IEEE

UNIVERSITÀ
DEGLI STUDI
DI BRESCIA

2023 IEEE INTERNATIONAL WORKSHOP ON

METROLOGY FOR
INDUSTRY4.0 & IoT

UNIVERSITY OF BRESCIA/ JUNE 6-8, 2023

Brescia 2023

WORKSHOP
PROGRAM

www.**metroind40iot**.org

ATHENA
BUSINESS AND TECHNOLOGY CONSULTING

TABLE OF CONTENTS

Welcome Message from the Conference Chairs

On behalf of the Organizing Committee, we wish to welcome you to the 2023 IEEE International Workshop on Metrology for Industry 4.0 and IoT. It is a pleasure to have you here at this 6th edition of IEEE MetroInd4.0&IoT and we hope that the Workshop can be the starting point for fruitful collaborations between the participants.

This sixth edition is again in Brescia, where it all began. It was 2018, when the University of Brescia hosted the first edition of MetroInd4.0&IoT. The second edition was organized in Naples and hosted by the University of Naples Federico II. Then, two years of emergency of COVID-19 outbreak forced the editions 2020 and 2021 expected in Rome, and organized with the precious help of University Campus Bio-Medico di Roma, to be held online. In 2022, the Workshop finally came back to the normality and it was hosted in Trento. Now we are glad to host you again here in Brescia, Italy. The organization is coordinated by University of Brescia, University Campus Bio-Medico di Roma, University of Trento, and Universitad Politecnica de Catalunia, together with the invaluable contribution of the University of Sannio.

In this sixth edition, the aim is to bring together researchers, academics, practitioners and industry partners and disseminate the most recent researches in the metrology field applied to industry 4.0 and IoT devices. The classic themes of industrial metrology and IoT have been expanded to allow fruitful collaborations even with related and heterogeneous sectors. If the fourth industrial revolution represents a fundamental change in our way of living, working and relating to others, metrology can and must help in this human development. We, therefore, hope that this workshop can help to go in this direction.

The received extended abstracts were submitted to a peer-review process. Relevance, quality, significance, and novelty of the scientific contribution were the main attributes for acceptance and publication in the Proceedings. The Proceedings are going to be submitted for publication in the IEEEXplore Digital Library. We would like to thank all the reviewers who actively contributed to the selection and quality improvement of the presented works.

MetroInd4.0&IoT 2022 is honored to have experts in robotics and Industry 4.0 as Invited Speakers.

- Diego Galar, from Luleå University of Technology, Sweden, will present the first day "4.0 to 5.0: Ten years of Digitization to Sustainable Human Centric Industry."

- Pedro Martins, from University of Minho, Portugal, will present "Printing and Electronics: Friends with benefits" on the second day.

- Cristian Sartori, Siemens Spa, will give a talk on "Distributed measuring and control using edge computing and container based software for industrial applications", on the last day of the workshop.

We are grateful to the Invited Speakers for joining the Workshop.

To recognize the most outstanding paper presented at the annual *2023 IEEE International Workshop on Metrology for Industry 4.0 and IoT*, the Best Conference Paper Award sponsored by Sensors Journal will be assigned. Other awards will be assigned to the Best Paper presented by a Young Researcher, and to the Best Paper Presented by a Woman, this last sponsored by IEEE Women in Engineering, to recognize the full engagement of women in all aspects of the Metrology in Industry 4.0 and IoT.

We sincerely wish to thank all the sponsors and the patronages who made this event possible.

The *2023 IEEE International Workshop on Metrology for Industry 4.0 and IoT* is about to begin. Metrologists, Industrial ICT engineers and IoT designers enjoy the Workshop!

June 2023

Mauro Serpelloni, University of Brescia, Italy
Pasquale Daponte, University of Sannio, Italy
Emiliano Schena, Università Campus Bio-Medico di Roma, Italy
MetroInd4.0&IoT 2022 General Chairs

Message from the Program Chairs

Welcome to MetroInd4.0&IoT 2023, the 2023 IEEE International Workshop on Metrology for Industry 4.0 & IoT, organized in Brescia (Italy). MetroInd4.0&IoT 2023 is organized by the University of Brescia, with the aim of establishing an important world forum for discussing the latest advances in metrology for the fourth industrial revolution and, more in general, for IoT applications.

The Technical Program of MetroInd4.0&IoT 2023 has 83 papers divided into 22 sessions distributed over the three days of the workshop. Metrology for Industry 4.0 & IoT launched a call for special sessions and received a variety of different proposals from the session chairs. The review process selected ten special sessions, who are aimed at mini-workshops on specific topics. These topics range from the application of machine learning in industrial measurement systems to predictive maintenance, including the development of advanced sensor systems or measurements of physiological parameters. We are convinced that all these matters will define the technological future of these scientific and industrial areas in the next few years. Researchers working on the same area can be aware with each other's contributions to the creation of knowledge beyond the current state of the art in the following special sections:

1. Special Session on Machine learning and IoT for industrial measurement systems (S1.1 and S2.1)
2. Special Session on Reliable wireless solutions for IoT and Industrial IoT (S1.2 and 2.2)
3. Special Session on Measurements and Virtual Measurements for Industry 4.0: Approaches and Solutions for Smart Manufacturing (S3.1, S4.1 and S11.2)
4. Special Session on Wearable Sensors for Unobtrusive Monitoring of Physiological Parameters and Human Activities (S3.2, S4.2 and S5.2)
5. Special Session on Positioning, tracking and navigation in the Industry 4.0 era (S5.1 and S8.1)
6. Special Session on Printed Sensors for Industrial and Medical IoT: Innovation and Challenges (S6.1 and S7.1)
7. Special Session on Augmented products for safety and sports (S6.2 and S11.1)
8. Special Session on Smart sensors for measurements in biomedical and biotechnological applications (S7.2 and S8.2)
9. Special Session on Optical Sensors in Industry 4.0: Roles, Capacities, and Applications (S9.1 and S10.1)
10. Special Session on Advances in predictive maintenance and fault detection for Industry 4.0 (S9.2 and S10.2)

We gratefully acknowledge the hard work of the Technical Program Committees in the process of reviewing the papers and helping to shape the program and other activities, such as keynotes and tutorials. The TPC is composed of 64 internal experts in Measurements and Internet of

Things for Industry 4.0. Also, we thank the dozens of reviewers who agreed to review papers with their specific expertise. Finally, we especially thank authors who honored the 2023 edition of MetroInd4.0&IoT 2023, submitting high-quality contributions with their research results. All these people played an important role in making this workshop come through.

We wish all participants a very enjoyable and professionally fruitful experience at MetroInd4.0&IoT 2023 in Brescia.

Thanks to you all for your participation.

June 2023,

Davide Brunelli, University of Trento, Italy
Oscar Casas, Universitat Politècnica de Catalunya, Spain
Paolo Ferrari, University of Brescia, Italy
Technical Program Chairs

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Krzysztof Kozłowski, Poznan University of Technology, Poland

IEEE MetroInd 2023 Keynote Speakers

Plenary Session - Tuesday June 6 - H 14:30

4.0 to 5.0: Ten years of Digitization to Sustainable Human Centric Industry

Diego **Galar**

LULEÅ UNIVERSITY OF TECHNOLOGY, SWEDEN

ABSTRACT

The digital transformation of industry has been rapidly accelerating thanks to one decade of Industry 4.0 enabling technologies transforming how we produce and consume goods and services. This revolution is characterized by the integration of advanced technologies into the manufacturing process, including cyber-physical systems, the Internet of Things (IoT), and cloud computing. These technologies have paved the way for the creation of digital twins, virtual representations of physical objects or systems, which can be used to optimize and improve products and services.

As we look ahead to Industry 5.0, we must consider the potential of emerging technologies such as the metaverse and industrial AI. The metaverse refers to a virtual world, a fully immersive and interconnected virtual space, where individuals can interact with each other and with digital objects. In Industry 5.0, the metaverse can be leveraged to enhance collaboration between human-machine and machine-machine, bringing together individuals from different locations and backgrounds to solve complex problems and create innovative solutions. Industrial AI, on the other hand, refers to the integration of artificial intelligence (AI) into industrial processes becoming the AI engine of such metaverse facilitating a new playground for industry where processes are more efficient and sustainable. This virtual space powered by AI can also be used to predict and prevent equipment failures, reducing downtime and maintenance costs, evolving the Maintenance 4.0 concept to Maintenance 5.0.

In this speech, we will explore the journey from Industry 4.0 to Industry 5.0 and discuss the role of digital twins, the metaverse, and industrial AI in achieving a sustainable, human-centric industry. We will examine the challenges and opportunities presented by these emerging technologies and their potential to transform industry. We will also look at the role of businesses, policymakers, and society in shaping the adoption of these technologies and highlight the importance of collaboration and innovation in achieving this goal.

Ultimately, this speech aims to inspire and inform individuals and organizations to embrace the possibilities of a digital future that puts people and the planet at the center of industry. By harnessing the power of emerging technologies to enhance collaboration, creativity, and sustainability, we can create a better future for all.

SPEAKER BIOGRAPHY

Dr. Diego Galar is Full Professor of Condition Monitoring in the Division of Operation and Maintenance Engineering at LTU, Luleå University of Technology where he has coordinated several European projects related to different aspects of cyber physical systems, Industry 4.0, IoT or Industrial AI and Big Data. He was also involved in the SKF UTC centre located in Lulea focused on SMART bearings and also actively involved in national projects with the Swedish industry or funded by Swedish national agencies like Vinnova.

He was also principal researcher in Tecnalia (Spain), heading the Maintenance and Reliability research group within the Division of Industry and Transport and Professor in Skovde University holding the Volvo chair.

He has authored more than five hundred journal and conference papers, books and technical reports in the field of maintenance, working also as member of editorial boards, scientific committees and chairing international journals and conferences and actively participating in national and international committees for standardization and R&D in the topics of reliability and maintenance.

In the international arena, he has been visiting Professor in the Polytechnic of Braganza (Portugal), University of Valencia and NIU (USA) and the Universidad Pontificia Católica de Chile. Currently, he is currently visiting professor in University of Sunderland (UK), University of Maryland (USA), and Chongqing University in China.

Plenary Session - Wednesday June 7 - H 09:00

Printing and Electronics: Friends with benefits

Pedro **Martins**
UNIVERSITY OF MINHO, PORTUGAL

ABSTRACT

In this talk, Pedro Martins reveals that printed electronics changed thinking in smart materials research some years ago, resulting in a generation of new high-performance materials and an increased focus on controlling structure, fabrication, and performance, as well as their implementation into proof-of-concept applications. Over the years, a high number of printing technologies have been used to pattern a wide range of electronic materials on diverse substrates. As a further expansion of printed technologies is expected in the near future due to the digitalization efforts (associated with the Internet of Things and 4.0 revolution), this talk will discuss the benefits, weaknesses, and opportunities of this joint field, trying to highlight the scientific obstacles that still limit a wider application of those materials nowadays. Additionally, it will discuss how these limitations could be overcome, together with an outlook on the remaining challenges and future research directions.

SPEAKER BIOGRAPHY

Pedro Martins graduated in Physics and Chemistry in 2006, receiving the Ph.D degree in Physics in 2012, from the University of Minho (Braga, Portugal) in collaboration with Basque Country University (Spain) and Cambridge University (UK). In 2013-2014 he was also a researcher at the International Iberian Nanotechnology Laboratory (Portugal). He is an Assistant Researcher in the Physics Center of the University of Minho, and his work is focused on polymer-based magnetoelectric materials, printed electronics, spintronics, and magnetoactive structures for advanced applications. He has over 120 papers in high-ranked journals, h-index of 40, 7000 citations, and 15 invited talks at international events.

IEEE MetroInd 2023 Tutorial

Tutorial Session - Thursday June 8 - H 09:00

Distributed measuring and control using edge computing and container based software for industrial applications

Cristian **Sartori**

SIEMENS SPA

ABSTRACT

Machine and process data coming from industrial production provides tremendously valuable insights. Both production and research could benefit from them... but a huge amount of data lies dormant and unused.

This situation is the result of decades of strict separation from control systems (e.g. PLC), measuring equipment (e.g. ATE), and data analysis (e.g. offline processing).

Today, thanks to virtualization and containerization techniques the situation has completely changed, allowing distributed measurement and control applications to take advantage of the recent edge computing paradigm. Working with open, ready-to-use, Edge computing platforms (consisting of Edge devices, Edge apps, Edge connectivity) lets measurement algorithms and control strategies to be placed and executed right where data is generated. The production machines, machine tools, processes, and plants directly host distributed applications in order to optimize workflows, save resources, and improve quality.

The flexible, centrally managed, deployment of software and applications from multiple sources and vendors, the complete versioning control, and the extensive security approach make Edge systems the most promising scenario for industry and research.

And if the application scales? if the research pushes the limits? Without losing the full control over data at all times, migration from edge to cloud computing is transparent when higher computing power, more storage, and remote accesses are needed.

In this speech, the focus will be on presenting the current situation describing the technology opportunities and providing some example applications.

SPEAKER BIOGRAPHY

After graduating in Telecommunications Engineering, I started my career as a validation engineer at a multinational manufacturer of optic fiber networking infrastructure products and solutions. I later changed roles and became Product Manager for software solutions for the management of networking devices on a national scale, where I also obtained a patent for their optimization. After 10 years, I changed sectors and was hired by a leading multinational in the digitalization world. After a few years as product manager and sales specialist, I became Director Business Segment Automation System for the Italian market, where I was able to gain experience in the digitalization needs of the major production markets. During my career, I acquired skills in product market management and sales. I am also a technology enthusiast and continue to keep up with the latest trends and developments especially in the world of edge computing and AI for manufacturing.

IEEE MetroInd 2023 Venue

IEEE MetroInd4.0&IoT 2023 will be held at the
University of Brescia - *Department of Engineering* - Via Branze, 38

ADDRESS
Via Branze, 28
Brescia

Use the QRCode to open the location on *Google Maps*

How to reach the University of Brescia - Department of Engineering by Underground (Metro)

From Brescia railway station "Stazione FS" underground station or from anywhere in the city center, take the Northbound line (end-of-line station "Prealpino") and get off at "Europa" underground station.
The University of Brescia, Department of Information Engineering is just 200 m away along Via Branze and is the white building on the right.

IEEE MetroInd 2023 Social Events

WELCOME PARTY
Tuesday June 6 - H 19:30

The Welcome Party will be held at the "*Vita Mood & Food*" on **Tuesday, June 6** - 19.30.

ADDRESS

Piazzale Arnaldo, 18
Brescia
Use the QRCode to open the location on *Google Maps*

GALA DINNER
Wednesday June 7 - H 20:00

The Gala Dinner will be held at "**La Sosta**" restaurant on **Wednesday, June 7** - 20.00.

ADDRESS
Via S. Martino della Battaglia, 20
Brescia

Use the QRCode to open the location on *Google Maps*

IEEE MetroInd 2023 Patronages

Program Schedule - Tuesday, June 6

TUESDAY, JUNE 6 2023		
09:30 - 10:00	Opening Ceremony - Welcome Addresses	
	Aula Consiliare	Hall N3
10:00 - 11:20	Session 1.1 - Machine learning and IoT for industrial measurement systems - Part I	Session 1.2 - Reliable wireless solutions for IoT and Industrial IoT - Part I
11:20 - 11:50	COFFEE BREAK	
11:50 - 13:10	Session 2.1 - Machine learning and IoT for industrial measurement systems - Part II	Session 2.2 - Reliable wireless solutions for IoT and Industrial IoT - Part II
13:10 - 14:30	LUNCH	
14:30 - 15:20	Keynote Speaker - Diego Galar, *Luleå University of Technology, Sweden* **4.0 to 5.0: Ten years of Digitization to Sustainable Human Centric Industry**	
	Aula Consiliare	Hall N3
15:20 - 16:20	Session 3.1 - Measurements and Virtual Measurements for Industry 4.0: Approaches and Solutions for Smart Manufacturing - Part I	Session 3.2 - Wearable Sensors for Unobtrusive Monitoring of Physiological Parameters and Human Activities - Part I
16:20 - 16:50	COFFEE BREAK	
16:50 - 18:10	Session 4.1 - Measurements and Virtual Measurements for Industry 4.0: Approaches and Solutions for Smart Manufacturing - Part II	Session 4.2 - Wearable Sensors for Unobtrusive Monitoring of Physiological Parameters and Human Activities - Part II
19:30 - 21:30	Welcome Party - Piazzale Arnaldo	

Program Schedule - Wednesday, June 7

WEDNESDAY, JUNE 7 2023		
09:00 - 09:50	Keynote Speaker - Pedro Martins, *University of Minho, Portugal* **Printing and Electronics: Friends with benefits**	
	Aula Consiliare	Hall N3
10:00 - 11:00	Session 5.1 - Positioning, tracking and navigation in the Industry 4.0 era - Part I	Session 5.2 - Wearable Sensors for Unobtrusive Monitoring of Physiological Parameters and Human Activities - Part III
11:00 - 11:30	COFFEE BREAK	
11:30 - 12:30	Session 6.1 - Printed Sensors for Industrial and Medical IoT: Innovation and Challenges - Part I	Session 6.2 - Augmented products for safety and sports - Part I
12:30 - 14:20	LUNCH	
	Aula Consiliare	Hall N3
14:20 - 15:40	Session 7.1 - Printed Sensors for Industrial and Medical IoT: Innovation and Challenges - Part II	Session 7.2 - Smart sensors for measurements in biomedical and biotechnological applications - Part I
15:40 - 16:10	COFFEE BREAK	
16:10 - 17:50	Session 8.1 - Positioning, tracking and navigation in the Industry 4.0 era - Part II	Session 8.2 - Smart sensors for measurements in biomedical and biotechnological applications - Part II
20:00 - 23:00	Gala Dinner - La sosta	

Program Schedule - Thursday, June 8

THURSDAY, JUNE 8 2023		
09:00 - 09:40	Tutorial - Cristian Sartori, *SIEMENS* **Distributed measuring and control using edge computing and container based software for industrial applications**	
	Aula Consiliare	Hall N3
09:40 - 11:00	Session 9.1 - Optical Sensors in Industry 4.0: Roles, Capacities, and Applications - Part I	Session 9.2 - Advances in predictive maintenance and fault detection for Industry 4.0 - Part I
11:00 - 11:30	COFFEE BREAK	
11:30 - 13:10	Session 10.1 - Optical Sensors in Industry 4.0: Roles, Capacities, and Applications - Part II	Session 10.2 - Advances in predictive maintenance and fault detection for Industry 4.0 - Part II
13:10 - 14:30	LUNCH	
	Aula Consiliare	Hall N3
14:30 - 15:30	Session 11.1 - Augmented products for safety and sports - Part II	14:30 - 15:50 - Session 11.2 - Measurements and Virtual Measurements for Industry 4.0: Approaches and Solutions for Smart Manufacturing - Part III
15:50 - 16:20	Closing and Award Ceremony	

Technical Program - Tuesday, June 6

09:00 - 17:00	*University of Brescia - Department of Engineering* **REGISTRATIONS**

09:30 - 10:00	*Aula Consiliare - University of Brescia* **OPENING CEREMONY - WELCOME ADDRESSES**

10:00 - 11:20	*Aula Consiliare - University of Brescia* **Session 1.1 - Machine learning and IoT for industrial measurement systems - Part I** **Chairs**: Ivanovich Silva, *Federal University of Rio Grande do Norte, Brazil* Paolo Ferrari, *University of Brescia, Italy*

10:00   **Applying automatic system log analysis to industrial automation systems for IoT integration**
Paolo Bellagente, University of Brescia, Italy
Alessandro Depari, University of Brescia, Italy
Emiliano Sisinni, University of Brescia, Italy
Alessandra Flammini, University of Brescia, Italy
Marco Pasetti, University of Brescia, Italy
Paolo Ferrari, University of Brescia, Italy
Stefano Rinaldi, University of Brescia, Italy
Dennis Brandão, University of São Paulo, Brazil

10:20   **Embedded Machine Learning for 3D Indoor Visible Light Positioning via Optimized Fingerprinting**
Irene Cappelli, University of Siena, Italy
Federico Carli, University of Siena, Italy
Ada Fort, University of Siena, Italy
Federico Micheletti, University of Siena, Italy
Marco Mugnaini, University of Siena, Italy

10:40   **A Multi Soft-sensor Approach for the Development of Emergencies Detection Units on the Edge**
Franklin Oliveira, Federal University of Bahia, Brazil
Daniel G. Costa, University of Porto, Portugal
Flavio Assis, Federal University of Bahia, Brazil
Ivanovitch Silva, Federal University of Rio Grande do Norte, Brazil

11:00 **A Low-Complexity FPGA-Based Neural Network for Hand-Arm Vibrations Classification**
Tommaso Addabbo, University of Siena, Italy
Elia Landi, University of Siena, Italy
Riccardo Moretti, University of Siena, Italy
Lorenzo Parri, University of Siena, Italy
Giacomo Peruzzi, University of Padua, Italy
Alessandro Pozzebon, University of Padua, Italy
Filippo Spinelli, University of Siena, Italy

10:00 - 11:20	*Hall N3 - University of Brescia*
	Session 1.2 - Reliable wireless solutions for IoT and Industrial IoT - Part I
	Chairs: Emiliano Sisinni, *University of Brescia, Italy*
	Paolo Bellagente, *University of Brescia, Italy*

10:00 **Data Transmission Using FSK Modulation on an Unconventional Channel**
Paolo Caruso, University of Salerno, Italy
Salvatore Dello Iacono, University of Salerno, Italy
Vincenzo Paciello, University of Salerno, Italy

10:20 **Experimental Analysis of Side-Channel Emissions for IoT Devices Activities' Profiling**
Andrea Amodei, University of Cassino and Southern Lazio, Italy
Domenico Capriglione, University of Cassino and Southern Lazio, Italy
Luigi Ferrigno, University of Cassino and Southern Lazio, Italy
Gianfranco Miele, University of Cassino and Southern Lazio, Italy
Luca Tari, University of Cassino and Southern Lazio, Italy
Giuseppe Tomasso, University of Cassino and Southern Lazio, Italy
Gianni Cerro, University of Molise, Italy

10:40 **CRT-LoRa: An efficient and reliable MAC scheme for real-time industrial applications**
Filippo Battaglia, University of Messina, Italy
Giovanni Gugliandolo, University of Messina, Italy
Rahma Mani, University of Monastir, Tunisia
Giuseppe Campobello, University of Messina, Italy
Nicola Donato, University of Messina, Italy

11:00 **Thermoelectric Generators (TEG) for the powering of energy-hungry LoRaWAN-based sensor nodes in industrial applications**
Marco Migliorini, University of Padova, Italy
Alessandro Pozzebon, University of Padova, Italy

11:20 - 11:50	*University of Brescia - Department of Engineering*
	COFFEE BREAK

11:50 - 12:50	*Aula Consiliare - University of Brescia*
	Session 2.1 - Machine learning and IoT for industrial measurement systems - Part II
	Chairs: Ivanovich Silva, *Federal University of Rio Grande do Norte, Brazil*
	Paolo Ferrari, *University of Brescia, Italy*

11:50 **Mel Power Spectrogram Approximation By Tiny Neural Networks for Home Appliances Classification**
Marc Dimbiniaina Randriatsimiovalaza, STMicroelectronics, University of Trento, Italy
Danilo Pietro Pau, STMicroelectronics, Italy
Tesfaye Amare Naramo, STMicroelectronics, University of Trento, Italy

12:10 **TinyML Custom AI Algorithms for Low-Power IoT Data Compression: A Bridge Monitoring Case Study**
Thaís Medeiros, Federal University of Rio Grande do Norte, Brazil
Miguel Amaral, Federal University of Rio Grande do Norte, Brazil
Matheus Targino, Federal University of Rio Grande do Norte, Brazil
Marianne Silva, Federal University of Rio Grande do Norte, Brazil
Ivanovitch Silva, Federal University of Rio Grande do Norte, Brazil
Emiliano Sisinni, University of Brescia, Italy
Paolo Ferrari, University of Brescia, Italy

12:30 **MetaPrinter: A Digital Twin-Enabled Platform for 3D Printer Diagnostics**
Gabriel Avelino R Sampedro, University of the Philippines, Philippines
Ramon Miguel Africa, Philippine Coding Camp, Philippines
Mideth Abisado, National University, Philippines
Dong Seong Kim, Kumoh National Institute of Technology, South Korea
Jae Min Lee, Kumoh National Institute of Technology, South Korea

11:50 - 13:10	*Hall N3 - University of Brescia*
	Session 2.2 - Reliable wireless solutions for IoT and Industrial IoT - Part II
	Chairs: Emiliano Sisinni, *University of Brescia, Italy*
	Paolo Bellagente, *University of Brescia, Italy*

11:50 **Distributed Wireless Monitoring in Oil&Gas Plants Through Mobile UAV-UGV RFID Platforms**
Alessio Mostaccio, University of Roma Tor Vergata, Italy
Sara Amendola, RADIO6ENSE Srl, Italy
Nicola D'Uva, RADIO6ENSE Srl, Italy
Gaetano Marrocco, University of Roma Tor Vergata, Italy
Cecilia Occhiuzzi, University of Roma Tor Vergata, Italy

12:10 **LoRa based remote expendable radiosonde network for environmental observations**
Shahbozbek Abdunabiev, Politecnico di Torino, Italy

Eros Pasero, Politecnico di Torino, Italy
Daniela Tordella, Politecnico di Torino, Italy

12:30 **Built-in battery-less sensors for the wireless temperature monitoring of undercarriages in connected industrial vehicles**
Carolina Miozzi, RADIO6ENSE Srl, Italy
Nicola D'Uva, RADIO6ENSE Srl, Italy
Sara Amendola, RADIO6ENSE Srl, Italy
Enrico Maggiolini, Berco S.p.A., Italy
Andrea Bianchi, Berco S.p.A., Italy
Cecilia Occhiuzzi, University of Roma Tor Vergata, RADIO6ENSE Srl, Italy
Gaetano Marrocco, University of Roma Tor Vergata, RADIO6ENSE Srl, Italy

12:50 **Can adaptive strategies sustain bidirectional LoRaWAN traffic?**
Emiliano Sisinni, University of Brescia, Italy
Alessandro Depari, University of Brescia, Italy
Paolo Bellagente, University of Brescia, Italy
Alessandra Flammini, University of Brescia, Italy
Ivanovitvh Silva, UFRN, Brazil
Thommas Flores, UFRN, Brazil
Paolo Ferrari, University of Brescia, Italy

13:10 - 14:30   *University of Brescia - Department of Engineering*
                    LUNCH

14:30 - 15:20   *Aula Consiliare - University of Brescia*
                    PLENARY SESSION - KEYNOTE SPEAKER
                    Chair: Mauro Serpelloni, *University of Brescia, Italy*

4.0 to 5.0: Ten years of Digitization to Sustainable Human Centric Industry

Diego Galar, *Luleå University of Technology, Sweden*

15:20 - 16:20   *Aula Consiliare - University of Brescia*
                    Session 3.1 - Measurements and Virtual Measurements for Industry 4.0: Approaches and Solutions for Smart Manufacturing - Part I
                    Chairs: Antonella Gaspari, *Politecnico di Bari, Italy*
                             Alessandro Schiavi, *INRiM, Italy*

15:20 **Metrology for next generation "Phygital Sensors"**
Alessandro Schiavi, INRiM – National Institute of Metrological Research, Italy
Fabrizio Mazzoleni, INRiM – National Institute of Metrological Research, Italy

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Alessio Facello, INRiM – National Institute of Metrological Research, Italy
Andrea Prato, INRiM – National Institute of Metrological Research, Italy

15:40 **Online 3D Geometry Reconstruction for Direct Energy Deposition Based on Melt Pool Images**
Vittorio Sala, SUPSI, Switzerland
Ambra Vandone, SUPSI, Switzerland
Michele Banfi, SUPSI, Switzerland
Stefano Baraldo, SUPSI, Switzerland
Federico Mazzucato, SUPSI, Switzerland
Anna Valente, SUPSI, Switzerland

16:00 **Temperature Sensitivity Analysis of a Power Quality Meter Using Thermal Step Test**
Gabriele Patrizi, University of Florence, Italy
Alessandro Bartolini, University of Florence, Italy
Libero Paolucci, University of Florence, Italy
Francesco Grasso, University of Florence, Italy
Marcantonio Catelani, University of Florence, Italy
Lorenzo Ciani, University of Florence, Italy

15:20 - 16:20	*Hall N3 - University of Brescia*
	Session 3.2 - Wearable Sensors for Unobtrusive Monitoring of Physiological Parameters and Human Activities - Part I
	Chairs: Carlo Massaroni, *Università Campus Bio-Medico di Roma, Italy*
	Martina Costa Angeli, *Free University of Bozen-Bolzano, Italy*
	Elena Bergamini, *University of Sport and Movement "Foro Italico"*

15:20 **Feasibility study on the use of a single digital camera for thoraco-abdominal pattern assessment**
Nunzia Molinaro, Università Campus Bio-Medico di Roma, Italy
Emiliano Schena, Università Campus Bio-Medico di Roma, Italy
Marco Bravi, Università Campus Bio-Medico di Roma, Italy
Sandra Miccinilli, Università Campus Bio-Medico di Roma, Italy
Silvia Sterzi, Università Campus Bio-Medico di Roma, Italy
Sergio Silvestri, Università Campus Bio-Medico di Roma, Italy
Carlo Massaroni, Università Campus Bio-Medico di Roma, Italy

15:40 **A flexible electrode strap for impedance plethysmography of the dorsalis pedis artery**
Christian Tronstad, Oslo University Hospital, Norway
Nigel A. Callender, Oslo University Hospital, Norway
Vahid Badeli, Graz University of Technology, Austria
Jonny Hisdal, Oslo University Hospital, University of Oslo, Norway

16:00 Novel silk hydrogel-based material for wearable energy harvesting and sensing mountaineers' activities

Raheel Riaz, Free University of Bolzano, Italy
Martina Aurora Costa Angeli, Free University of Bolzano, Italy
Abraham Mejia-Aguilar, EURAC Research, Italy
Roberto Monsorno, EURAC Research, Italy
Bhaskar Dudem, University of Surrey, UK
S. Ravi P. Silva, University of Surrey, UK
Paolo Lugli, Free University of Bolzano, Italy
Luisa Petti, Free University of Bolzano, Italy

16:20 - 16:50   *University of Brescia - Department of Engineering*
COFFEE BREAK

16:50 - 18:10   *Aula Consiliare - University of Brescia*
Session 4.1 - Measurements and Virtual Measurements for Industry 4.0: Approaches and Solutions for Smart Manufacturing - Part I
Chairs: Antonella Gaspari, *Politecnico di Bari, Italy*
              Luciano Chiominto, *University of L'Aquila, Italy*

16:50 Metrological characteristics of methods for the inspection of composite material components

Giulio D'Emilia, University of L'Aquila, Italy
Luciano Chiominto, University of L'Aquila, Italy
Laura Fabbiano, Polytechnic of Bari, Italy
Antonella Gaspari, Polytechnic of Bari, Italy
Emanuela Natale, University of L'Aquila, Italy
Antonios Stamopoulos, University of L'Aquila, Italy

17:10 Beam Straightness Measurement with Laser Triangulation System: a steel industry use case

Valentina Pasquinelli, Università Politecnica delle Marche, Italy
Milena Martarelli, Università Politecnica delle Marche, Italy
Nicola Paone, Università Politecnica delle Marche, Italy
Paolo Castellini, Università Politecnica delle Marche, Italy
Luigi Montalto, Università Politecnica delle Marche, Italy
Kosmas Alexopoulos, Laboratory for Manufacturing Systems and Automation, Greece
Nikolaos Nikolakis, Laboratory for Manufacturing Systems and Automation, Greece
Wilhelm van de Kamp, VDL Weweler bv, The Netherlands
Bart Verhoef, VDL Weweler bv, The Netherlands

17:30 A robot-based inspecting system for 3D measurement

Silvia Discepolo, Università Politecnica delle Marche, Italy
Milena Martarelli, Università Politecnica delle Marche, Italy

Nicola Paone, Università Politecnica delle Marche, Italy
Paolo Castellini, Università Politecnica delle Marche, Italy
Wilhelm van de Kamp, VDL Weweler bv, The Netherlands
Bart Verhoef, VDL Weweler bv, The Netherlands
Nikolaos Nikolakis, Laboratory for Manufacturing Systems and Automation, Greece
Kosmas Alexopoulos, Laboratory for Manufacturing Systems and Automation, Greece

17:50   **Torque Control of a Brushless DC Motor Using PID-Genetic Algorithm Optimization Method**
Mohamed Benchagra, USMS University Sultan Moulay Slimane, Morocco

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16:50 - 18:10   *Hall N3 - University of Brescia*
Session 4.2 - Wearable Sensors for Unobtrusive Monitoring of Physiological Parameters and Human Activities - Part I
Chairs: Carlo Massaroni, *Università Campus Bio-Medico di Roma, Italy*
          Martina Costa Angeli, *Free University of Bozen-Bolzano, Italy*
          Elena Bergamini, *University of Sport and Movement "Foro Italico"*

16:50   **Standard 12-lead ECG synthesis from homecare wearable measures**
Pau Sindreu, Universitat Politècnica de Catalunya, Spain
Iván Mansergas, Universitat Politècnica de Catalunya, Spain
David Cano, Universitat Politècnica de Catalunya, Spain
Oscar Casas, Universitat Politècnica de Catalunya, Spain

17:10   **The effects of different algorithms on the performance of a strain-based wearable device estimating respiratory rate during cycling exercise**
Carlo Massaroni, Università Campus Bio-Medico di Roma, Italy
Chiara Romano, Università Campus Bio-Medico di Roma, Italy
Lorenzo Innocenti, University of Rome "Foro Italico", Italy
Massimo Sacchetti, University of Rome "Foro Italico", Italy
Emiliano Schena, Università Campus Bio-Medico di Roma, Italy
Andrea Nicolò, University of Rome "Foro Italico", Italy

17:30   **Photoplethysmographic Signal Quality Assessment: a Comparative Study of Unsupervised and Supervised Neural Networks**
Anna Sabatini, Università Campus Bio-Medico di Roma, Italy
Luca Bacco, Università Campus Bio-Medico di Roma, Italy
Leonardo Lotini, Università Campus Bio-Medico di Roma, Italy
Giovanni Palombo, IASI-CNR, Italy
Giulia Di Tomaso, Heremos Srl, Italy
Riccardo Sabbadini, Heremos Srl, Italy
Mario Merone, Università Campus Bio-Medico di Roma, Italy
Luca Vollero, Università Campus Bio-Medico di Roma, Italy

17:50   **Affective state classification using timing-related features from short windowed PPG signal**
Damiano Fruet, University of Trento, Italy
Pietro Leonardelli, University of Trento, Italy
Giandomenico Nollo, University of Trento, Italy

19:30	**WELCOME PARTY**
	Vita Mood & Food - Piazzale Arnaldo - Brescia

Technical Program - Wednesday, June 7

09:00 - 17:00	*University of Brescia - Department of Engineering* **REGISTRATIONS**

09:00 - 09:50	*Aula Consiliare - University of Brescia* **PLENARY SESSION - KEYNOTE SPEAKER** **Chair**: Mauro Serpelloni, *University of Brescia, Italy*

Printing and Electronics: Friends with benefits

Pedro Martins, *University of Minho, Portugal*

10:00 - 11:00	*Aula Consiliare - University of Brescia* **Session 5.1 - Positioning, tracking and navigation in the Industry 4.0 era - Part I** **Chairs**: Alice Buffi, *University of Pisa, Italy* Luca Santoro, *University of Trento, Italy*

10:00   **An RFID Cartesian Portal Enables SAR-Based Localization for Worker Safety**
Gabriele Bandini, University of Pisa, Italy
Andrea Motroni, University of Pisa, Italy
Alice Buffi, University of Pisa, Italy
Mirko Marracci, University of Pisa, Italy
Bernardo Tellini, University of Pisa, Italy
Luciano Di Donato, INAIL, Italy
Marco Pirozzi, INAIL, Italy
Laura Tomassini, INAIL, Italy
Alessandra Ferraro, INAIL, Italy

10:20 **Experimental Validation of Vehicle Positioning with Ultra-Wide Band Roadside Infrastructure**
Marco Piavanini, Politecnico di Milano, Italy
Lorenzo Italiano, Politecnico di Milano, Italy
Mattia Brambilla, Politecnico di Milano, Italy
Simone Specchia, Politecnico di Milano, Italy
Stefano Carnier, Politecnico di Milano, Italy
Sergio Matteo Savaresi, Politecnico di Milano, Italy
Giovanni Miragliotta, Politecnico di Milano, Italy
Diego Franceschini, Movyon S.p.A. Gruppo Autostrade per l'Italia (ASPI), Italy
Benedetto Carambia, Movyon S.p.A. Gruppo Autostrade per l'Italia (ASPI), Italy
Monica Nicoli, Politecnico di Milano, Italy

10:40 **Operator 5.0: enhancing the physical resilience of workers in assembly lines**
Francesco Pilati, University of Trento, Italy
Andrea Sbaragli, University of Trento, Italy
Federica Tomelleri, University of Trento, Italy
Enrico Picariello, University of Sannio, Italy
Francesco Picariello, University of Sannio, Italy
Ioan Tudosa, University of Sannio, Italy
Matteo Nardello, University of Trento, Italy

10:00 - 11:00   *Hall N3 - University of Brescia*
Session 5.2 - Wearable Sensors for Unobtrusive Monitoring of Physiological Parameters and Human Activities - Part III
Chairs: Carlo Massaroni, *Università Campus Bio-Medico di Roma, Italy*
Martina Costa Angeli, *Free University of Bozen-Bolzano, Italy*
Elena Bergamini, *University of Sport and Movement "Foro Italico"*

10:00 **Graph and handwriting signals-based machine learning models development in Parkinson's screening and telemonitoring**
Annalisa Mancini, Sapienza University of Rome, Italy
Raffaella Calabrese, San Raffaele University of Rome, Italy
Matteo Angelucci, San Raffaele University of Rome, Italy
Giovanni Albani, Casa di Cura Le Terrazze, Italy
Giuseppe Veneziano, Casa di Cura Le Terrazze, Italy
Marianna Mazza, Università Cattolica del Sacro Cuore, Italy
Giuseppe Marano, Università Cattolica del Sacro Cuore, Italy
Alessandra Paffi, Sapienza University of Rome, Italy
Antonio Pallotti, San Raffaele University of Rome, Italy

10:20 **An innovative smart face mask for the estimation of respiratory rate: design, development and feasibility assessment**
Lucrezia Giorgi, Università Campus Bio-Medico di Roma, Italy
Federico Di Marco, Università Campus Bio-Medico di Roma, Italy

Daniela Lo Presti, Università Campus Bio-Medico di Roma, Italy
Carlo Massaroni, Università Campus Bio-Medico di Roma, Italy
Chiara Romano, Università Campus Bio-Medico di Roma, Italy
Antonio Moffa, Fondazione Policlinico Universitario Campus Bio-Medico, Italy
Manuele Casale, Fondazione Policlinico Universitario Campus Bio-Medico, Italy
Emiliano Schena, Università Campus Bio-Medico di Roma, Italy

10:40   **Automatic Detection of Myotonia using a Sensory Glove with Resistive Flex Sensors and Machine Learning Techniques**
Valerio Cesarini, University of Rome Tor Vergata
Giovanni Costantini, University of Rome Tor Vergata
Federica Amato, Polytechnic University of Turin
Vito Errico, University of Rome Tor Vergata
Luca Pietrosanti, University of Rome Tor Vergata
Alexandre Luis Calado, University of Rome Tor Vergata
Roberto Massa, University of Rome Tor Vergata
Erica Frezza, University of Rome Tor Vergata
Fernanda Irrera, Sapienza University of Rome, Italy
Alessandro Manoni, Sapienza University of Rome, Italy
Giovanni Saggio, University of Rome Tor Vergata

11:00 - 11:30   *University of Brescia - Department of Engineering*
COFFEE BREAK

11:30 - 12:30   *Aula Consiliare - University of Brescia*
Session 6.1 - Printed Sensors for Industrial and Medical IoT: Innovation and Challenges - Part I
Chairs: Bruno Andò, *University of Catania, Italy*
        Michela Borghetti, *University of Brescia, Italy*

11:30   **Preliminary Results on Fully-Printed and Silver-Based Temperature Sensors for Aerospace Industry**
Tiziano Fapanni, University of Brescia, Italy
Michela Borghetti, University of Brescia, Italy
Stefano Bellotti, University of Brescia, Italy
Emilio Sardini, University of Brescia, Italy
Mauro Serpelloni, University of Brescia, Italy

11:50   **Investigation on Readout Strategy for Aqueous NH3 Sensor Developed by Additive Technology**
Bruno Andò, University of Catania, Italy
Salvatore Baglio, University of Catania, Italy
Salvatore Castorina, University of Catania, Italy
Salvatore Graziani, University of Catania, Italy

Salvatore Petralia, University of Catania, Italy
Marianna Messina, University-Polyclinic of Catania, Italy
Ludovica Maugeri, University of Catania, Italy
Emilio Sardini, University of Brescia, Italy
Mauro Serpelloni, University of Brescia, Italy
Paolo Bellitti, University of Brescia, Italy
Giovanni Neri, University of Messina, Italy
Angelo Ferlazzo, University of Messina, Italy

12:10   3D Printed Flow-Cells for Brillouin-based Tapered Optical Fiber Biosensors
Ester Catalano, Università della Campania Luigi Vanvitelli, Italy
Raffaele Vallifuoco, Università della Campania Luigi Vanvitelli, Italy
Francesco Arcadio, Università della Campania Luigi Vanvitelli, Italy
Nunzio Cennamo, Università della Campania Luigi Vanvitelli, Italy
Luigi Zeni, Università della Campania Luigi Vanvitelli, Italy
Aldo Minardo, Università della Campania Luigi Vanvitelli, Italy
Cosimo Trono, CNR-IFAC, Italy
Ambra Giannetti, CNR-IFAC, Italy
Francesco Baldini, CNR-IFAC, Italy
Sara Tombelli, CNR-IFAC, Italy

11:30 - 12:30   *Hall N3 - University of Brescia*
Session 6.2 - Augmented products for safety and sports - Part I
Chairs: Teodorico Caporaso, *University of Naples Federico II, Italy*
         Giuseppe Di Gironimo, *University of Naples Federico II, Italy*

11:30   A Wearable Sensor Network for Cyclists Safety in Mixed Traffic, a Pilot Study
Giuseppe Sanseverino, Chemnitz University of Technology, Germany
Moritz Rothermel, Chemnitz University of Technology, Germany
Stephan Odenwald, Chemnitz University of Technology, Germany

11:50   Design and development of a serious game with physical interface for return to work in construction site
Teodorico Caporaso, University of Naples Federico II, Italy
Andrea Tarallo, University of Naples Federico II, Italy
Gianluca D'Anna, University of Naples Federico II, Italy
Mario Armano, University of Naples Federico II, Italy
Stefano Papa, University Niccolo Cusano, Italy
Gennaro Bufalo, University of Naples Federico II, Italy
Raffaele D'Angelo, INAIL Campania, Italy
Antonio Lanzotti, University of Naples Federico II, Italy

12:10   Preliminary Evaluation of an Active Soft Bellow Exoskeleton for Industrial Overhead Tasks
Benedetta M. V. Ostuni, University of Naples Federico II, Italy
Teodorico Caporaso, University of Naples Federico II, Italy
Stanislao Grazioso, University of Naples Federico II, Italy

Angela Palomba, University of Campania Luigi Vanvitelli, Italy
Giuseppe Di Gironimo, University of Naples Federico II, Italy
Antonio Lanzotti, University of Naples Federico II, Italy

12:30 - 14:20	*University of Brescia - Department of Engineering* **LUNCH**

14:20 - 15:40	*Aula Consiliare - University of Brescia* **Session 7.1 - Printed Sensors for Industrial and Medical IoT: Innovation and Challenges - Part II** **Chairs**: Bruno Andò, *University of Catania, Italy* Michela Borghetti, *University of Brescia, Italy*

14:20 **Preliminary study of a sensorized system for realtime feedback for arachnoid collapse during neurosurgical training**
Giacomo Santona, University of Brescia, Italy
Tiziano Fapanni, University of Brescia, Italy
Antonio Fiorentino, University of Brescia, Italy
Francesco Doglietto, Catholic University School of Medicine, Italy
Mauro Serpelloni, University of Brescia, Italy

14:40 **Towards V-shaped Plasmonic probes made by exploiting 3D printers and UV-cured optical adhesives for Medical applications**
Chiara Marzano, University of Campania L. Vanvitelli, Italy
Francesco Arcadio, University of Campania L. Vanvitelli, Italy
Aldo Minardo, University of Campania L. Vanvitelli, Italy
Luigi Zeni, University of Campania L. Vanvitelli, Italy
Domenico Del Prete, University of Campania L. Vanvitelli, Italy
Gianluca Cicala, University of Catania, Italy
Lorena Saitta, University of Catania, Italy
Nunzio Cennamo, University of Campania L. Vanvitelli, Italy

15:00 **Preliminary Results on Carbon-Based Thermistors Produced by Aerosol Jet Printing**
Tiziano Fapanni, University of Brescia, Italy
Stefano Bellotti, University of Brescia, Italy
Michela Borghetti, University of Brescia, Italy
Emilio Sardini, University of Brescia, Italy
Mauro Serpelloni, University of Brescia, Italy

15:20 **Preliminary Study on a 3D Printed Sensorized Probe to Characterize Pituitary Adenoma Hardness**
Giacomo Santona, University of Brescia, Italy
Tiziano Fapanni, University of Brescia, Italy
Antonio Fiorentino, University of Brescia, Italy
Francesco Doglietto, Catholic University School of Medicine, Italy
Mauro Serpelloni, University of Brescia, Italy

14:20 - 15:40	*Hall N3 - University of Brescia*

Session 7.2 - Smart sensors for measurements in biomedical and biotechnological applications - Part I

Chairs: Sarah Tonello, *University of Padova, Italy*

Alessandra Galli, *University of Padova, Italy*

14:20 **Signal amplification properties of Electrolyte-Gated Organic Field-Effect Transistors**
Nicolò Lago, University of Padova, Italy
Sara Ruiz Molina, Institut de Ciència de Materials de Barcelona, Spain
Marta Mas Torrent, Institut de Ciència de Materials de Barcelona, Spain
Stefano Casalini, University of Padova, Italy
Andrea Cester, University of Padova, Italy

14:40 **Design and implementation of an IoT based wheelchair for the treatment of spinal cord injuries**
Ewerton V. Lopes, Federal University of Rio Grande do Norte, Brazil
Neuman F. de O. Fernandes, Federal University of Rio Grande do Norte, Brazil
José Carlos, Federal University of Rio Grande do Norte, Brazil
Diego R. C. Silva, Federal University of Rio Grande do Norte, Brazil
Marcelo B. Nogueira, Federal University of Rio Grande do Norte, Brazil
Marconi C. Rodrigues, Federal University of Rio Grande do Norte, Brazil

15:00 **Hallmarks of Parkinson's disease progression determined by temporal evolution of speech attractors in the reconstructed phase-space**
Federica Amato, Poliytechnic University of Turin, Italy
Valerio Cesarini, University of Rome Tor Vergata, Italy
Luca Pietrosanti, University of Rome Tor Vergata, Italy
Giovanni Costantini, University of Rome Tor Vergata, Italy
Gabriella Olmo, Poliytechnic University of Turin, Italy
Giovani Saggio, University of Rome Tor Vergata, Italy

15:20 **In-Vivo Validation of Smart Device for on Body Hydration Monitoring**
Sarah Tonello, University of Padova, Italy
Alberto Zacchini, University of Padova, Italy
Alessandra Galli, University of Padova, Italy
Claudio Narduzzi, University of Padova, Italy
Ata Golparvar, EPFL, Switzerland
Ali Meimandi, EPFL, Switzerland
Sandro Carrara, EPFL, Switzerland

15:40 - 16:10	*University of Brescia - Department of Engineering*

COFFEE BREAK

16:10 - 17:50	*Aula Consiliare - University of Brescia*
	Session 8.1 - Positioning, tracking and navigation in the Industry 4.0 era - Part II
	Chair: Luca Santoro, *University of Trento, Italy*

16:10 **A tag-less ultrawide-band passive tracking system**
Luca Santoro, University of Trento, Italy
Matteo Nardello, University of Trento, Italy
Davide Eccher, University of Trento, Italy
Mattia Sittoni, University of Trento, Italy
Davide Brunelli, University of Trento, Italy
Daniele Fontanelli, University of Trento, Italy

16:30 **UNPOSED: an Ultra-wideband Network for Pose Estimation with Deep Learning**
Giulia Martinelli, University of Trento, Italy
Luca Santoro, University of Trento, Italy
Matteo Nardello, University of Trento, Italy
Davide Brunelli, University of Trento, Italy
Daniele Fontanelli, University of Trento, Italy
Nicola Conci, University of Trento, Italy

16:50 **A Plug-and-Play TinyML-based Vision System for Drone Automatic Landing**
Luca Santoro, University of Trento, Italy
Andrea Albanese, University of Trento, Italy
Marco Canova, University of Trento, Italy
Matteo Rossa, University of Trento, Italy
Daniele Fontanelli, University of Trento, Italy
Davide Brunelli, University of Trento, Italy

17:10 **Pedestrian Inertial Navigation with Multi-Head CNN**
Gokhan Cetin, Gumushane University, Turkey
Mehmet Ali Kucuk, Gumushane University, Turkey
Muhammed Taha Koroglu, Gumushane University, Turkey

17:30 **Considerations of Achieving Ubiquitous PNT in Industry 4.0 and Beyond**
Martta-Kaisa Olkkonen, Finnish Geospatial Research Institute, Finland
Martti Kirkko-Jaakkola, Finnish Geospatial Research Institute, Finland
Sanna Kaasalainen, Finnish Geospatial Research Institute, Finland

16:10 - 17:50	*Hall N3 - University of Brescia*
	Session 8.2 - Smart sensors for measurements in biomedical and biotechnological applications - Part II
	Chairs: Sarah Tonello, *University of Padova, Italy*
	Alessandra Galli, *University of Padova, Italy*

16:10   **A portable, low cost clot permeability measurement system**
Ada Fort, University of Siena, Italy
Elia Landi, University of Siena, Italy
Marco Mugnaini, University of Siena, Italy
Tunahan Vatansever, University of Siena, Italy
Claudia Fiorillo, University of Firenze, Italy
Matteo Becatti, University of Firenze, Italy

16:30   **Fully Automatic Gym Exercises Recording: An IoT Solution**
Sizhen Bian, ETH Zurich PBL-DITET, Switzerland
Alexander Rupp, ETH Zurich PBL-DITET, Switzerland
Michele Magno, ETH Zurich PBL-DITET, Switzerland

16:50   **IoT system for non-invasive measurement of physiological parameters in animals**
Sergio Mainar Álvarez, Universitat Politècnica de Catalunya, Spain
Óscar Casas, Universitat Politècnica de Catalunya, Spain
Ernesto Serrano-Finetti, Universitat Politècnica de Catalunya, Spain

17:10   **Multiphysics simulations of screen-printed electrodes for electrochemical biosensing**
Stefano Bonaldo, University of Padova, Italy
Lara Franchin, University of Padova, Italy
Giulio Rosati, ICN2, CSIC and BIST, Spain
Sarah Tonello, University of Padova, Italy
Arben Merkoçi, ICN2, CSIC and BIST, Spain
Alessandro Paccagnella, University of Padova, Italy

17:30   **Gesture recognition for Healthcare 4.0: a machine learning approach to reduce clinical infection risks**
Bernardo Lanza, University of Brescia, Italy
Enrico Ferlinghetti, University of Brescia, Italy
Cristina Nuzzi, University of Brescia, Italy
Lorenzo Sani, Idea-Re S.r.l., Italy
Alberto Garinei, Marconi University, Idea-Re S.r.l., Italy
Lorenzo Maiorfi, K-Digitale S.r.l., Italy
Simone Naso, Baxter S.p.A., Italy
Emanuele Piccioni, Idea-Re S.r.l., Italy
Federico Bianchi, Idea-Re S.r.l., Italy
Massimiliano Proietti, Idea-Re S.r.l., Italy
Andrea Marini, Idea-Re S.r.l., Italy
Stefano Speziali, Idea-Re S.r.l., Italy
Marcello Marconi, Marconi University, Italy
Alessandro Vispa, Idea-Re S.r.l., Italy
Matteo Lancini, University of Brescia, Italy

20:00   **GALA DINNER**
La Sosta - Brescia

Technical Program - Thursday, June 8

09:00 - 13:00	*University of Brescia - Department of Engineering* **REGISTRATIONS**

09:00 - 09:40	*Aula Consiliare - University of Brescia* **PLENARY SESSION - TUTORIAL** **Chair**: Paolo Ferrari, *University of Brescia, Italy*

Distributed measuring and control using edge computing and container based software for industrial applications

Cristian Sartori, *SIEMENS*

09:40 - 11:00	*Aula Consiliare - University of Brescia* **Session 9.1 - Optical Sensors in Industry 4.0: Roles, Capacities, and Applications - Part I** **Chairs**: Daniela Lo Presti, *Università Campus Bio-Medico di Roma, Italy* Elena De Vita, *Università degli studi di Napoli Parthenope, Italy*

09:40 **Indoor Fall Detection Using FPI-Based Accelerometers**
Alessandra Kalinowski, University of Aveiro, Portugal
Matilde Rocha, University of Aveiro, Portugal
Carolina Sousa, University of Aveiro, Portugal
Catia Leitao, University of Aveiro, Portugal
Margarida Facao, University of Aveiro, Portugal
M. Fatima Domingues, Khalifa University, United Arab Emirates, University of Aveiro, Portugal
Nélia Alberto, University of Aveiro, Portugal
Paulo Antunes, University of Aveiro, Portugal

10:00 **Design, fabrication and metrological characterization of a 3D-printed strain sensor based on fiber Bragg grating technology**
Daniela Lo Presti, Università Campus Bio-Medico di Roma, Italy
Fabio Pizza, Università Campus Bio-Medico di Roma, Italy
Catia Leitao, University of Aveiro, Portugal
Carlo Massaroni, Università Campus Bio-Medico di Roma, Italy

Michele A. Caponero, ENEA Research Center of Frascati, Italy
Paulo Antunes, University of Aveiro, Portugal
Emiliano Schena, Università Campus Bio-Medico di Roma, Italy

10:20 **Flexible wearables for in-vivo plant health monitoring: the effect of colored and uncolored substrates on plant photosynthesis and transpiration**
Daniela Lo Presti, Università Campus Bio-Medico di Roma, Italy
Sara Cimini, Università Campus Bio-Medico di Roma, Italy
Stefano Cinti, University of Naples Federico II, Italy
Francesca De Tommasi, Università Campus Bio-Medico di Roma, Italy
Carlo Massaroni, Università Campus Bio-Medico di Roma, Italy
Laura De Gara, Università Campus Bio-Medico di Roma, Italy
Emiliano Schena, Università Campus Bio-Medico di Roma, Italy

10:40 **Fiber Bragg Grating Embedded in Soft Patch for Finger Tapping Assessment**
Elena De Vita, University of Naples Parthenope, Italy
Pasquale Di Palma, University of Naples Parthenope, Italy
Vincenzo Romano Marrazzo, University of Naples Federico II, Italy
Giovanni Breglio, University of Naples Federico II, Italy
Agostino Iadicicco, University of Naples Parthenope, Italy
Stefania Campopiano, University of Naples Parthenope, Italy

09:40 - 11:00 *Hall N3 - University of Brescia*
Session 9.2 - Advances in predictive maintenance and fault detection for Industry 4.0 - Part I
Chair: Mauro Serpelloni, *University of Brescia, Italy*

09:40 **The Design of Critical Data Communication Applications for Railways: an Approach**
Ivaylo Atanasov, Technical University of Sofia, Bulgaria
Vasil Vatakov, "Todor Kableshkov" University of Transport, Bulgaria
Evelina Pencheva, "Todor Kableshkov" University of Transport, Bulgaria

10:00 **Smart Fault Dictionary for Active Magnetic Bearings Systems**
Michele Basso, University of Florence, Italy
Giovanni Donati, University of Florence, Italy
Marco Mugnaini, University of Siena, Italy

10:20 **Measurement system and data analysis methods to evaluate Flow Induced Vibration in a nuclear fuel pin bundle with heavy liquid metal flow**
Tiziano Rovai, ISE S.R.L., Italy
Simone Mozzon, ISE S.R.L., IIT-CNR, Italy
Giorgio Mongiardini, Sapienza University of Rome, Italy
Marco Ramacciotti, ISE S.R.L., Italy
Edoardo Zambonini, ISE S.R.L., Italy
Valerio Raschioni, ISE S.R.L., Italy

10:40 **Identifying electric power system fault types with Deep Neural Network**
Tomi Nieminen, JAMK University of Applied Sciences, Finland
Olli Väänänen, JAMK University of Applied Sciences, Finland
Pasi Puttonen, JAMK University of Applied Sciences, Finland
Teppo Flyktman, JAMK University of Applied Sciences, Finland
Ari Latvala, JAMK University of Applied Sciences, Finland

11:00 - 11:30	*University of Brescia - Department of Engineering* **COFFEE BREAK**

11:30 - 12:50	*Aula Consiliare - University of Brescia* **Session 10.1 - Optical Sensors in Industry 4.0: Roles, Capacities, and Applications - Part II** **Chairs**: Daniela Lo Presti, *Università Campus Bio-Medico di Roma, Italy* Elena De Vita, *Università degli studi di Napoli Parthenope, Italy*

11:30 **Interference Management in Visible Light Communications based on Reconfigurable Photodetectors for Industrial IoT**
Maximo Morales-Céspedes, Universidad Carlos III de Madrid, Spain

11:50 **Experimental Analysis and Computational Modeling of Agarose Phantoms for Photothermal Laser Ablation**
Federica Bianconi, University Campus Bio-Medico of Rome, Italy
Elena De Vita, University of Naples Parthenope, Italy
Daniela Lo Presti, University Campus Bio-Medico of Rome, Italy
Carlo Massaroni, University Campus Bio-Medico of Rome, Italy
Daniele Bianchi, University Campus Bio-Medico of Rome, Italy
Agostino Iadicicco, University of Naples Parthenope, Italy
Stefania Campopiano, University of Naples Parthenope, Italy
Emiliano Schena, University Campus Bio-Medico of Rome, Italy
Alessio Gizzi, University Campus Bio-Medico of Rome, Italy

12:10 **Postural Data Analysis using AI-powered Classification Models**
Luca Bacco, Università Campus Bio-Medico di Roma, Italy
Matteo Coletta, Università Campus Bio-Medico di Roma, Italy
Martina Zaltieri, Università Campus Bio-Medico di Roma, Italy
Daniela Lo Presti, Università Campus Bio-Medico di Roma, Italy
Carlo Massaroni, Università Campus Bio-Medico di Roma, Italy
Emiliano Schena, Università Campus Bio-Medico di Roma, Italy
Mario Merone, Università Campus Bio-Medico di Roma, Italy

12:30 **An innovative multiparametric wearable system for monitoring cardiorespiratory parameters in a pregnant woman and detecting fetal movements**
Daniela lo Presti, Università Campus Bio-Medico di Roma, Italy

Sofia Famiani, Università Campus Bio-Medico di Roma, Italy
Carlo Massaroni, Università Campus Bio-Medico di Roma, Italy
Pawar Dnyandeo Krabhari, Università Campus Bio-Medico di Roma, Italy
Valeria Tomarchio, Fondazione Policlinico Campus Bio-Medico di Roma, Italy
Emiliano Schena, Università Campus Bio-Medico di Roma, Italy

11:30 - 13:10	*Hall N3 - University of Brescia*
	Session 10.2 - Advances in predictive maintenance and fault detection for Industry 4.0 - Part II
	Chair: Mauro Serpelloni, *University of Brescia, Italy*

11:30 **Application of CRISP-DM and DMME to a Case Study of Condition Monitoring of Lens Coating Machines**
Fatima Sajid Butt, Frankfurt University of Applied Sciences, Germany, Universidad de Cadiz, Spain
Jorg Schafer, Frankfurt University of Applied Sciences, Germany
Matthias F. Wagner, Frankfurt University of Applied Sciences, Germany
Dirk Stegelmeyer, Frankfurt University of Applied Sciences, Germany
David Gomez-Ullate Oteiza, Universidad de Cadiz, IE University, Spain

11:50 **An IoT-Based Anomaly Detection and Identification Approach for Gas Sensor Networks**
Sebastian A. Schober, Infineon Technologies AG, Germany, Johannes Kepler University Linz, Austria
Cecilia Carbonelli, Infineon Technologies AG, Germany
Robert Wille, Technical University of Munich, Germany, Software Competence Center Hagenberg GmbH, Austria

12:10 **A Statistical Approach for Electrochemical Impedance Spectroscopy Analysis on LFP Batteries' State of Charge**
Luca Tari, University of Cassino and Southern Lazio, Italy
Carmine Bourelly, University of Cassino and Southern Lazio, Italy
Michele Vitelli, University of Cassino and Southern Lazio, Italy
Filippo Milano, University of Cassino and Southern Lazio, Italy
Mario Molinara, University of Cassino and Southern Lazio, Italy
Luigi Ferrigno, University of Cassino and Southern Lazio, Italy

12:30 **Edge Computing supporting On-Time Diagnostics of Industrial Motor Drives**
Marco Alberto Baccanini, University of Pavia, Italy
Ezio Bassi, University of Pavia, Italy
Filippo Marabelli, Lenze Italia srl, Italy
Francesco Benzi, University of Pavia, Italy
Lucia Frosini, University of Pavia, Italy

12:50   **A Novel Monitoring Dashboard And Hardware Implementation Simplifying The Remote Access In Industry**
Erkan Demir, Marmara University, Turkey
Hayriye Korkmaz, Marmara University, Turkey

13:10 - 14:30	*University of Brescia - Department of Engineering*
	LUNCH

14:30 - 15:10	*Aula Consiliare - University of Brescia*
	Session 11.1 - Augmented products for safety and sports - Part II
	Chair: Mauro Serpelloni, *University of Brescia, Italy*

14:30   **Internet of things for intelligent management of professional football turf pitches**
Caio Camargo, Intelligent Technologies Collaborative Laboratory Mountains of research, Portugal
Goncalo Silva, Intelligent Technologies Collaborative Laboratory Mountains of research, Portugal
Higor Vendramini Rosse, Intelligent Technologies Collaborative Laboratory Mountains of research, Portugal
José Barbosa, Intelligent Technologies Collaborative Laboratory Mountains of research, Portugal
David Marques, Loki Lighting Lda., Portugal

14:50   **Immersive VR Environments, Full Body Tracking and Digital Human Models for Ergonomic Validation of Maritime Patrol Aircraft's Interiors**
Sara Buonocore, University of Naples Federico II, Italy
Enrico Fontana, Leonardo, Italy
Stanislao Patalano, University of Naples Federico II, Italy
Sergio Vigorito, Leonardo, Italy
Giuseppe Di Gironimo, University of Naples Federico II, Italy

14:30 - 15:50	*Hall N3 - University of Brescia*
	Session 11.2 - Measurements and Virtual Measurements for Industry 4.0: Approaches and Solutions for Smart Manufacturing - Part III
	Chair: Lorenzo Ciani, *University of Florence, Italy*

14:30   **Integration of Non-Destructive Inspection (NDI) systems for Zero-Defect Manufacturing in the Industry 4.0 era**
Vittoria Medici, Università Politecnica delle Marche, Italy
Milena Martarelli, Università Politecnica delle Marche, Italy
Nicola Paone, Università Politecnica delle Marche, Italy
Giuseppe Pandarese, Università Politecnica delle Marche, Italy
Wilhelm van de Kamp, VDL Weweler B.V., The Netherland

Bart Verhoef, VDL Weweler B.V., The Netherland
Konstantinos Sipsas, NETCOMPANY-INTRASOFT, Greece
Raimund Broechler, NETCOMPANY-INTRASOFT, Greece
Lara Barja Besada, AIMEN Centro Tecnológico, Spain
Kosmas Alexopoulos, Laboratory for Manufacturing Systems and Automation, Greece
Nikolaos Nikolakis, Laboratory for Manufacturing Systems and Automation, Greece

14:50   Development of an Instrumented Equipment for Intelligent Resistance Spot Welding
Francesco Lambiase, University of L'Aquila, Italy
Edoardo Fiorucci, University of L'Aquila, Italy
Simone Mari, University of L'Aquila, Italy
Silvia Ilaria Scipioni, University of L'Aquila, Italy
Giovanni Bucci, University of L'Aquila, Italy
Fabrizio Ciancetta, University of L'Aquila, Italy
Andrea Fioravanti, University of L'Aquila, Italy
Alfonso Paoletti, University of L'Aquila, Italy

15:10   Measuring material temperature in high-temperature microwave-based heating process: a virtual sensor approach
Nicola Giulietti, Politecnico di Milano, Italy
Paolo Chiariotti, Politecnico di Milano, Italy
Gloria Cosoli, Università Politecnica delle Marche, Italy
Giuseppe Pandarese, Università Politecnica delle Marche, Italy
Luca Violini, Università Politecnica delle Marche, Italy
Angel M. Lopez Buendia, Ceinnmat (Innceinnmat, sl), Spain
Luis Guaita Delgado, Keraben Grupo SA, Spain
Beatriz Garcia Banos, Univeristat Politècnica de València, Spain
Gian Marco Revel, Università Politecnica delle Marche, Italy

15:30   Pseudo-Adiabatic Concrete Curing Monitoring IoT-Enabled System
Enzo Martinelli, University of Salerno, Italy
Marco Pepe, University of Salerno, Italy
Carmine Lima, TESIS s.r.l, Italy
Salvatore Dello Iacono, University of Salerno, Italy
Matteo Ferro, University of Salerno, Italy
Vincenzo Paciello, University of Salerno, Italy
Paolo Sommella, University of Salerno, Italy

15:50 - 16:20   Aula Consiliare - University of Brescia
CLOSING AND AWARD CEREMONY