**	Computational Analysis for Failure of a Metal Rod Suchakree Euaumpon, Vichayuth Satja, Thira Jearsiripongkul Presenter: Thira Jearsiripongkul, Thammasat University, Thailand Abstract: The objective of this research is to study the trend of natural frequencies between a uniform rod and a cracked rod with various crack positions by equations based on the non-local elasticity theory. For this study, we study a uniform fixed-free rod undergoing a free longitudinal vibration. The results of the natural frequency obtained from the eigenfunction for the cracked rod yielded results that correspond with the theory that the natural frequency was supposed to decrease if cracks are present.
CE306 **14:15-14:30**	Modified ArCAI for Quadrotor under Rotor Failure Yu Hirayama, Kenji Uchiyama, and Kai Masuda Presenter: Yu Hirayama, Nihon University, Japan Abstract: Rotor failure is a significant factor in unmanned aircraft system accidents. In particular, the rotor failure heavily affects a quadrotor because its controller depends on rotor torque and thrust. Then, the fault tolerance control (FTC) system is adapted to a quadrotor controller. On the other hand, the traditional FTC system focuses only on its effect or not for failure; it is difficult to compensate for the performance of a failed quadrotor. The degree of controllability (DOC) is proposed to represent how controllable a given system is. The DOC is defined as the norm between the outer boundary of the stability point and the recovery region. The Available Reduced Control Authority Index (ArCAI) uses the DOC to analyze the controllability of a multirotor under rotor failure. However, the failed quadrotor DOC cannot be calculated accurately by the ArCAI because the criterion does not consider the gyroscopic moment generated by the yawing of the quadrotor. Therefore, we propose a new analysis method of controllability for quadrotors under rotor failure called modified ArCAI. The method calculates the accurate DOC of a failed quadrotor by considering the gyroscopic moment for its dynamics. We verified the validity of the modified ArCAI through numerical simulation.

CE310 **14:30-14:45**	A Human-Centric Assembly 4.0 System – The Workers' Perspective Jacqueline Humphries, Pepijn Van de Ven, Alan Ryan Presenter: Jacqueline Humphries, Technological University of the Shannon, Ireland Abstract: In Industry 4.0, manual assembly has become more complex. This complexity brings challenges for operators who are expected to work on a wider range of un-familiar assemblies and results in greater opportunity for error. However the dig-ital transformation that enabled Industry 4.0 can be applied to Assembly Systems in a concept known as Assembly Systems 4.0. It is important though that these systems are not just data-driven, but based on the new schools of thought on Quality 4.0 and Operator 4.0, which are human-centric. An industry exemplar Assembly 4.0 system is built, and evaluated in a case study. This system leverages technologies such as machine learning to augment the operator in the assembly of products, by the provision of context-specific timely instructions and feedback. In this system the operator is empowered by data to be their own quality assessor, where assembly data is presented to the op-erator allowing them to rework the assembly if necessary. User satisfaction is essential for adoption, and so the system is evaluated with operators from a satisfaction perspective, using the System Usability Scale. Ten operators participated in the study. The system is ranked by operators on the 99% percentile, with an adjective rating of 'best imaginable'.
CE332 **14:45-15:00**	Evaluating the Impact of an Assembly System 4.0 on Human Error Jacqueline Humphries, Pepijn Van de Ven, Alan Ryan Presenter: Jacqueline Humphries, Technological University of the Shannon, Ireland Abstract: Assembly Systems assist the human in manufacturing by providing easy access to the assembly procedure. However, they are static systems that provide the same information to all users. Assembly Systems 4.0 are a relatively new concept that use data-driven insights to assist the human by providing context-specific information about the assembly process. Assembly Systems 4.0 should have a positive impact on reducing human error in manufacturing. In this research the utility of an Assembly System 4.0 is evaluated. Two experiments are conducted to investigate potential effects on human performance from the lens of error and failed quality parts. Through the first experiment, a laboratory simulation, it is proven that the Assembly System 4.0 can detect human error. In the second experiment, the system is compared against a traditional Assembly System. Four hundred assemblies are conducted, in a two-independent sample test. It is found that neither system prevents human error from occurring. However how the error is treated is significant. The users of the Assembly System 4.0 detected, and corrected the errors, producing higher quality products.
JA519 **15:00-15:15**	Parametric Analysis of Metal Matrix Syntactic Foams Imre Czinege, Imre Fekete Presenter: Imre Czinege, Széchenyi István University, Hungary Abstract: Metal matrix syntactic foams are playing an increasingly important role in

	vehicle structures. Their application is primarily aimed at weight reduction, resulting in significant energy savings in the operation of vehicles. In doing so, they contribute to sustainable development, either by reducing the use of fossil energy in case of conventional cars, resulting in reduced carbon dioxide emissions, or by increasing the range of electric vehicles with the same battery capacity. Therefore, considerable attention has been paid to the development of these materials in recent decades. This publication supports sustainable development through the optimization of properties relevant for their use. The strength of metal matrix syntactic foams is determined by their two main components, the matrix and the filler. The tendency of their effects is known from experiments, and several models have been published in the literature based on them. However, little information is available to quantitatively characterize the relationships between input and output parameters. The present research uses sensitivity analysis, response surface methodology and principal component analysis to quantify the effect of matrix yield strength, matrix-to-filler ratio, ceramic sphere wall strength and wall thickness to diameter ratio on the critical compressive strength of metal matrix syntactic foam. The model calculations were performed using data from the literature and includes verification of the models used, followed by calculation and comparison of the defined sensitivity parameters. The constraints between the input parameters were characterized by appropriate process windows. It was found that the developed new process windows are suitable for the preliminary design of metal matrix syntactic foams.
JA512 **15:15-15:30**	Antimicrobial Activity and Biocompatible Performance of Sputtered TiO2/Cu Films on Ti6Al4V Alloy Maria Plamenova Nikolova, Yordan Handzhiyski, Veronika Ivanova, Andreana Andreeva, Stefan Valkov, Maria Ormanova, Margarita Dimitrova Apostolova Presenter: Maria Plamenova Nikolova, University of Ruse, Department of Material Science and Technology, Bulgaria Abstract: This work aims to deposit nanostructured TiO2/Cu multifunctional coatings by sputtering in a glow-discharge on Ti6Al4V alloy and in vitro inves-tigation of their antimicrobial activity and biocompatible performance. Before the deposition, the substrates were dual acid etched to obtain a microroughened surface. After depositing TiO2 coatings, to obtain overlaying Cu film, the depo-sition time was varied to reach a different amount of nanostructured copper on the surface. The influence of the deposition time of Cu on the roughness, structure and composition of the hybrid coating was investigated by atomic force micros-copy (AFM), scanning electron microscopy (SEM) with energy-dispersive X-ray spectroscopy (EDS) and X-ray diffraction (XRD) analysis. The corrosion re-sistance and release of Cu from the coating were investigated in simulated body fluid (SBF) at 37°C. The antimicrobial efficacy of the Cu/TiO2-coated Ti6Al4V substrates was examined using the direct contact experiment. The results have shown that hydrophobicity and copper ion release increase with the increase in Cu deposition time whereas the roughness and corrosion resistance decrease with the increase in surface Cu content. Due to the formation of TiO2/Cu2O-containing films TiO2/Cu-coated Ti6Al4V samples have up to 98% higher antimicrobial ac-tivity than the

	substrates. At the same time, human osteosarcoma (MG63) cells growing on TiO2/Cu-coated Ti6Al4V substrates showed lower viability after 24 h incubation compared to the control. Depending on the deposition time of the sputtering process, different amounts of Cu were released which affected the bi-ocompatibility and antimicrobial activity of the coatings.

Author Parallel Session 3

Topic: Advanced Control Methods for Autonomous Vehicles
15:50-18:20, January 26 | Room: K507 (Kende Street -5th Floor)
Session Chair: Prof.Kenji Uchiyama, Nihon University, Japan

CE318 **15:50-16:05**	Advanced Motion Planning Method for Unmanned Vehicles to Consider 3d Objects Dénes Tompos, Tamás Hegedűs, Balázs Németh Presenter: Dénes Tompos, Grenoble INP / UGA, France Abstract:This paper proposes a motion planning method which focuses on the consideration of moving 3D objects along the route of theunmanned vehicles. The goal of the method is to detect conflict situationsand to avoid collisions to the objects. The proposed method continuouslyrecognizes conflict situations using a clustering algorithm. The motionplanning with a reinforcement-learning-based (RL) agent is facilitated,which can result in efficient and collision-free motion. The effectiveness ofthe method is illustrated on the route planning for an unmanned drone,which has to fly in an area with moving obstacles.
CE322 **16:05-16:20**	PID Controller Design for an Active Air Suspension System on Passenger Bus Trong Tu Do, Van Tan Vu, Olivier Sename, Peter Gaspar Presenter: Olivier Sename, Grenoble INP / UGA, France Abstract: This study concerns a dynamic vertical quarter model of a passenger bus using with an innovative air suspension system. A PID controller is designed to adjust air spring element stiffness through pressure modulation. The air sus-pension system on the vehicle model is compared to traditional leaf spring with alterations in stiffness. The investigation reveals compelling results, showcasing the remarkable improvements achieved by the proposed model and controller. Specifically, the observation makes a remarkable 87.1% reduction in sprung mass acceleration and a substantial 76.6% decrease in displacement for two road surface excitation scenarios, while the variables that characterize the safety of movement of the vehicle is the displacement of the suspended mass, which is reduced by about 80%. These results underscore the potential for enhanced road holding and ride comfort through advanced air suspension control strategies.
CE323 **16:20-16:35**	Linear Parameter Varying and Reinforcement Learning Approaches for Trajectory Tracking Controller of Autonomous Vehicles András Mihály, Vu Van Tan, Do Trong Tu, Kieu Duc Thinh, Nguyen Van Vinh, Péter Gáspár Presenter: András Mihály, Hungarian Research Network Institute for Computer Science and Control, Magyarország Abstract: This research focuses on controlling the motion trajectory of autonomous vehicles by using a combination of two high-performance control methods: Linear Parameter Varying (LPV) and Reinforcement Learning (RL). First, a single-track motion model is researched and developed with coordinate systems to determine the car's motion trajectory through signals from GPS. Then the LPV control method is used to design a controller to control the car's motion trajectory. Reinforcement learning method with detailed training procedures is used to

	combine with the advantages of LPV controller. Finally, the simulation results are evaluated in the time domain through the use of specialized Car-Sim software, which clearly demonstrates the superiority of the research method.
CE325 **16:35-16:50**	Safe Control Framework of Autonomous Vehicles for Collision Prevention Attila Lelkó, Balázs Németh, Péter Gáspár Presenter: Attila Lelkó, HUN-REN Institute for Computer Science and Control, Hungary Abstract: This paper presents a safe control framework for autonomous vehicle systems with high-performance data-based elements e.g. a reinforcement learning-based agent. The controller is augmented with a classic robust controller and a supervisor to achieve the highest performance while providing stable and robust motion control even in critical situations. The supervisor prioritizes the control signal of the RL-agent, however, it is able to switch to the robust controller in potentially unsafe situations. The decision is based on a model-based predictive algorithm that uses the model of the vehicle to predict future motion. In addition, the predictive layer is able to detect if the vehicle is about to leave the road or crash with a nearby object is imminent by solving a nonlinear constrained optimization problem. The effectiveness of the proposed control method using a simulated scenario is illustrated.
CE331-A **16:50-17:05**	PI Control for Adjusting the Slew Rate of the Falling Edge of a High-voltage Pulser Jinsu An, Hyung-Sik Kim Presenter: Hyung-Sik Kim, Konkuk University, South Korea Abstract:In this study, a PI control circuit was developed to control the slew rate of the falling part of a high-voltage pulser. The system consists of a control unit, a booster unit, and an output unit. The control unit uses a microcontroller to control amplitude, inter-pulse interval, pulse width, pulse number, slew rate adjustment, charge, discharge, and PI control algorithm. The booster part is a flyback con-verter structure using UC3845D, which boosts the voltage and charges the capac-itor bank. The output part is composed of an insulated gate bipolar transistor (IGBT), a power switching device, a relay, an electromagnet switch, and a capaci-tor bank, allowing the slew rate of the falling part to be adjusted. The amplitude of the output pulse is from 100 Volts to 3,000 Volts in 50 Volts increments, the interval between pulses is from 10 μs to 150 μs in 10 μs increments, the pulse width is from a minimum of 10 μs to a maximum of 150 μs in 10 μs units, and the number of pulses is It is configured to be adjustable from 1 to 15. In order to adjust the slew rate of the high-voltage pulse, the values of the four capacitor banks were set between 1000 μF and 2000 μF so that they could be adjusted in 16 steps. As a result of the experiment with a 100 Ω load, it was possible to con-trol the slew rate of the falling edge with time constants from 100 ms to 200 ms. From the results, it is thought that new pulse parameter research may be possible for studies that were applied only in the form of square wave pulses.
CE334 **17:05-17:20**	ML Based Methodology of The Truck Driving Evaluation Eugene Alooeff Presenter: Eugene Alooeff, ATEK, Poland Abstract: This work is devoted to the development of a methodology for as-sessing the performance of truck drivers in terms of safety, driving efficiency and use of working time in

	accordance with the AETR Convention. The purpose of this development is the introduction of automated systems aimed at complying with legislation on the work and rest hours of drivers, respecting vehicles and saving material resources at enterprises engaged in international transportation of goods.
JA502-A **17:20-17:35**	Optimal Vehicle Position Estimation Using Adaptive Unscented Kalman Filter Based on Sensor Fusion Giseo Park Presenter: Giseo Park, University of Ulsan, Republic of Korea Abstract: Vehicle position estimation systems can be utilized in a variety of automotive applications. Focusing primarily on practicality, this paper presents a new method for estimating vehicle velocity in real time using low-cost sensor fusion combining a global positioning system (GPS) and inertial measurement unit (IMU) sensors. In this paper, an adaptive unscented Kalman filter (AUKF) with excellent estimation accuracy and robustness against model nonlinearity is developed for vehicle position estimation. The proposed AUKF provides robust and highly accurate estimation of the vehicle position. It adjusts the noise covariance matrices in order to adapt to various environments, such as ever-changing GPS conditions. It is a practical solution that can be easily implemented in mass-produced vehicles due to its high availability, high estimation accuracy and high robustness against model nonlinearity. The estimation performance of the proposed AUKF is verified through experimental results using a test vehicle. Finally, the effectiveness of the proposed estimation algorithm can be confirmed through a comparative study.
CE315 **17:35-17:50**	Simulation Model Verification and Special Control Modes of DJI M600 Pro Multicopter Peter Bauer, Mihaly Nagy, Sandor Csurgai Presenter: Peter Bauer, HUN-REN SZTAKI, Hungary Abstract:This paper analyzes the Onboard Software Development Kit (OSDK) control modes of the DJI M600 Pro hexacopter drone and compares its factory flight simulator to real flight test results. First, the available OSDK control modes are listed together with the evaluated modes and the related references. Then the DJI simulator outputs are compared to real flight test results applying the same controllers. A separate section analyzes the found special control modes which give unexpected results from a control design point of view. The conclusion is the applicability of the DJI simulator for OSDK control development and design and the need for a standalone simulator making these tasks even more easier.
CE324 **17:50-18:05**	Tensor Product Type Polytopic LPV Model-based Active Flutter Suppression Design Bela Takarics, Balint Vanek Presenter: Béla Takarics, HUN-REN Institute for Computer Science and Control, Hungary Abstract: The paper presents a flutter suppression control design solution for flexible aircraft based on the linear parameter varying (LPV) framework. The aim of the flutter suppression controller is to increase the damping of the aeroelastic modes and to extend the aircraft's flutter free envelope. The control oriented aeroservoelastic (ASE) LPV model is developed based on the"bottom-up" modeling approach. The Tensor Product (TP) type polytopic approach of LPV modeling is considered in the paper. First, a grid based LPV model is

	obtained from the nonlinear by Jacobian linearization. Then, the Tensor Product (TP) type polytopic model of the aircraft is obtained from the grid based model via TP model transformation. TP model transformation is a numerical method based on the higher order singular value decomposition (HOSVD). It can generate various types of convex representations of LPV systems and offers a trade-off between the accuracy and the complexity of the resulting TP model. Flutter suppression controller is designed based on the TP type polytopic representation. The specific aircraft under consideration is the mini MUTT aircraft designed within the PAAW project. The developed control system is validated by simulations using the high-fidelity, nonlinear model and the TP type polytopic model based control solution is evaluated.
CE329 **18:05-18:20**	Multi-Agent Reinforcement Learning based Traffic Control for Urban Intersections using Variable Speed Limit Control XUAN FANG, Tamás Tettamanti Presenter: XUAN FANG, Budapest University of Technology and Economics, Hungary Abstract: As a typical traffic bottleneck, urban intersections are usually high-incidence areas for traffic congestion and traffic accidents. Instead of the classic approach to developing an adaptive traffic light, a novel approach is introduced to the urban intersection control problem where the speed limits of intersection approaches are regulated cooperatively in a dynamic fashion. The primary objective of this paper is the smoothing the turbulent traffic flow to reduce traffic conflicts in the urban intersection using Variable Speed Limit control (VSL) control. A Multi-Agent Reinforcement Learning (MARL) framework is utilized to get the optimal speed limits. The control effect was tested applying high-fidelity microscopic traffic simulation (SUMO). Moreover, the traffic conflicts were evaluated through the Surrogate Safety Assessment Model (SSAM). Simulation results show that the proposed MARL-based VSL control framework is a potential, effective control method to smooth traffic dynamics in general and to reduce accident risk at urban intersections. Compared with existing traffic safety strategies, our control method reduces the total traffic conflicts by 9.39%.

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