Conference Program

2025 the 9th International Conference on Mechanical Engineering and Robotics Research (ICMERR 2025)

Workshop

2025 4th International Conference on Power Electronics and Control Engineering (PECE 2025)

January 15 to 17, 2025

Barcelona, Spain

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lomar Y. Ismael, Ninevah University, Iraq

Chew Kuew Wai, Universiti Tunku Abdul Rahman, Malaysia

Chunhui Yang, Institute of Blood Transfusion, Chinese Academy of Medical Science, China

Welcome Message

Dear Distinguished Delegates,

Benvinguts a Barcelona! On behalf of the Universitat Politècnica de Catalunya, it is our great pleasure to welcome you to the 9th International Conference on Mechanical Engineering and Robotics Research (ICMERR) and its workshop PECE. As a leading institution in engineering and technology, we are honoured to host this prestigious gathering of researchers and practitioners from around the globe. We are eager to witness the exchange of knowledge and ideas that will undoubtedly shape the future of this dynamic field.

Barcelona, a city known for its vibrant culture, stunning architecture, and innovative spirit, provides the perfect backdrop for ICMERR 2025. We hope this dynamic environment will inspire fruitful discussions and collaborations that push the boundaries of mechanical engineering and robotics. Beyond the conference halls, we encourage you to explore the many treasures Barcelona has to offer. From the awe-inspiring Sagrada Familia to the charming streets of the Gothic Quarter, there is something to captivate every visitor.

We wish you a productive and memorable conference experience.

Yours sincerely,
ICMERR General Chair
Prof. Jordi Olivella, Polytechnic University of Catalonia, Spain

Dear Distinguished Delegates,

Welcome to the 9th International Conference on Mechanical Engineering and Robotics Research (ICMERR 2025) and the 4th International Conference on Power Electronics and Control Engineering (PECE 2025) in Barcelona! This year the conferences are hosted by Polytechnic University of Catalonia (UPC) in Barcelona and AGH University of Krakow, co-hosted by Warsaw University of Technology, sponsored by University of Crete, co-sponsored by IEEE and IEEE Robotics & Automation Society. INTECO Ltd and SENSORS are the patrons of this conference.

ICMERR aims to be one of the leading international conferences for presenting novel and fundamental advances in the fields of mechanical engineering and robotics. The conference brings together experts from academia and industry to promote interdisciplinary collaborations and facilitate the development of innovative solutions to real-world problems.

88 articles from all over the world were submitted to the conference. After peer review, 37 full papers were accepted. Congratulations to their authors! The accepted papers, after successful presentation, will be published as ICMERR2025 Conference Proceedings by IEEE, some selected papers will be published in the journals cooperating with us.

Over the next few days, we will be exploring the latest research and advancements in mechanical engineering, robotics, power electronics. The detailed Topics of this multidisciplinary conference cover almost 40 fields!

We hope that you will engage in insightful discussions, network with fellow researchers and experts, and gain valuable knowledge and inspiration from the presentations.

I would like to take this opportunity to thank all those who contributed to the realization of ICMERR 2025. I would like to thank Reviewers for taking the time and effort necessary to review the manuscripts. Thanks go to the Keynote Lecturers, who extend by now tradition of highest-level keynote lecturers at the ICMERR conferences. Special thanks to Professor Jordi Olivella Nadal from the Institute of Industrial and Control Engineering of UPC for his help in organizing and promoting the conference.

We look forward to a productive and rewarding conference experience together. Enjoy your time in Barcelona!

Yours sincerely,
ICMERR General Chair
Prof. Wojciech Grega, AGH University of Krakow, Poland

Conference Venue

NH Sants Barcelona

Address: Carrer de Numància, 74, Les Corts, 08029 Barcelona, Spain
Email: nhsantsbarcelona@nh-hotels.com

Time Zone

UTC/GMT+1

Important Notes

- ✧ Please take care of your belongings during the conference. The conference organizer does not assume any possibility for the loss of personal belongings of the participants.
- ✧ Please wear delegate badge during the conference. There will be NO access for people without a badge. Never discard your badge at will.
- ✧ Accommodation is not provided. Early reservation is suggested to be made for delegates.
- ✧ Please show the badge and meal coupons during lunch and dinner.
- ✧ Don't stay too late in the city and don't be alone in the remote area. Be aware of the strangers who offer you service, signature of charity, etc., at scenic spots. More Tourist Information and Security tips are available online.
- ✧ Delegates are advised to carry sufficient cash with them when travelling around.

Important Phone Numbers

Emergency alarm telephone: 112 Medical Emergency: 061 Fire Alarm Call: 080/085

Police Call: 091

January Climate & Weather Averages in Barcelona

High Temp: 13 °C Low Temp: 4 °C Mean Temp: 8 °C

Online APP

ZOOM Download Link: https://zoom.us/download

ZOOM Using & Presentation Instruction:

https://icmerr.com/kits.rar

Please rename your screen name before entering the room

Rename Screen Name Before Entering the Room	Examples
Authors: Paper ID-Name	BC101-San Zhang
Delegate: Delegate- Name	Delegate-San Zhang
Keynote Speaker: Keynote-Name	Keynote-San Zhang
Committee Member: Committee-Name	Committee-San Zhang

Materials Prepared by the Presenters

✧ **Oral Presentation:**

PowerPoint or PDF files

PowerPoint Background Template: https://icmerr.com/kits.rar

Duration of Each Presentation

✧ Keynote Speech: 40 Minutes of Presentation including Q&A.

✧ Invited Speech: 25 Minutes of Presentation including Q&A.

✧ Regular Oral Presentation: 15 Minutes of Presentation including Q&A.

Note

✧ The regular oral presentation time arrangement is for reference only. In case any absence or some presentations are less than 15 minutes, please join your session before it starts.

An excellent presentation will be selected from each session which will be announced and awarded an excellent presentation certificate.

Keynote Speaker I

January 16, Thursday, 09:40-10:20, GMT+1, Madrid Time

ZOOM Link: https://us02web.zoom.us/j/89859743431

ZOOM ID: 898 5974 3431

Password: 011517

Meeting Room: Salon Niagara (-1 Floor)

Prof. Hamid Reza Karimi

Politecnico di Milano, Italy

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

Speech Title: Intelligent Soft Sensing and Prediction for Industrial Applications

Abstract: In this talk, we explore innovative methodologies for efficient and cost-effective process optimization in industrial applications. Soft sensing refers to approximating hard-to-measure variables using easy-to-measure ones under the constraint of the current instant, whereas prediction extends the focus to future horizons. The presentation highlights several novel soft sensing and prediction frameworks developed for two specific case studies: industrial aluminum electrolysis and undermining systems. These frameworks leverage semi-supervised and self-supervised learning to address few-shot labeled sample scenarios while maintaining performance integrity. Furthermore, a unified prediction and control framework is proposed, enabling full-scale AI-based applications for these industries. The talk concludes with key insights and future directions.

Bio: Hamid Reza Karimi is Professor of Applied Mechanics with the Department of Mechanical Engineering, Politecnico di Milano, Milan, Italy and the Honorary Visiting Professor within the School of Computing & Engineering at the University of Huddersfield, UK. Prof. 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. Prof. Karimi is an ordinary Member of Academia Europa (MAE), Honorary Academic Member of National Academy of Sciences of Bolivia, 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, the IFAC Technical Committee on Automotive Control as well as member of the board of Directors of The International Institute of Acoustics and Vibration (IIAV). Prof. Karimi is the recipient of the 2021 BINDT CM Innovation Award, the 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. Prof. 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.

Keynote Speaker II

January 16, Thursday, 10:20-11:00, GMT+1, Madrid Time

ZOOM Link: https://us02web.zoom.us/j/89859743431

ZOOM ID: 898 5974 3431

Password: 011517

Meeting Room: Salon Niagara (-1 Floor)

Assoc. Prof. Bruno Domenech

Technical University of Catalonia, Spain

Serra Húnter Fellow

Speech Title: Introducing Scheduling Flexibility into Industrial Productive Systems to Enable Energy Transition

Abstract: The penetration of renewable energy sources into the national electric grid matrices forces the need to increasing flexibility in different ways (grid, storage and demand-side). A key strategy is Industrial Demand Response, especially for intensive electricity consumers. In this context, several initiatives aim to adapt industrial production planning and scheduling to the renewable generation and offer flexibility to electricity markets. The Flex4Fact project gathers five European industries and analyses how their production scheduling can be adapted to take higher advantage of renewable self-generation facilities and offer flexibility of the cluster as a whole. For this purpose, Digital Twins of industrial processes allow identifying flexibility options and scheduling algorithms aim to optimise production while taking into account the energy vector. As future research, robotics and automation systems are expected to increase flexibility options.

Bio: Dr. Bruno Domenech is Associate Professor at the Department of Management of the Technical University of Catalonia (UPC). His research, within the framework of the Institute of Industrial and Control Engineering (IOC) and the research group on Design and Optimisation of Processes and Services (DOPS), focuses on the application of quantitative methods to solve industrial problems with an applied, social and sustainable approach. In particular, his main research areas are: energy planning and production management. He has participated in several European, Spanish and local research projects, and he is (co)author of more than 50 publications, including books, book chapters and JCR papers.

Keynote Speaker III

January 16, Thursday, 11:30-12:10, GMT+1, Madrid Time

ZOOM Link: https://us02web.zoom.us/j/89859743431

ZOOM ID: 898 5974 3431

Password: 011517

Meeting Room: Salon Niagara (-1 Floor)

Prof. Joanna Kwiecień

AGH University of Krakow, Poland

Speech Title: Process Management with Augmented Reality And Mobile Devices

Abstract: The speech will cover the aspect of modeling and describing real industrial processes. Such a process integrates augmented reality (AR), mobile devices, rule systems and various methods of articial intelligence, such as image analysis using deep learning methods. A framework of maintenance process supported by augmented reality and mobile devices (which collect data from measurements) to support employees during repair and service procedures will be presented. This system uses interactive AR goggles, and integrates solutions that use augmented reality to visualize objects in 3D space. This solution significantly increases work safety. Moreover, some challenges and future directions from process management perspective will be discussed.

Bio: Joanna Kwiecień - a Professor at AGH University of Krakow. She received her PhD degree in Automatics and Robotics, and DSc degree at AGH-UST in 2004, and 2019, respectively. She is a specialist on methods and algorithms of artificial intelligence (mainly swarm intelligence), which have many applications in robotics (e.g. path planning, swarm robotics). Her interests include also modeling and optimization of real systems, discrete optimization, and decision making. She is the author and co-author of over 50 national and international research papers. She has been a reviewer for several international conferences and journals, such as: IEEE Transactions on Industrial Informatics, Expert Systems with Applications, Swarm and Evolutionary Computation. She has been involved in research projects as one of the contractors - most of them has been funded by The National Centre for Research and Development (NCBR).

Keynote Speaker IV

January 16, Thursday, 12:10-12:50, GMT+1, Madrid Time

ZOOM Link: https://us02web.zoom.us/j/89859743431

ZOOM ID: 898 5974 3431

Password: 011517

Meeting Room: Salon Niagara (-1 Floor)

Assoc. Prof. M. Ilhan Akbas

Embry-Riddle Aeronautical University, Daytona Beach, Florida, USA

Speech Title: Validation and Verification of Autonomous Vehicles: Landscape, Challenges and an Open-Source Validation Platform, PolyVerif

Abstract: The validation and verification (V&V) of Artificial Intelligence (AI) based cyber-physical systems, such as Autonomous Vehicles (AVs), remains a complex and unresolved challenge. AVs incorporate subsystems in areas including detection, sensor fusion, localization, perception, and path planning, each of which integrates substantial AI/ML content with traditional hardware and software components. The intricacy involved in validating even a single subsystem is formidable, and the task of validating the entire system is exceedingly arduous. Thus, fundamental research aimed at advancing the state-of-the-art in AV V&V is imperative. However, V&V researchers encounter significant obstacles due to the extensive infrastructure required to demonstrate the feasibility of any proposed solutions. This talk presents PolyVerif, an open-source initiative dedicated to expediting advancements in AV V&V research. This framework offers an AI design and verification architecture that includes a digital twin creation process, an open-source AV engine, access to multiple open-source physics-based simulators, and an open-source symbolic test generation engine. PolyVerif aims to equip V&V researchers with a framework that extends the state-of-the-art along any of the major axes of interest, utilizing the remaining infrastructure to promptly showcase the feasibility of their solutions. The open-source nature also provides the opportunity for researchers to contribute their innovations to the project. The talk will also include examples from several past and ongoing projects leveraging PolyVerif.

Bio: Dr. M. Ilhan Akbas, associate professor at the Electrical Engineering and Computer Science Department, co-director of WIDE Lab, and a member of the leadership team of the Center for Aerospace Resilient Systems (CARS) at Embry-Riddle Aeronautical University (ERAU), has over 20 years of experience in the complex systems, modeling and simulation, and validation & verification. He was a founding member of the Advanced Mobility Institute at Florida Polytechnic University before joining ERAU. He also has more than eight years of defense

industry and enterprise level software development experience. Dr. Akbas and his research group's research has been supported through grants from agencies such as National Science Foundation, Federal Aviation Administration, Office of Naval Research, as well as industry. He is a member of IEEE, ACM, AIAA, SAE, International Alliance for Mobility Testing and Standardization, Complex Systems Society and Cyber Safety Commercial Aviation Team.

Invited Speaker I

January 16, Thursday, 14:00-14:25, GMT+1, Madrid Time
Meeting Room: Salon Niagara (-1 Floor)

Assoc. Prof. Ali Abolfathi

University College London, United Kingdom

Speech Title: Novel Flapping-wing Micro Aerial Vehicles Utilising Dynamic Amplification

Abstract: This paper introduces a novel design for flapping wing micro aerial vehicles (FWMAVs) that employs dynamic amplification. By utilising mechanical resonance, the design amplifies wing stroke and pitching motions, reducing the energy requirement while enhancing lift production. This approach also minimises the maximum strain on the actuator, thereby improving its structural integrity. A comprehensive mathematical model of the flapping mechanism is developed, incorporating the electromechanical characteristics of piezoelectric materials, nonlinear structural dynamics and aerodynamics. Numerical simulations using MATLAB and Simulink demonstrate the advantages of dynamic amplification, showing a significant improvement in lift generation compared to rigidly structured flapping systems. Using a practical actuator and wing setup, the model predicts a stroke angle of 45 °, a pitching angle of 67 °, a lift generation of 28.4 mN, and average input and output powers of 6.7 mW and 2.9 mW, respectively. This design approach offers a promising pathway for developing high-performance FWMAVs, with potential applications in autonomous flight operations.

Bio: Dr Ali Abolfathi is currently an Associate Professor in the Department of Mechanical Engineering at UCL. He completed his PhD in nonlinear vibrations at the ISVR, University of Southampton, UK. He has worked at the industry and other UK institutions before joining UCL in 2016. Dr Abolfathi leads the Advanced Dynamical Systems Lab at UCL Mechanical Engineering, with research interests spanning nonlinear dynamics, bioinspired micro-flapping wing drones, insect flight mechanisms, and energy harvesting from fluid-induced oscillations. He has supervised over 80 MSc and PhD students and has published extensively in high-impact journals.

Invited Speaker II

January 17, Friday, 09:00-09:25, GMT+1, Madrid Time

ZOOM Link: https://us02web.zoom.us/j/89859743431

ZOOM ID: 898 5974 3431

Password: 011517

Assoc. Prof. Qingshan Wu

Xi'an University of Technology, China

Speech Title: Design and Analysis of Efficient Desert straw checkerboard Laying Machine Based on PLC Automatic Control Technology

Abstract: As a method to prevent soil erosion in deserts and develop sandy agriculture, straw checkerboard laying technology has been widely recognized and has been successfully applied in various parts of the world. In order to solve the problems of high labor intensity and low efficiency in manually laying desert straw checkerboard, this paper designs an efficient desert straw checkerboard laying machine based on PLC and single-chip microcomputer automatic control technology. The desert straw checkerboard laying machine mainly consists of five parts: tractor, power unit, slotted plow assembly, cam hammer assembly, and walking assembly. In the structural design, CATIA software is used to design the mechanical structure of the laying machine, and the finite element analysis software Simulation is used to perform static analysis on key components. The results show that the maximum deformation and maximum stress of the parts are within the allowable range of the material. The monitoring system uses modern common sensing.

Bio: Qingshan Wu, Associate Professor,A teacher of Xi'an Technology and Business College, representative of the 17th National People's Congress of Xi 'an Gaoling District, special supervisor of Gaoling District Supervision Committee, Special Commissioner of Science and Technology Department of Shaanxi Province, member of IEEE (ICMEE, ICMERR, RAAI) Professional Committee, member of the Expert Database of Undergraduate and Graduate Education dissertation Sampling Review of the Ministry of Education of China. Xi 'an Gaoling District Luyuan Middle School vice principal of science and technology. Main research directions: Mechanical design and theory, 3D CAD/CAM digital design and analysis, mathematical algorithms and agricultural machinery, innovation and entrepreneurship education.

In recent years, He have hosted or participated in 9 provincial and school-level educational reform projects and scientific research fund projects. He have published 16 papers (including 3 papers indexed by EI and Scopus; 1 paper indexed by the prestigious Chinese academic journal), applied for 11 patents and software copyrights. He have guided 11 student projects to apply for the "Student Innovation and Entrepreneurship Training Program of Shaanxi

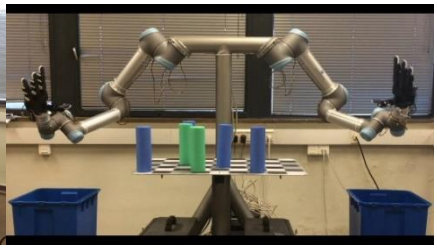
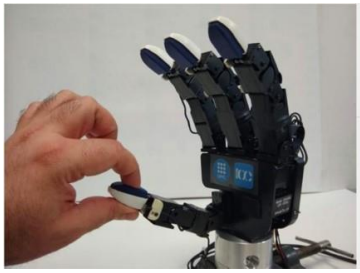
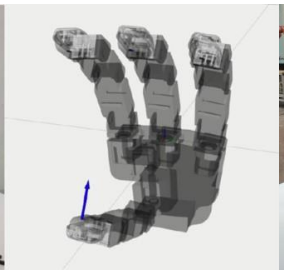
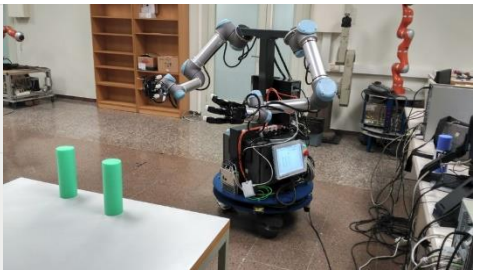
Provincial Education Department," 11 of which were approved at the provincial level and 3 at the national level. He have guided students to participate in national competitions such as the 3D Digital Design Competition, the National Mechanical Innovation Design Competition, and the China "Internet Plus" University Student Innovation and Entrepreneurship Competition, winning over 20 national first, second, and third prizes and over 70 provincial prizes.

He has received numerous honorary titles, including "Outstanding Worker of Shaanxi Education Department" and "Advanced Individual of the Ministry of Education's Graduate Employment Association.", a teacher at the School of Mechanical and Electrical Engineering, is a representative of the 17th People's Congress of Gaoliang District, Xi'an City, a special monitor for the Gaoliang District Supervisory Commission, a science and technology special envoy of the Shaanxi Science and Technology Department, a member of the EI paper review expert panel of the IEEE (ICMEE, ICMERR, RAAI), a member of the Evaluation Expert Panel for Bachelor's and Master's Degree Education Graduation Theses of the Ministry of Education, and the vice principal for science and technology of Luyuan Middle School in Gaoliang District, Xi'an City.

In recent years, he has served as the principal investigator or co-investigator for one key project of Shaanxi Province's educational reform and three provincial research projects, as well as six projects funded by the Gaoliang District President's Research Fund. He has published 16 academic papers, including three papers indexed by EI and Scopus and one paper indexed by CSSCI. He has also filed for nine patents. He has guided 11 students to apply for the Shaanxi Education Department's "College Student Innovation and Entrepreneurship Training Plan Project," with eight projects approved at the provincial level and three at the national level. He has guided students to win more than 20 national first, second, and third prizes in various science and technology competitions, including the 3D Digital Design Competition, the National Mechanical Innovation Design Competition, and the China "Internet Plus" College Student Innovation and Entrepreneurship Competition. They have also won more than 70 provincial prizes.

Wu has received numerous honorary titles, including "Outstanding Worker of Shaanxi Education Department" and "Advanced Individual of the Ministry of Education's Graduate Employment Association."

Introduction to Institute of Industrial and Control Engineering of Universitat Politècnica de Catalunya


The **Institute of Industrial and Control Engineering (IOC)** is a university research institute of the Universitat Politècnica de Catalunya (UPC) located at the ETSEIB building. Its activities follow a path that started more than thirty years ago, including research, academic courses and technology transfer. These activities are developed in transversal areas such as automation, artificial intelligence, computer science, industrial engineering.

The staff is composed of researchers, professors, technical support, undergraduate and postgraduate students, and administration. Part of the staff is shared with different departments of the UPC, providing the IOC with multidisciplinary character.

The infrastructure counts with laboratories for each of the divisions, an internal network of computers, servers and workplaces, and specialized library comprising over six thousand volumes and numerous journals.

The IOC fosters the relationship with both Spanish and foreign research centers in order to promote the connection in related research areas and encourages the international exchange of research experiences.

All the activities are possible thanks to public funds via both European and national research and collaboration projects, agreements with companies, academic courses via official masters and recognized doctoral programs.

Day 1- January 15, 2025 (Wednesday, GMT+1, Madrid Time)

Onsite Sign-in		
Time	**Event**	**Venue**
13:00-17:00	Onsite Sign-in	NH Sants Barcelona Lobby
15:00-17:00	Visit the Institute of Industrial and Control Engineering of Universitat Politècnica de Catalunya For details, please visit page 19	Gather at NH Sants Barcelona Lobby at 15:00

Online Pretest		
Time	**Presenters**	**ZOOM Information**
09:00-12:00	Keynote Speakers (Online), Invited Speaker (Online), Session Chairs (Online), Committee Members (Online)	ZOOM Link: https://us02web.zoom.us/j/89859743431 ZOOM ID: 898 5974 3431 Password: 011517
09:00-12:00	**Online Session 1: Engineering Robots and Intelligent Mechanical Systems** BC182, BC154, BC164, BC121, BC125, BC172-A, BC145, BC178-A, BC163	
	Online Session 2: Radar-based Signal Detection and Mechanical System Performance Analysis BC138, BC131, BC127, BC188, BC175-A, BC126, BC181, BC3005	

Online Test Tips:

- ✧ Please get your presentation file ready for the pretest.
- ✧ Please unmute audio and start video while your presentation.
- ✧ It's suggested to use headset with microphone or earphone with microphone.

Day 2- January 16, 2025 (Thursday, GMT+1, Madrid Time)

Opening Ceremony and Keynote Speeches Onsite Meeting Room –Salon Niagara (-1 Floor) Zoom ID: 898 5974 3431 Zoom Link: https://us02web.zoom.us/j/89859743431 Password: 011517 **Host: Prof. Wojciech Grega, AGH University of Krakow, Poland**	
09:30-09:35	**Welcome Message** Prof. Jordi Olivella Polytechnic University of Catalonia, Spain
09:35-09:40	**Opening Remarks** Prof. Wojciech Grega AGH University of Krakow, Poland
09:40-10:20	**Keynote Speech I** Prof. Hamid Reza Karimi Politecnico di Milano, Italy **Speech Title: Intelligent Soft Sensing and Prediction for Industrial Applications**
10:20-11:00	**Keynote Speech II** Assoc. Prof. Bruno Domenech Technical University of Catalonia, Spain **Speech Title: Introducing Scheduling Flexibility into Industrial Productive Systems to Enable Energy Transition**
11:00-11:30	**Group Photo & Coffee Break**
11:30-12:10	**Keynote Speech III** Prof. Joanna Kwiecień AGH University of Krakow, Poland **Speech Title: Process Management with Augmented Reality And Mobile Devices**
12:10-12:50	**Keynote Speech IV** Assoc. Prof. M. Ilhan Akbas Embry-Riddle Aeronautical University, Daytona Beach, Florida, USA **Speech Title: Validation and Verification of Autonomous Vehicles: Landscape, Challenges and an Open-Source Validation Platform, PolyVerif**
13:00-14:30	**Break & Lunch (NH Sants Barcelona Restaurant -1 Floor)**

14:30-16:25	Salon Niagara (-1 Floor)	**Onsite Session 1 -Power Machinery and Aerospace Engineering** **Session Chair:** Assoc. Prof. Ali Abolfathi, University College London, UK **Invited Speaker:** Assoc. Prof. Ali Abolfathi, University College London, UK BC168, BC150-A, BC144, BC137, BC177, BC122
14:30-16:30	Salon Sena (-1 Floor)	**Onsite Session 2 -Image-based Mechanical Equipment Detection and System Model** **Session Chair:** Prof. Wojciech Grega, AGH University of Krakow, Poland BC124, BC151, BC184-A, BC123, BC169, BC140, BC149, BC170
16:25-16:45		**Group Photo & Coffee Break**
16:40-18:25	Salon Niagara (-1 Floor)	**Onsite Session 3 -Modern Mechanical Theory and Manufacturing Technology** **Session Chair:** Prof. Sanjeev Kumar, Punjab Engineering College, Chandigarh, India BC176, BC159-A, BC148, BC119, BC118, BC183-A, BC167
16:45-18:45	Salon Sena (-1 Floor)	**Onsite Session 4 -Intelligent Robot Structure Design and Motion Control** **Session Chair:** Prof. Jordi Olivella, Polytechnic University of Catalonia, Spain BC115, BC141, BC116, BC185, BC114, BC157, BC186, BC189-A
19:00-20:00		**Dinner (NH Sants Barcelona Restaurant -1 Floor)**

Day 3 –January 17, 2025 (Friday, GMT+1, Madrid Time)

Online Sessions

Zoom Link: https://us02web.zoom.us/j/89859743431
Zoom ID: 898 5974 3431
Password: 011517

09:00-11:40	**Online Session 1 –Engineering Robots and Intelligent Mechanical Systems** **Session Chair:** Assoc. Prof. Hui Shan Lee, Universiti Tunku Abdul Rahman, Malaysia **Invited Speaker:** Assoc. Prof. Qingshan Wu, Xi'an Technology and Business College, China BC182, BC154, BC164, BC121, BC125, BC172-A, BC145, BC178-A, BC163
11:40-13:00	**Break Time**
13:00-15:00	**Online Session 2 –Radar-based Signal Detection and Mechanical System Performance Analysis** **Session Chair:** Prof. Hakim Kbab, University of Blida, Algeria BC138, BC131, BC127, BC188, BC175-A, BC126, BC181, BC3005

Onsite Session 1

Time: 14:30-16:25 (GMT+1, Madrid Time)
Date: Thursday, January 16
Venue: Salon Niagara (-1 Floor)
Topic: Power Machinery and Aerospace Engineering
Chaired by: Assoc. Prof. Ali Abolfathi, University College London, UK

Invited Speech **14:30-14:55**	**Title: Novel Flapping-wing Micro Aerial Vehicles Utilising Dynamic Amplification** **Authors:** Moonsoo Park and Ali Abolfathi **Invited Speaker:** Ali Abolfathi, University College London, UK **Abstract:** This paper introduces a novel design for flapping wing micro aerial vehicles (FWMAVs) that employs dynamic amplification. By utilising mechanical resonance, the design amplifies wing stroke and pitching motions, reducing the energy requirement while enhancing lift production. This approach also minimises the maximum strain on the actuator, thereby improving its structural integrity. A comprehensive mathematical model of the flapping mechanism is developed, incorporating the electromechanical characteristics of piezoelectric materials, nonlinear structural dynamics and aerodynamics. Numerical simulations using MATLAB and Simulink demonstrate the advantages of dynamic amplification, showing a significant improvement in lift generation compared to rigidly structured flapping systems. Using a practical actuator and wing setup, the model predicts a stroke angle of 45 °, a pitching angle of 67 °, a lift generation of 28.4 mN, and average input and output powers of 6.7 mW and 2.9 mW, respectively. This design approach offers a promising pathway for developing high-performance FWMAVs, with potential applications in autonomous flight operations.
BC168 **14:55-14:10**	**Title: Comparative Analysis of Power Consumption in Electric and Autonomous Vehicles** **Authors:** Fay Alzahrani, Dhay Alzahrani, Omar D. Mohammed, Jamal F. Nayfeh **Presenter:** Fay Alzahrani, Prince Mohammad Bin Fahd University, Saudi Arabia **Abstract:** Electric vehicles (EVs) and autonomous vehicles (AVs) are subject to increasing demands for sustainable transportation. In the current paper, a model design is developed that can fit both EV and AV applications. A comparative analysis is studied for power consumption between EVs and AVs, focusing on how the integration of autonomous systems influences energy efficiency. While both EVs and AVs contribute to sustainable transportation, the power demands of AVs are heightened due to the additional computational and sensor systems required for real-time decision-making and navigation. The study evaluates power consumption across several factors, including propulsion, sensor and onboard computation, and HVAC systems, under similar driving conditions. Results indicate that even when Avs and EVs have the same weight, AVs consume more power due to their advanced sensor suites and computational systems, leading to noticeable differences in power consumption across both urban and highway driving scenarios. The findings highlight the impact of automation on vehicle efficiency and provide insights into future design considerations for energy-efficient autonomous transportation. This paper aims to bridge existing gaps in the literature by offering a direct comparison of power usage between EVs and AVs, ultimately contributing to the development of more sustainable vehicle technologies.
BC150-A **14:10-15:25**	**Title: Review and Exploration of Flapping Mechanisms in Flapping Wing Unmanned Aerial Vehicles** **Authors:** Ken-I Tan, Bing Feng Ng **Presenter:** Ken-I Tan, Nanyang Technological University, Singapore **Abstract:** There has been an interest in increasing the efficiency of Unmanned Aerial Vehicles (UAVs) by mimicking the flying behaviour of birds. In the current literature, despite extensive

	studies on flapping wings, most of them are focused on small UAVs or micro air vehicles (MAVs). Although MAVs are also propelled by flapping methods, the flapping frequency is typically 10 Hz or higher and the wingspan is below 15cm. Some key characteristics of large Flapping Wing UAVs (FWUAVs) include low flapping frequencies of 2 to 6 Hz and mission objectives centred around efficiency, range and flight endurance. The focus of this presentation will be on reviewing state-of-the-art bird-inspired UAVs with a wingspan larger than 1 metre and discussing the technical challenges within, including the implications of mechanical complexity on the aircraft weight, and the difficulties of creating a flexible structure that can withstand aerodynamic loads during operation. Specifically, we will discuss the flapping mechanisms, aerodynamics, structural design, system integration and controls of the FWUAVs. Case studies from existing literature will be presented to provide the audience with an appreciation of the design workflow in developing large FWUAVs. This includes RoboEagle, which was developed using a design process focused on refining each design iteration based on the aerodynamic efficiency, which was validated using simulations and wind tunnel experiments. Another design, Smartbird, focuses on improving the structural integrity of such FWUAVs with relation to bending and torsional rigidity. Subsequently, the potential areas of improvement and exploration will be covered, including the mechanisms and the combination of different forms of flight to improve the flight performance. The presentation will then conclude by identifying technical gaps in large FWUAV design and recommend research directions.
BC144 **15:25-15:40**	**Title: Drag Reduction System with Sliding Variable Rear Wing for Enhanced Racing Car Performance** **Authors:** Shinji KAJIWARA, Cito TON **Presenter:** Shinji KAJIWARA, Kindai Universiy, Japan **Abstract:** Rear wings, designed to enhance driving performance and cornering stability, need to generate significant downforce at relatively low speeds. However, a large rear wing angle of attack increases aerodynamic drag at high speeds, reducing overall performance and fuel efficiency. To mitigate this, the goal is to decrease the angle of attack at high speeds, thereby reducing both downforce and drag, which in turn lowers fuel consumption. Conversely, at low speeds, such as during cornering, the angle of attack is increased to produce greater downforce and improve driving stability. To achieve both objectives, a DRS (Drag Reduction System) with a variable rear wing will be developed. The rear wing is designed with a two-stage configuration, where the lower stage slides, utilizing the tail section at the rear of the vehicle. Initially, the system's behavior was validated through both CAE analysis and wind tunnel testing, followed by the construction of a full-scale rear wing, which was tested on a Student Formula SAE vehicle to measure downforce. The results indicated that 80 N of downforce could be generated at a low speed of 30 km/h (8.3 m/s) and 145 N at a high speed of 50 km/h (13.9 m/s).
BC137 **15:40-15:55**	**Title: The CFD study of methanol-diesel dual fuel combustion for greener engine** **Author:** Osama Ghazal **Presenter:** Osama Ghazal, Zarqa University, Jordan **Abstract:** The use of methanol as a fuel for neat and dual-fuel combustion engines is being extensively researched within the internal combustion engine field. Introducing methanol into diesel dual-fuel engines has been found to lower the combustion temperature, resulting in reduced NOx, CO2 and soot emissions. The primary focus of the study is to optimize the combustion process parameters to enhance efficiency and reduce emissions in methanol-diesel dual-fuel engines. The research investigates the effects of the optimal diesel injection timing strategy as well as the diesel engine speed on engine performance and emissions, utilizing computational fluid dynamics (CFD) code. The study also involves creating a diesel engine model with a variable injection system to determine the best injection angle for methanol-diesel blends and neat diesel combustion mode along with engine speeds. The results of the study demonstrate that; using methanol fuel in neat and dual-fuel mode combined with optimum injection angle and speed is affect positively fuel economy, brake thermal efficiency, and greenhouse gas emissions reduction. The results are fully presented and discussed.

BC177 **15:55-16:10**	**Title: Control of a VTOL aircraft model with air-launched missile release impact and wind disturbances** **Authors:** Selim Sivrioğlu, Sinan Basaran **Presenter:** Selim Sivrioğlu, Turkey Piri Reis University **Abstract:** This study focuses on vertical take-off and landing (VTOL) unmanned aircraft, examining the impact of air-launched missile releases on the system. The release process not only disrupts the system's symmetric structure but also alters its mass and inertia parameters. To address these challenges, the study introduces a model to analyze the effects of missile releases and incorporates a wind turbulence model to evaluate aircraft performance under various scenarios.
BC122 **16:10-16:25**	**Title: Automatic Verification of Camera, Radar, LIDAR Sensors Synchronization and Calibration for Automotive Applications** **Authors:** Gaweł Bartosik, Mateusz Komorkiewicz, Dariusz Marchewka, Paweł Skruch **Presenter:** Dariusz Marchewka, Aptiv Services Poland S.A. **Abstract:** The development and verification of automotive perception systems require collecting data from various sensors mounted on a vehicle, such as cameras, radars, and LIDARs. It is not enough to simply record the data; maintaining proper calibration and synchronization between the sensors throughout the entire data recording process is crucial. This paper presents a device designed specifically to verify the calibration and synchronization of vehicle sensors, including LIDARs, radars, and cameras. The proposed solution utilizes a spinning disk that is precisely synchronized with an external clock signal, offering adjustable phase shifting and featuring permeable zones that act as shutters to trigger sensor activation. A cascade double-loop control system is implemented to minimize phase differences, ensuring high accuracy in synchronization. The quality of the synchronization mechanism was evaluated using an oscilloscope, with results showing a high level of precision. Finally, the device's effectiveness was validated through an experiment conducted on the target vehicle sensor system, confirming its efficiency in maintaining synchronization.

Onsite Session 2

Time: 14:30-16:30(GMT+1, Madrid Time)
Date: Thursday, January 16
Venue: Salon Sena (-1 Floor)
Topic: Image-based Mechanical Equipment Detection and System Model
Chaired by: Prof. Wojciech Grega, AGH University of Krakow, Poland

BC124 **14:30-14:45**	**Title: Comparison of Different Weld Bead Area Prediction Models for Overlay Deposition by Robot-based Cold Metal Transfer Process** **Authors:** Nitin Patel, Sunil Jha, Aman Nohwal **Presenter:** Nitin Patel, Indian Institute of Technology Delhi, India **Abstract:** Arc welding, a predominant joining process, is increasingly being utilized in new applications, particularly metal 3D printing. Before 3D printing a part, its 3D CAD model is sliced into thin layers. Accurate identification of the geometry of individual layers and proper hatch spacing between these layers are equally important. Both factors significantly influence the quality of the final metal part printed by a robot-based Cold metal transfer wire arc additive manufacturing (CMT-WAAM) process. Experiments were conducted based on a two-factor central composite rotatable design. The bead area measured from the bead profile is compared with the area predicted by different bead models and, it was found that at lower wire feed speed to torch ratio (≤ 8), the cosine model best predicts the weld bead profile area whereas at higher wire feed speed to torch ratio (> 8), the circular model best predicts the weld profile area. Further, these models have been utilized to identify the optimum hatch spacing, so that proper area filling could be achieved during the CMT-WAAM process. Based on this prediction, multi-bead horizontal overlay experiments were conducted that were found free from any kind of lack of fusion voids and produced minimal surface waviness. Extended inter-layer dwell time reduces heat accumulation but increases surface waviness and lack of fusion voids due to arc deflection and misalignment, resulting in uneven bead heights.
BC151 **14:45-15:00**	**Title: Video Streaming Protocols Comparison in Field Experiments for Aerial Teleoperation** **Authors:** Manuel J. Fernandez, Riccardo Francheschini, Julian Cayero and Matteo Fumagalli **Presenter:** Riccardo Franceschini, Eurecat, Spain **Abstract:** As aerial robots gain the ability to navigate freely and perform a wide range of tasks, it is crucial to keep the pilot at the core of the decision-making process. This ensures both mission safety and the incorporation of the pilot's expertise. Reliable data transmission between the robot and the pilot is essential for establishing effective collaboration. This paper presents a performance comparison of four video streaming protocols—RTP (Real-time Transport Protocol), RTSP (Real-Time Streaming Protocol), SRT (Secure Reliable Transport), and ROSTCP (ROS Transport Control Protocol)—based on field experiments. The study assesses each protocol's efficiency in terms of CPU consumption, network throughput, latency, streaming quality, and packet integrity over varying distances. Data were gathered using tools like iperf, ping, GStreamer, and Wireshark for comprehensive analysis. The results reveal significant performance differences based on distance: SRT and RTP excel in network stability and packet loss, while RTSP and ROSTCP demonstrate lower CPU consumption. This study offers valuable insights into optimizing video streaming for real-world applications, highlighting the strengths and trade-offs of each protocol.

BC184-A **15:00-15:15**	**Title: Deep Learning Techniques for Wafer Defect Pattern Analysis: Achivements and Challenges** **Authors:** Minjoo Kim, Jitae Shin **Presenter:** Minjoo Kim, Sungkyunkwan University, Republic of Korea **Abstract:** Wafer defect map images are generated by performing electrical tests on each chip on a wafer. These images demonstrate specific failure patterns occurred from a semiconductor manufacturing process. Since these patterns can cause other defects in a subsequent process, it is important for engineers to classify early what defect pattern this wafer has. In an attempt to automate the analytics of wafer defect maps, which is currently manual dependent, various machine learning and deep learning techniques have been introduced. In this study, we introduce various deep learning techniques developed for wafer defect map analysis. First, we introduce a lightweight supervised learning model that integrates the Inception Module and the Skip Connection Module for classification of wafer defect pattern images. The model is designed by considering both classification performance and computational volume. Second, we introduce a deep learning-based anomaly detection model for detecting unknown defect patterns without prior information. Recently, as semiconductor manufacturing processes become more complex and shrink, new types of defect patterns are continuously occurring, and methods for detecting them have become important. Finally, we introduce a YOLO-based object detection model. While defect pattern classification is important, finding the location and number of defect patterns is also important, which is very effective for detailed process cause analysis. In many fields, deep learning-based image analysis methods have already been firmly established as powerful tools. In this study, we introduce various deep learning techniques applied to real fields for wafer defect map analysis, and discuss the achivements of the application and future research directions.
BC123 **15:15-15:30**	**Title: Welding Defect Detection using Deep Learning and Semantic Segmentation** **Authors:** Aman Nohwal, Sunil Jha, Nitin Patel, Sivanandam Aravindan **Presenter:** Aman Nohwal, Indian Institute of Technology Delhi, India **Abstract:** Numerous computer-aided techniques have been created to automatically detect defects and imperfections in welding radiography images. The purpose of these strategies is to circumvent the challenges that are associated with human interpretation. In the subject of welding problem diagnostics, deep learning algorithms have garnered a substantial amount of attention due to the inherent benefits that they deliver. These advantages include powerful generalization capabilities and automated feature extraction techniques. Additional research is required, however, to investigate several various areas. These features include the gathering and improvement of welding radiography data, the selection and development of deep neural networks, and the enhancement of the model's capacity to be applied to a variety of situations while being easily understandable. This work intends to construct an automated system that can identify defects in welding by utilizing a semantic segmentation technique on radiographic images taken from a specific dataset of welds. This is taking into consideration the context in which this study is being conducted. Utilizing the UNet architecture, the procedure entails the training of several models, in addition to the incorporation of transfer learning strategies that utilize multiple backbones. A comprehensive comparative analysis is carried out after the model has been developed, and the evaluation criteria that are used are those that have been developed expressly for deep learning models. The results of the tests demonstrate that the method that was recommended is effective in precisely defining the boundaries of the various types of Defects and in faithfully identifying the various types of defects. In addition, the findings demonstrate that the system is capable of doing an automatic analysis of radiographic images to detect welding defects. Due to this fact, it is an indispensable component for quality inspection systems that are utilized in welding tasks

BC169 **15:30-15:45**	**Title: Energy Harvesting from Human Body Motion - Wearable System** **Authors:** Omar D. Mohammed, Haleema Al-Muneef, Wafa Al-Dossary, Jalilah Alforehe, Hala Alherz, Fatima Amsseri, Jood Alharbi. **Presenter:** Wafa Al-Dossary, Prince Mohammad Bin Fahd University, Saudi Arabia **Abstract:** Finding an effective, clean and sustainable power source, which is independent on traditional power sources, is becoming more necessary. The current work is under an ongoing project for Energy harvesting from human body motion, which aims to create an applicable physical system that uses a pendulum-to-rotary power conversion system to transform the kinetic energy of human body motion into electrical energy. The need for efficient, light and wearable power source mechanism is needed in different applications, such as mobile device chargers, smartwatches, fitness trackers and portable personal fans. In the current work a wearable device system is designed to improve energy production and make the device comfortable and user-friendly. Motion and power calculations are presented and the developed design is discussed in different studied cases. The generated power shows the effectiveness of this application. The studied device can be widely used in applications where energy is harvested and stored utilizing contemporary energy storage devices, allowing low-power gadgets to run continuously without needing to be charged. The initiative sets itself apart by offering an application-focused strategy that illustrates a practical way to incorporate energy harvesting into daily tasks.
BC140 **15:45-16:00**	**Title: Limited Field of View-Driven Path Planning for Human Search in Indoor Environments** **Authors:** Jeong-Seop Park, Miyoung Sim, Yong Jun Lee, Woo-Jin Ahn, Jong Jin Woo*, Myo Taeg Lim **Presenter:** Jeong-Seop Park, Korea University, Republic of Korea **Abstract:** This study proposes an innovative and efficient approach to indoor robot navigation by integrating Limited Field of View Optimization with Room Segmentation. Our method effectively maximizes both sensor coverage and path planning efficiency, setting it apart from traditional topology based navigation techniques that often fall short in complex indoor environments. Using ROS2 and Gazebo, we validate the algorithm in a simulated environment, where Voronoi Diagrams and Distance Transform Maps are employed for optimized node placement and path planning. Additionally, experiments conducted with a LiDAR- and HD camera-equipped robot in a real-world indoor setup demonstrate a notable 64% reduction in travel distance when compared to baseline models, highlighting the algorithm's strong potential to enhance human-robot interaction through more efficient cover age. Future work will explore further improvements in robustness across a variety of indoor settings and dynamic environments.
BC149 **16:00-16:15**	**Title: Generation of quadruped gait using asymmetric flexible trunk and neural oscillator model** **Authors:** Shohei Misaka, Takashi Takuma **Presenter:** Shohei Misaka, Osaka Institute of Technology, Japan **Abstract:** This study targets a four-legged model with a flexible trunk with an anterior–posterior asymmetric structure, and aims to enable the model to autonomously acquire periodic and high speed gaits by using a neural oscillator model. Simulation results showed that a trunk with an anterior flexible joint and the neural oscillator model provided a high-speed, bouncy gait, whereas a trunk with a flexible joint in the middle or rigid body achieved a slower gait.

BC170 **16:15-16:30**	**Title: Energy Harvesting from Human Body Motion – Stepping-on System** **Authors:** Omar D Mohammed, Haleema Al-Muneef, Wafa Al-Dossary, Jalilah Alforehe, Hala Alherz, Fatima Amsseri, Jood Alharbi **Presenter:** Haleema Al-Muneef, Prince Mohammad bin Fahd University PMU, Khobar, Saudi Arabia **Abstract:** There is an increasing need for step-on energy harvesting systems that can transform human foot pressure into electrical power to energize low-power devices, for example, lights or small fans. In the current work, a harvesting system that converts kinetic energy produced during stepping into electrical energy through a pendulum-to-rotary power conversion mechanism is presented. In order to achieve effective energy transmission, the system is designed using a pendulum-pulley architecture that is adjusted for foot pressure dynamics. The mechanism produces energy output while guaranteeing user comfort and versatility in a range of applications by meticulously regulating the pendulum's length, mass, and pulley ratios. Power and motion calculations are presented and the developed design is discussed in different parameter cases. The results show the effectiveness of this application in power production. With possible uses in both public and private areas that might profit from self-sufficient, motion-activated ventilation systems, this solution exemplifies a realistic, environmentally friendly method of energy harvesting.

Onsite Session 3

Time: 16:40-18:25(GMT+1, Madrid Time)
Date: Thursday, January 16
Venue: Salon Niagara (-1 Floor)
Topic: Modern Mechanical Theory and Manufacturing Technology
Chaired by: Prof. Sanjeev Kumar, Punjab Engineering College, Chandigarh, India

BC176 **16:40-16:55**	**Title: Comparison of Standard Ant Colony Optimization, Dijkstra and A* algorithms for Path Planning of Robot in an Indoor Environment** **Authors:** Sudeep Sharan, Anh Tong Ngoc Minh, Juan José Domínguez-Jiménez, Peter Nauth **Presenter:** Sudep Sharan, Frankfurt University of Applied Sciences, Germany **Abstract:** The research topic of Path planning is extremely challenging area of concentration within the field of mobile robots. However, path planning algorithms for mobile robot tasks are contingent upon the environment and its level of complexity. This paper analyzes four distinct path planning methods for simulated indoor environment. The proposed algorithms include conventional Ant Colony methods, Ant System (AS), Ant Colony System (ACS), as well as standard methods Dijkstra and A-Star (A*). We analyzed and examined these algorithms by employing various metrics/maps with complexity. The results indicate that the traditional path planning algorithm Dijkstra and A* approaches surpass the other ant colony techniques in terms of both computation time and path distance.
BC159-A **16:55-17:10**	**Title: Micro- to Nanoscale 3D Printing: Toward Multifunctional Multi-scale Hierarchical Structures** **Authors:** Daniel Jee Seng Goh, Guo Liang Goh, Wai Yee Yeong **Presenter:** Daniel Goh Jee Seng, Nanyang Technological University, Singapore **Abstract:** Additive manufacturing (AM) has disrupted the landscape of engineering and materials research, by enabling the fabrication of highly complex and customizable structures across multiple scales. Multi-scale hierarchical structures are prevalent in natural materials and have inspired the rapidly growing field of synthetic smart materials. This includes the goal of achieving single step fabrication of structures with enhanced mechanical, thermal, and electrical properties. To achieve such properties through hierarchical design, there is a need for precise manipulation and assembly of the precursor material's most fundamental building blocks. However, transitioning AM into these lower scales poses many limitations and challenges in its current state. This brief review aims to summarize the major existing high-resolution AM technologies and research efforts for polymers, metals, and ceramics. The capabilities in resolution and material choices are discussed, along with the characteristic working principles. Emphasis is placed on strategies for achieving multi-material, high-resolution structures for electronics and sensor applications, including possibilities of hybridized methods such as two-photon polymerization with computed axial lithographic volumetric printing, as well as the relevant design considerations.
BC148 **17:10-17:25**	**Title: Natural frequency variation of a water tower by controlling the amount of water** **Authors:** Omar D Mohammed; Stephen John Limbos **Presenter:** Dr. Omar D. Mohammed, Prince Mohammad bin Fahd University, Saudi Arabia **Abstract:** Avoiding resonance is crucial in design to save the system from high vibration levels that can be induced at the resonance frequency. When the excitation frequency equals one of the systems' natural frequencies resonance can happen. Therefore, to avoid resonance it is essential to evaluate the systems' natural frequencies and avoid exciting the system by one of them. However, controlling the excitation frequency is sometimes not feasible. So, in this case, shifting the natural frequency is

	useful to save the structure. The current article discusses the effect of adding or removing mass on the system's natural frequency of a water tower. Changing mass can be implemented by pumping or draining an amount of water. Modelling the controlled tower system is presented and studied. A Single Degree of Freedom SDOF model is used for examining the relation between the amount of pumped or drained water and the natural frequency shift. Different cases of frequency shift are studied. Dynamic response signals and Frequency Response Functions are obtained to demonstrate the impact on the system's natural frequency. The control system layout is presented. The article concludes with results that can be useful practically in saving the tower structure. The natural frequency can be shifted significantly by controlling the amount of water.
BC119 **17:25-17:40**	**Title: Experimental Investigations of Pressure Loss Characterizations for Coal-Water Mixture Transport through Pipe Fittings** **Authors:** Mohit Bhayana, Sanjeev Kumar, Satish Kumar, Dwarikanath Ratha **Presenter:** Sanjeev Kumar, Punjab Engineering College, Chandigarh, India **Abstract:** The pipeline method of coal transportation has numerous benefits, such as a cost-effective solution to transport high volumes of material, continuous operation, environmental benefits, reduced labour costs compared to traditional modes of transport like rail or truck. Moreover, coal slurry transport is crucial in many industrial applications, such as coal-fired power plants, steel manufacturing, coal liquefaction plants, mining operations, etc. Understanding the pressure drop characteristics of coal slurry behaviour inside the pipeline is vital for efficient system design and operation. In this experimental study, pilot level pipe loop experiments were conducted to analyse the coal slurry flow behaviour inside a pilot plant test loop having sudden contractions, and bends. Experimental setup was fabricated to transport coal slurry, mixture of coal and water, through pipeline transitions. The coal particles characteristics were examined using various characterization techniques such as scanning electron microscope, thermal analyzer etc. The pressure drops were examined for a flow rate ranging from 10 m^3/hr. to 40 m^3/hr. and coal concentration (Cw) of 3%, 7%, and 10% over the bend and sudden contraction pipeline transitions. The results revealed complex relationships between pressure drop, slurry properties, flow conditions, and pipeline geometry. The understanding of key flow regimes, assessment of the relationship between particle size distribution and pressure loss, and the development of correlations developed empirically for pressure drop prediction over pipeline transitions were amongst the key findings. The present study provides valuable insights for optimizing coal slurry transport systems and contributed to the broader understanding of multiphase flow dynamics in complex geometries.
BC118 **17:40-17:55**	**Title: Deep Active Inference with Generative Actions and Diversity-based Action Choice** **Authors:** Yacine Benabderrahmane, Godefroy Clair, Jérémy Dufourmantelle, Claire Ky **Presenter:** Yacine Benabderrahmane, OCTO Technology, France **Abstract:** The literature of Deep Active Inference, im- plementing the generative, biologically inspired Active Inference framework with the Deep Learning approach, often makes use of a hidden state transition model to generate current hidden states. It also usually leverages the Monte Carlo family methods to choose the agent's next action that minimizes the Expected Free Energy. The action identification typically uses either a stochastic sampling process or a learning of sampled actions by a 'habit' model. In this work, the goal is to explore an approach based on the learning and generation of actions as a result of hidden state transitions. The corresponding generative model, along with the variational form of the Free Energy and the Expected Free Energy, are formulated for an environment represented as a Partially Observable Markov Decision Process, and the model architecture is also presented. We also suggest a novel approach for the action choice: the generated action minimizing the Expected Free Energy is chosen based on the diversity of the expected risk relatively to that of its originating action set. The Active Inference agent is also equipped with top-down, selective, context-dependent attention mechanisms to control its behavior. Experiments have been conducted by addressing the continuous versions of Mountain Car and Inverted Pendulum problems. The results show the ability of the agent to learn and solve both problems with promising

	performance, requiring noticeable changes only on high-level attention parameters. This work highlights that this approach of action generation, choice and plan- ning by Active Inference agents might represent a worthy alternative to usual methods, noticeably for considerations of computational efficiency and bio-mimetism.
BC183-A **17:55-18:10**	**Title: Study on the Mechanical Properties of Basalt/Epoxy Composites with Varying CNT/Graphene Content** **Author:** Kyoungsik Cho **Presenter:** Kyoungsik Cho, Sungkyunkwan University, South Korea **Abstract:** Basalt fiber, a widely distributed natural resource globally, is an eco-friendly inorganic fiber that serves as anext-generation material capable of replacing organic fibers. Compared to other fibers, basalt fiber has low toxicity tohumans, excellent mechanical properties, and outstanding chemical resistance. Due to these advantages, research onbasalt fiber composites is actively conducted worldwide. Existing studies have demonstrated that Basalt/PET compositesoutpertorm glass fiber composites in bending and tensile properties. Additionally, mechanical properties have beenshown to improve after surface treatment of MWCNTs/Epoxy. This study aims to explore the mechanical properties,such as high strength and wear resistance, of basalt fiber composites by incorporating additives while maintaining theinherent thermal properties, durability, and strength of basalt fiber. The nano powders added were CNTs (CarbonNanotubes) and graphene, both characterized by a hexagonal carbon structure and sp2 bonds. These two materials,widely studied as next-generation advanced materials, were added in varying amounts, and their impact on mechanicalproperties was analyzed. The test specimens were prepared by mixing basalt fiber with epoxy and a curing agent,followed by the addition of CNTs and graphene. The mixture was then compressed using a hot press to produce thespecimens, which underwent tensile, bending, and wear testing. The results indicated that basalt fiber composites withCNTs/graphene showed a 50% improvement in flexural stress and a 19% improvement in tensile stress compared tobasalt fiber composites without CNTs/graphene. This study highlights the potential of basalt fiber, an eco-friendlymaterial, to be utilized across various industrial applications.
BC167 **18:10-18:25**	**Title: Numerical Study of a Frustum-Shaped Wick Heat Pipe at Low Power Input** **Authors:** Mohammad Mustafa Ghafurian, Ali Masrouri, Bahareh Bakhsh Zahmatkesh, Peter Weinberger, Ahmad Arabkoohsar, Hamid Niazmand **Presenter:** Mohammad Mustafa Ghafurian,Technical University of Denmark, Denmark **Abstract:** Heat pipes are highly efficient heat transfer devices utilized in Mechanical Engineering and Robotics. They operate by exploiting the phase change of a working fluid to transfer heat from a hot source to a cooler sink. A significant challenge for these systems is to reduce their size and cost while ensuring that performance remains uncompromised. To this aim, this study investigates the thermal performance of novel frustum-shaped heat pipes through numerical simulations using COMSOL Multiphysics. Firstly, four different geometries are evaluated, including conical and frustum vapor cavities with the evaporator and condenser sections positioned at the smaller or larger diameter ends. These geometries are compared against a conventional cylindrical heat pipe design. Governing equations for fluid flow and heat transfer in the vapor cavity and porous wick structure are solved under constant heat input and constant temperature boundary conditions at the evaporator. Steady-state temperature distributions and heat transfer rates are analyzed to evaluate the thermal resistance of each geometry. Results show that while the cylindrical design exhibits the lowest overall thermal resistance due to its larger fluid capacity, certain frustum geometries like the Frustum-condenser case demonstrate competitive thermal performance. The findings provide insights into optimizing heat pipe geometries for applications with space constraints or specific thermal management needs. This numerical study highlights the potential of shape modification as an effective approach to enhance heat pipe capabilities

Onsite Session 4

Time: 16:45-18:30(GMT+1, Madrid Time)
Date: Thursday, January 16
Venue: Salon Sena (-1 Floor)
Topic: Intelligent Robot Structure Design and Motion Control
Chaired by: Prof. Jordi Olivella, Polytechnic University of Catalonia, Spain

BC115 **16:45-17:00**	**Title: Path planning design for robot based non-planar additive manufacturing case study: coronary stent** **Authors:** Adrián López-Arrabal, Álvaro Guzmán-Bautista, William Solórzano-Requejo, Amparo Sancho-Arellano, Francisco Franco-Martínez, Andrés Díaz Lantada **Presenter:** Adrián López Arrabal, Universidad politécnica de Madrid, Mechanica Engineering Department, Spain **Abstract:** This study investigates the application of non-planar additive manufacturing (NPAM) combined with robotic systems to enhance the production of coronary stents. Traditional additive manufacturing methods typically produce planar layers, which can limit the mechanical properties and surface quality of printed objects. In contrast, NPAM allows for the creation of continuous, curved layers, reducing anisotropic mechanical properties and minimizing stress concentrations. The methodology automates the generation of non-planar, axisymmetric layers, facilitating the fabrication of complex stent geometries that closely mimic the natural anatomy of coronary arteries. By employing advanced motion planning algorithms, robotic arms can precisely deposit materials along these curved trajectories, resulting in smoother surfaces and enhanced structural integrity. The study successfully generated trajectories for the case study and designed the necessary support structures, enabling fabrication on a cylindrical build platform giving a complete perspective of the usage of this methodology.
BC141 **17:00-17:15**	**Title: Leveraging Swarm Robotics for Environmental Radiation Monitoring: An Interdisciplinary Perspective** **Authors:** Hadi Ardiny, Ammirmohammad Beigzadeh **Presenter:** Hadi Ardiny,Radiation Applications Research School, NSTRI, Tehran, Iran **Abstract:** This study develops interdisciplinary models and algorithms to enhance the coordination and autonomy of multiple robots in radioactive environments. By integrating dynamic radiation source behaviors into a robotic simulator, we aim to create a comprehensive tool for simulating and testing complex robotic behaviors in hazardous settings. The scenario of exploring and mapping radioactive environments was chosen due to the significant challenges posed by potential hazards. Deploying multiple autonomous robots can expedite exploration and increase the likelihood of detecting radioactive sources. Our study evaluates various factors, including the number of robots, their radiation tolerance, and their efficiency in navigating and mapping contaminated areas. The findings reveal the substantial potential of swarm robotics in nuclear applications and highlight the importance of interdisciplinary collaboration in developing innovative solutions for hazardous environments. These results demonstrate that swarm robotics can significantly enhance operational efficiency, safety, and precision in radiation monitoring and response.
BC116 **17:15-17:30**	**Title: Design for Robot-Based Non-Planar Additive Manufacturing Case Study: Soft Robotics Gripper** **Author:** Laura Gil-Villacastin **Presenter:** Laura Gil-Villacastin, Mech. Eng. Dept., ETSI Industriales Universidad Polit´ecnica de Madrid Madrid, Spain **Abstract:** Robot-based Non-Planar Additive Manufacturing, as a manufacturing technique, may be a candidate for the fabrication of soft robotics compliant mechanisms, owing to the increased design freedom and final part mechanical properties of these methods compared to conventional Additive

	Manufacturing. The non-planar slicing method applied in this work involves the bijective homomorphism between the Cartesian map and a slicing map, used for planar part design. This paper explores this novel Design for Non-Planar Additive Manufacturing technique and applies it on a case study of a Yoshimura-style origami compliant mechanism-based grasping end-effector. Three different build platforms are proposed for different to-be-grasped applications. For all three cases, the complete methodology is applied, starting from CAD model preparation, model isomorphism onto the Cartesian map, planar additive manufacturing trajectory generation and toolpath isomorphism for manufacturing. This case study showcases the possibilities of Robot-based Non- Planar Additive Manufacturing for the manufacture of improved mechanical properties soft robotics compliant mechanisms, and suggests the transversality of the methodology for other areas of knowledge, including aerospace, embedded electronics, and biomedical industries.
BC185 **17:30-17:45**	**Title: ASH-1: Advancing Grasping Capabilities in Soft Dexterous Humanoid Robotic Hands** **Authors:** Peng Jiang, Hongyu Yu **Presenter:** Peng Jiang, The Hong Kong University of Science and Technology, China **Abstract:** This paper presents the design and development of the ASH-1, a soft robotic hand inspired by human anatomy. The ASH-1 closely mimics the natural structure of the human hand and features 11 independent degrees of actuation (DOA), including a thumb with 3 DOA and four fingers, each with 2 DOA. A key distinction of the ASH-1, compared to other humanoid robotic hands, is its superior adaptability to the weight of the objects being grasped. Experimental results demonstrate the ASH-1's capability to handle ranging from a 0.15 g steel wire to a 20L water jug. Except for the palm skin, the entire ASH-1 is 3D printed using thermoplastic polyurethane (TPU). Each finger is a unified structure comprising hollow intermediate phalanges connected by pneumatic actuators, resulting in a total weight of just 295.4 grams. Furthermore, the hand can exert a grip force of up to 3.7 kg, with the middle finger capable of withstanding a pull exceeding 95 N, and the entire hand supporting over 150 N. The ASH-1's broad payload capacity and lightweight design expand the possibilities for practical applications in soft dexterous manipulation, making it a promising tool for various fields.
BC114 **17:45-18:00**	**Title: Automatic State Space-based Dynamic Characterization of Industrial Machining Robots** **Authors:** Alvaro Guzman-Bautista, Laura Gil-Villacastin, Adrian Lopez-Arrabal, Enrique Chacon-Tanarro, Juan Manuel Muñoz-Guijosa, Antonio Vizan-Idoipe **Presenter:** Alvaro Guzman-Bautista, Mech. Eng. Dept., ETSI Industriales Universidad Polit´ecnica de Madrid Madrid, Spain **Abstract:** Robotic manipulators play a crucial role in precision machining, and understanding their dynamic behavior is essential for optimizing performance. This study presents the dynamic characterization of a six-degree-of-freedom serial robotic manipulator for precision machining operations. A simplified dynamic model is proposed using Frequency Response Functions (FRFs), pole-zero estimation, and regression analysis. The robot's dynamic behavior is represented through the mechanical admittance matrix, linearized by transfer functions dependent on joint states. Experimental data were collected through automated torque impacts within a defined Region of Interest and analyzed using Fast Fourier Transforms. The resulting FRFs guided the estimation of transfer functions, optimizing model complexity to balance accuracy and computational efficiency. Regression analysis indicated that cubic models with interaction terms best capture the system's dynamics. The identified models closely approximate experimental data, though minor discrepancies suggest potential areas for refinement. This methodology has may enable improvements in the precision and dynamic accuracy of robotic manipulators in machining tasks, as well as broader applications in automated manufacturing.

BC157 **18:00-18:15**	**Title: Robotic belt grinding with passive-complaint tool: process characterization and control** **Authors:** Ramon Torres-Izu, Jokin Aginaga, Xabier Iriarte, Sara Mata, David Barrenetxea, Ibai Inziarte **Presenter:** Ramon Torres-Izu, Aldakin Automation, Spain **Abstract:** Robotic belt grinding has emerged as an effective solution for industries requiring high surface quality and dimensional accuracy, such as aerospace and automotive. This work presents a study on material removal and process control in robotic belt grinding with a passive-compliant grinding tool. A predictive material removal model has been developed, considering key process variables such as feed speed and belt wear. Experimental tests were conducted to validate the model, showing the correlation between predicted and actual material removal rates. Additionally, an adaptive control algorithm has been introduced to adjust the feed speed based on real-time wear data, maintaining consistent material removal across passes. The results demonstrate that the proposed model and control system result in a process with high accuracy and productivity, providing a reliable framework for industrial robotic grinding applications.
BC186 **18:15-18:30**	**Title: A Development Framework for Automated Design of Modular Wheeled Mobile Robots** **Authors:** Malte Springer, Lukas Heinrich, Annika Raatz, Daniel Schütz **Presenter:** Malte Springer, Volkswagen Group Innovation, Germany **Abstract:** The growing demand for flexible and accessible robotic solutions underscores the need for streamlined development processes, particularly for non-expert users. This work introduces a novel development framework for modular wheeled mobile robots, designed to simplify the integration of plug-and-play hardware and software modules. By automating software generation and incorporating a kinematics classification method for controller selection, the framework reduces development complexity while accommodating diverse robot configurations. Validation through various robot designs and scenarios substantiates the framework's adaptability, demonstrating its efficacy and practicability in supporting the development of robotic systems across a wide range of applications.
BC189-A **18:30-18:45**	**Title: Automated Testing of Robotic Software using Machine Learning-Based Test Case Generation** **Author:** Gedion Moche, Lukas Heinrich, Annika Raatz, Daniel Schütz **Presenter:** Gedion Moche, University of WSB Merito, Wroclaw, Poland **Abstract:** Robotic systems are becoming increasingly integral to various domains, from manufacturing and healthcare to autonomous navigation. Ensuring their reliability is critical to avoid system failures and ensure safety. Traditional software testing methods often fall short in addressing the complexity and dynamic nature of robotic systems. This paper presents a machine learning-based approach to software testing that enhances the reliability of robotic systems. By leveraging predictive models and automated anomaly detection techniques, the proposed framework identifies potential software bugs and system vulnerabilities early in the development cycle. The methodology includes the generation of synthetic test cases using ML algorithms, real-time monitoring of system behavior, and adaptive testing strategies that evolve based on observed performance. Experimental validation demonstrates the approach's efficacy, achieving higher defect detection rates and reduced testing time compared to conventional methods. The paper also explores limitations and provides insights into integrating ML-based testing into existing robotic software development pipelines. This work aims to bridge the gap between advanced testing techniques and the growing demands of reliable robotic systems.

Online Session 1

Time: 9:00-11:40 (GMT+1, Madrid Time)
Date: Friday, January 17
ZOOM Link: https://us02web.zoom.us/j/89859743431
ZOOM ID: 898 5974 3431
Password: 011517
Topic: Engineering Robots and Intelligent Mechanical Systems
Chaired by: Assoc. Prof. Hui Shan Lee, Universiti Tunku Abdul Rahman, Malaysia

Invited Speech **09:00-09:25**	**Title: Design and Analysis of Efficient Desert straw checkerboard Laying Machine Based on PLC Automatic Control Technology** **Authors:** Qingshan Wu, Mianhao Zhu, Yanqi Shang, Yue Chen, Huibao Zhang, Zhimin Sun **Invited Speaker:** Qingshan Wu, Xi'an Technology and Business College, China **Abstract:** As a method to prevent soil erosion in deserts and develop sandy agriculture, straw checkerboard laying technology has been widely recognized and has been successfully applied in various parts of the world. In order to solve the problems of high labor intensity and low efficiency in manually laying desert straw checkerboard, this paper designs an efficient desert straw checkerboard laying machine based on PLC and single-chip microcomputer automatic control technology. The desert straw checkerboard laying machine mainly consists of five parts: tractor, power unit, slotted plow assembly, cam hammer assembly, and walking assembly. In the structural design, CATIA software is used to design the mechanical structure of the laying machine, and the finite element analysis software Simulation is used to perform static analysis on key components. The results show that the maximum deformation and maximum stress of the parts are within the allowable range of the material. The monitoring system uses modern common sensing
BC182 **09:25-09:40**	**Title: Proposal of a Novel Dual-Bell Axisymmetric Rocket Propulsive Nozzle Design** **Authors:** Anis Tcherak, Hakim Kbab, Abdelkrim Haddad **Presenter:** Anis Tcherak, University of Blida 1, Algeria **Abstract:** The dual-bell propulsive nozzle is an altitude- adaptive nozzle design that has been the focus of extensive research. It provides two working modes, sea-level and high- altitude modes without requiring of mechanical activation devices, resulting in improved payload capacity and enhanced performance for space rockets. This study presents an innovative subscale dual-bell axisymmetric nozzle design developed using an in-house method of characteristics (MoC) code. Numerical simulations utilizing the ANSYS Fluent computational fluid dynamics (CFD) solver were performed to validate the design and examine the flow characteristics and performance of the dual-bell nozzle. The results demonstrated the reliability of the in-house MoC design code and validated the potential of the proposed nozzle design.
BC154 **09:40-09:55**	**Title: Aeroelastic and CFD Analysis of Bladeless Wind Turbines: Investigating the Impact of Reynolds and Strouhal Numbers on Performance** **Authors:** Mohamed Mahran Kasem, Tasneem Tarek Abdelkareem, Deyaa Elhaq **Presenter:** Mohamed Mahran Kasem, Nile University, Egypt **Abstract:** Bladeless wind turbines (BWTs) offer a novel approach to energy harvesting by utilizing vortex-induced vibrations (VIV) instead of traditional rotating blades. This paper presents a comprehensive study of BWT performance using a combination of Computational Fluid Dynamics (CFD) and aeroelastic analysis based finite element model. A two-dimensional CFD model is developed to simulate the flow behavior around a BWT mast at various Reynolds and Strouhal numbers. The CFD simulations focused on evaluating flow lift and vortex shedding frequency,

	which are subsequently integrated into a finite element method (FEM) model to assess aeroelastic response, including lift, displacement, and frequency. The results demonstrate a direct relationship between increasing wind speed, Reynolds number, and Strouhal number with enhanced aeroelastic lift and displacement. This study provides valuable insights into optimizing BWT design for improved energy harvesting efficiency.
BC164 **09:55-10:10**	**Title: Reinforcement Learning for Quadrupedal Locomotion: Current Advancements and Future Perspectives** **Authors:** Maurya Gurram, Prakash Kumar Uttam and Dr. Shantipal S. Ohol **Presenter:** Maurya Gurram, COEP Technological University Pune, India **Abstract:** In recent years, reinforcement learning (RL) based quadrupedal locomotion control has emerged as an extensively researched field, driven by the potential advantages of autonomous learning and adaptation compared to traditional control methods. This paper provides a comprehensive study of the latest research in applying RL techniques to develop locomotion controllers for quadrupedal robots. We present a detailed overview of the core concepts, methodologies, and key advancements in RL-based locomotion controllers, including learning algorithms, training curricula, reward formulations, and simulation-to-real transfer techniques. The study covers both gait-bound and gait-free approaches, highlighting their respective strengths and limitations. Additionally, we discuss the integration of these controllers with robotic hardware and the role of sensor feedback in enabling adaptive behavior. The paper also outlines future research directions, such as incorporating exteroceptive sensing, combining model-based and model-free techniques, and developing online learning capabilities. Our study aims to provide researchers and practitioners with a comprehensive understanding of the stateof- the-art in RL-based locomotion controllers, enabling them to build upon existing work and explore novel solutions for enhancing the mobility and adaptability of quadrupedal robots in real-world environments.
BC121 **10:10-10:25**	**Title: Brick by brick - Findings in a of-the-shelf automation system application for building block component group disassembly** **Authors:** Dominique Briechle, Tobias Geger, Lena Schartow, Andreas Rausch **Presenter:** Dominique Briechle, Clausthal University of Technology, Germany **Abstract:** Automation is one of the key drivers in today's global economy. It ensures the conduction of a manifold of standardized processes which helps tackle the decreasing amount of skilled workers in certain areas as well as reducing cost. Although automation is broadly used nowadays, the overall applicability of automated processes is often limited to use cases with predefined process steps of minor flexibility. However, new and upcoming sustainable industries that are focusing on product life-cycle prolonging (e.g. repair, refurbish, and remanufacture (3Rs)) options to enable Circular Economy-friendly treatment, require a high amount of adaptability in automated systems to tackle the high variability of product compositions in disassembly scenarios. The goal of the conducted case study is therefore to investigate the possibilities of a nowadays available of-the-shelf automation system regarding its functions and mechanisms towards enabling automated adaptability by using disassembly scenarios of component groups consisting of different building blocks as an example scenario and the concluding future research areas. The paper, therefore, investigates the different methods offered by the default system and applies them to various levels of disassembly scenarios. The conducted study helps to clarify the capabilities of the system's functionalities in the overall goal to enhance adaptability in disassembly processes.

BC125 **10:25-10:40**	**Title: Design and Kino-dynamic modeling of SERP: A Modular Snake Robot** **Authors:** Anish Patil, Yash Gavit, Shantipal Ohol **Presenter:** Anish Patil, COEP Technological University, India **Abstract:** This paper presents the design and kino-dynamic modeling of SERP, a novel hyper-redundant articulated snake-like robot, focusing on its modular structure and locomotion. The robot comprises of eight modules, each equipped with two degrees of freedom enabled by individual motors for both revolute and twist movements. This alternating joint configuration enhances maneuverability and adaptability to varied terrains. The modules feature a hexagonal cross-section, optimizing ground interaction and friction manipulation. All electronics and power supplies are onboard, ensuring untethered functionality and increased operational flexibility. The paper also proposes and simulates a kino-dynamic model in MATLAB, incorporating frictional forces and torques, joint parameters and constraints for serpent-like locomotion along with the results of a test case on helical rolling motion. This robot model aims to advance the capabilities of snake robots in complex environments where conventional robots face challenges. The results proved that the modular snake robot's unique design enhanced terrain adaptability and bio-mimetic locomotion, while the kino-dynamic model validated the proposed robot's feasibility, usage and performance parameters.
BC172-A **10:40-10:55**	**Title: A Comprehensive Review on Robotics Advancements Through Imitation Learning for Self-Learning Systems** **Authors:** Yagna Jadeja, Mahmoud Shafik, Paul Wood, Aaisha Makkar **Presenter:** Yagna Jadeja, University of Derby, United Kingdom **Abstract:** In recent years, robotics and artificial intelligence have witnessed significant growth, particularly in self-learning systems. This paper examines the remarkable progress made in this area, with a particular focus on the utilization of imitation learning. Self-learning robotics systems have demonstrated the ability to autonomously acquire new skills, making them highly adaptable and versatile. Imitation learning emerges as a crucial technique, allowing robots to gain knowledge from human demonstrations. This paradigm allows machines to learn and replicate human ac-tions, thus enhancing the capabilities of self-learning robotic technology. The primary objective of this research is to investigate the potential of imitation learning and its impact on advancements in the field of self-learning robotics. The paper provides a comprehensive overview of self-learning robotic systems using imitation learning, examining the foundational concepts, es-sential methodologies, and various applications in this intriguing area. Furthermore, we highlight recent developments, discuss current trends, and outline potential research initiatives to guide the continued development of self-learning robotic systems using imitation learning. This review aims to contribute to the evolving landscape of autonomous robotics by consolidating knowledge, identifying challenges, and fostering further innovation in the pursuit of intelligent, self-learning machines.
BC145 **10:55-11:10**	**Title: Autonomous Rock Detection for LHD Vehicles in Underground Block Caving** **Authors:** Luis Guevara, Franco Rivadeneira, Jose Pezo, Roberto Furukawa **Presenter:** Roberto Furukawa, Pontificia Universidad Catolica del Peru, Peru **Abstract:** Underground mining, a common extraction method for rocks, presents obstacles in the removal and transportation of materials phase, like limited space, strict safety requirements, and high energy consumption, which can account for a substantial portion of operational costs, leading to congestion and delays in underground roads. To address these challenges, this research focuses on the development of an autonomous Load-Haul-Dump (LHD) vehicle aimed at enhancing operational efficiency, safety, and productivity in underground mining operations. This vehicle is equipped with an AI-powered visual inspection system capable of effectively detecting rocks to

	facilitate the block caving technique. To support the effectiveness of this system, a vibration analysis was performed, which determines displacements of 1.44 um and 1.61 um against two different types of floors. Utilizing the YOLOv9 architecture and having tested with seven different optimizers to find the ideal machine learning parameters for the rocks, the system achieved an F1-Score of 99.12% for rocks and 74.33% for scattered rocks, both optimized with the Stochastic Gradient Descent (SGD) algorithm.
BC178-A **11:10-11:25**	**Title: Enhancing GPS/IMU Localization Accuracy in Autonomous Vehicles through Deep Learning-Based Error Correction Models** **Authors:** Uchenna Charles. Mahmoud Shafik **Presenter:** Mahmoud Shafik, United Kingdom University of Derby, UK **Abstract:** Improving the precision of GPS/IMU localisation in autonomous cars is crucial for ensuring safe and efficient navigation. Several research studies have concentrated on enhancing the precision of localisation systems by employing sensor fusion and sophisticated algorithms. This study proposes a novel approach to enhance GPS/IMU localization accuracy in autonomous vehicles using deep learning-based error correction models. Leveraging Long Short-Term Memory (LSTM) networks, the method captures and corrects inherent errors in GPS/IMU data, leading to significantly improved positional accuracy. The LSTM model was meticulously designed to process sequential data, incorporating an LSTM layer with 50 units to capture temporal relationships and a Dense output layer to predict corrected longitude and latitude values. The model was trained using the Adam optimizer and mean squared error (MSE) loss function, achieving notable reductions in prediction error across 50 epochs. Comparative analyses between actual and predicted coordinates demonstrated the model's high precision. The model was further validated through deployment in a Flask application for continuous testing and a web application for real-time tracking of autonomous vehicles. Results underscore the potential of deep learning models to substantially improve localization accuracy, thereby enhancing the reliability and performance of autonomous navigation systems.
BC163 **11:25-11:40**	**Title: Design of a Novel 3-DOF Parallel Manipulator with Extended Workspace** **Authors:** Anubhav Mishra, Pawan Kumar, Nachiketa Tiwari **Presenter:** Nachiketa Tiwari, Indian Institute of Technology Kanpur, India **Abstract:** A restricted workspace poses a significant limitation for parallel manipulators, especially in terms of their applicability. The novel design presented in this paper significantly enhances their workspace without necessarily requiring expensive custom-designed actuators. Thus, the work presented here can be used for several applications including those related to simulation of ocean waves, stabilization platforms, vibration testing for space application. Towards such a goal we present an inverse kinematics and an inverse dynamics model for a novel 3-DOF parallel manipulator with its degrees of freedom in roll, pitch, and heave directions. A lever mechanism is employed to amplify the displacement of the linear actuators, thereby extending its motion range. The inverse dynamic model developed here has been formulated using the Newton-Euler method and by eliminating constraint moments of individual components. Such an approach reduces the number of algebraic equations required to analyze the system. The model developed here has been used to solve the equations in MATLAB environment, and it has been validated through simulations conducted in MSC ADAMSTM. Our work shows that it is possible to extend the workspace of the parallel manipulator by a very large factor. Thereby enhancing its applicability.

Online Session 2

Time: 13:00-15:00 (GMT+1, Madrid Time)
Date: Friday, January 17
ZOOM Link: https://us02web.zoom.us/j/89859743431
ZOOM ID: 898 5974 3431
Password: 011517
Topic: Radar-based Signal Detection and Mechanical System Performance Analysis
Chaired by: Prof. Hakim Kbab, University of Blida, Algeria

BC138 **13:00-13:15**	**Title: Three-Stage Hierarchical LIDAR SLAM with Confidence-Based Pose Selection for Enhanced Vertical Accuracy** **Authors:** Yongchao Wang, Jian Sun, Fan Zhou **Presenter:** Yongchao Wang, Xi'an Jiaotong University, China **Abstract:** Multi-line LiDAR Simultaneous Localization and Mapping (SLAM) is a fundamental technology for autonomous driving, robotic navigation, and environmental perception. Achieving precise localization in GPS-denied environments is cru cial for advanced autonomous systems, particularly in complex and dynamic scenarios. This paper presents a hierarchical three stage optimization framework designed to significantly enhance SLAM accuracy, especially in challenging environments. The proposed method optimizes feature point clouds across three distinct clusters: the previous frame, the global point cloud, and keyframe clusters. Each stage of optimization progressively refines the pose estimation with increasing precision and stability, allowing the system to adapt to various environmental conditions. The first stage provides initial values for subsequent stages, while the second and third stages yield results with varying degrees of accuracy and stability. To achieve an optimal balance between precision and robustness, we introduce a confidence-based result selection mechanism, which evaluates the reliability of the third stage results to determine the final pose estimate. Extensive experiments conducted on the KITTI public dataset and the NTU VIRAL UAV dataset demonstrate that our approach achieves substantial improvements in SLAM performance, with notable gains in vertical localization accuracy and overall robustness.
BC131 **13:15-13:30**	**Title: Petri Nets and X-CDSM based Disassembly Sequences Improvement of Complex Products Family** **Authors:** Serigne DIAGNE, Amadou COULIBALY, Cherif Ahmed Tidiane AIDARA, Mbaye SENE **Presenter:** Serigne DIAGNE, Assane Seck University, Ziguinchor, Senegal **Abstract:** The identification of the optimal disassembly sequences of complex products is very important for the evaluation at the early design stage of its maintainability and the analysis of its recyclability at the end of life. Several tools can be used to reach this goal (genetic algorithms, graphs, Petri nets, etc.). However, methodologies based on these tools do not take into account information such as the accessibilities and the positions of the links and the criticalities and the reliabilities of the components. They generally focused on a single system too. Thus, we propose in this paper a methodology based on Petri Nets, using eXtended Conceptual Design Semantic Matrix (X-CDSM) and new disassembly indicators for improving optimal disassembly sequences of complex system's families at the early design stage.
BC127 **13:30-13:45**	**Title: Information-theoretic Improvement of Model Predictive Control** **Author:** Piotr Bania **Presenter:** Piotr Bania, AGH University of Krakow, Poland **Abstract:** An information-theoretic improvement of the stochastic Model Predictive Control has been proposed and examined. First, it was observed that optimal feedback must, if possible, actively generate information about the system state. Since standard MPC algorithm does not do

	this, it was hypothe- sized that adding a penalty for information deficit to the standard MPC cost function can generate a control strategy closer to the optimal one. An exact formula for the cost has been derived for a class of linear systems with control-dependent matrices. Then, it was shown on the basis of simple, two dimensional, example that the proposed modification generates significantly better strategy, for which the cost functional is more than five times smaller compared to the standard MPC algorithm.
BC188 **13:45-14:00**	**Title: Cockpit crew task analysis for civil aircraft based on image recognitio** **Authors:** Jun Jiang, Xinyang Zhu,Yiyuan Zheng **Presenter:** Jun Jiang, Cockpit integration Shanghai Aircraft Design and Research Institute, China **Abstract:** Whether the cockpit crew task design of civil aircraft is accurate and reasonable directly affects the preparation y requirements of civil aircraft crew and flight safety. Civil aircraft cockpit minimum flight crew provisions is also an important provision in the process of airworthiness certification of new models, at this stage, the airworthiness certification of this provision is mainly analysed through the simulator test and test flight test through the pilot's subjective evaluation, there is a strong subjectivity, not able to objectively evaluate the workload of the crew, which has brought a lot of challenges to the airworthiness certification. This paper proposes a method based on image recognition to carry out the minimum crew task analysis in the cockpit of a civil aircraft. According to the route operation scenario of a civil aircraft, we carry out the simulation test of the man-in-the-loop, use the camera to track and record the spatial movement trajectory of the pilot's hand, judge the crew's operation task in the cockpit by identifying the crew's gesture, and make use of the cockpit's interface for displaying some information to carry out the analysis of the crew's task in the cockpit of a civil aircraft. The method helps to improve the accuracy and efficiency of the monitoring of crew tasks in the cockpit of civil aircraft, and provides a basis for optimising crew resource management and flight safety.
BC175-A **14:00-14:15**	**Title: Behavior of Inertial Mass-Spring Mechanisms with Zigzag Slots in Fuze Systems: Drop Test Load Analysis** **Authors:** Tezcan Kahraman, Mehmet Fatih Aycan, Resul Sercan Altintas, Kadri Onuk **Presenter:** Tezcan KAHRAMAN, Gazi University, Turkey **Abstract:** The fuze is a critical subsystem within ammunition, primarily responsible for ensuring safety during transportation and storage, as well as enabling the ammunition to function correctly under specified conditions. It is advisable for fuze systems to achieve their operational objectives by detecting at least two independent environmental parameters, such as axial acceleration, rotational forces, temperature, and pressure. One common method to ensure safety involves the use of inertial mass-spring systems with zigzag slots. These mechanisms are favored in various ammunition systems due to their simplicity and effectiveness in detecting environmental conditions, specifically axial acceleration. The zigzag slot is employed to prolong the duration required for the inertial mass-spring mechanism to complete its movement under drop impacts, which are characterized by short durations (microseconds) and high accelerations (on the order of 10^3 g). This study presents a mathematical solution for the equation of motion governing inertial mass-spring mechanisms with zigzag slots. It includes both numerical and analytical analyses of these mechanisms subjected to drop test loads. Additionally, the study explores the effects of various packaging methods on the performance of inertial mass-spring mechanisms with zigzag slots under drop test conditions, through both experimental and numerical investigations. The numerical analyses are conducted using Ansys Motion and Ansys LS-Dyna software.
BC126 **14:15-14:30**	**Title: Vibration attenuation in AESA radar transmit/receive module via particle damping: an experimental study** **Authors:** Sunil Kumar, Anil Kumar **Presenter:** Sunil Kumar, IIT Roorkee, India

	Abstract: Vibration may compromise the integrity of the electronic components on printed circuit boards (PCBs). Thus, effective vibration reduction measures are essential to ensure maximum performance and longevity when designing electronic assembly enclosures. This study uses the particle damper for vibration suppression in a PCB enclosure. First, with finite element modeling, modal analysis is performed to identify the modal-sensitive areas where particle dampers can be installed. An electrodynamic vibration shaker is then used for sinusoidal sweep testing to verify the finite element modal analysis results. Experimental investigations are carried out on the enclosure with particle damper for various input acceleration loads, and the effect of a damper's filling ratio on the enclosure's response is studied. The findings suggest that the response reduces as we increase the filling ratio to a limit. If the filling ratio is increased further from this limit, the response starts increasing due to particle locking phenomena. Moreover, the peak amplitude with the proposed particle damper is decreased by 88%, 81%, and 67% for input acceleration loads of 1 g, 1.5 g, and 2.0 g, respectively.
BC181 **14:30-14:45**	**Title: Analysis Of Thermal Stabilization For Satellite Electronics Using Phase Change Materials and Optimized Heat Sink Design** **Authors:** Rabab El Attar, Mustapha Malha, Abdellah Bah **Presenter:** Rabab El Attar, Morocco National School of Arts and Crafts, Mohammed V University **Abstract:** This paper explores the assessment of a thermal stabilization system for satellite electronics, featuring a phase change material (PCM) as a thermal capacitor. Three configurations were analyzed: a system without PCM, a system integrating PCM, and a system combining PCM with a triangular fin heat sink. The results demonstrate that incorporating PCM reduces the maximum temperature by 6.5 °C compared to the system without PCM, significantly enhancing thermal stability. Moreover, the addition of triangular fins further optimizes heat dissipation, achieving a maximum temperature of 73.8 °C, compared to 84.5 °C for the PCM-only configuration and 90.7 °C for the system without PCM. These findings underscore the effectiveness of PCMbased systems with optimized heat sink designs in addressing thermal management challenges in space environments, offering improved performance and reduced mass for satellite electronic systems.
BC3005 **14:45-15:00**	**Title: Development of a Discrete-Time Map for Nonlinear Analysis of Flyback Converter** **Authors:** David E. Giraldo, Mario A. Bolaños, Fabiola Angulo, Gustavo Osorio, Nicols Astaiza, Juan David Mina-Casaran, Wilder Herrera **Presenter:** David Eduardo Giraldo Hernández, Universidad Nacional de Colombia, Colombia **Abstract:** This paper presents a discrete-time map calculated from the nonlinear averaged model for a flyback DC-DC converter with peak current control. Traditional switched models, although accurate, are computationally expensive, limiting their practicality for rapid analysis. To address this limitation, we propose a novel discrete-time map of the flyback converter. The model achieves a simulation time reduction of over 97% compared to event-driven models while preserving high accuracy in both transient and steady-state conditions, with errors of less than 1%. Numerical simulations validate the model's performance and its ability to predict system responses to perturbations effectively. This method enables precise detection of transitions between Continuous Conduction Mode (CCM) and Discontinuous Conduction Mode (DCM). This feature provides an advantage over standard averaged models by simplifying mode detection and improving computational efficiency. This approach is particularly useful for applications in renewable energy and power electronics. Future work will focus on integrating this model into real-time simulation environments to enhance control strategies.

Memo