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**UNIVERSITÀ
DI TRENTO**



2020 IEEE INTERNATIONAL WORKSHOP ON METROLOGY FOR AGRICULTURE AND FORESTRY



Virtual Conference

MetroAgriFor

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WORKSHOP PROGRAM



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Welcome Message form the General Chairs

On behalf of the Organizing Committee, we cordially welcome you to the 2020 IEEE International Workshop on Metrology for the Agriculture and Forestry (MetroAgriFor 2020).

The 2020 IEEE International Workshop on Metrology for Agriculture and Forestry intends to create an active and stimulating forum where academics, researchers, and industry experts in measurement and data processing techniques for Agriculture, Forestry, and Food can meet and share new advances and research results.

Attention is paid, but not limited to, new technologies for agriculture and forestry environment monitoring, food quality monitoring, metrology-assisted production in agriculture, forestry and food industries, sensors and associated signal conditioning for agriculture and forestry, calibration methods for electronic test and measurement for environmental and food applications.

The first edition of MetroAgriFor was hosted by Polytechnic University of Marche, Italy, from an insightful and brilliant idea of Professor Enrico Primo Tomasini. He served as the first General Chair of this adventure. Last year, the Department of Agricultural Sciences, University of Naples "Federico II", Italy, hosted the second edition of the Workshop, with Leopoldo Angrisani, Pasquale Daponte and Matteo Lorito as General Chairs.

This 3rd edition of MetroAgriFor was originally planned to be held in Trento (Italy), hosted by the University of Trento. However, due to the COVID-19 emergency, we were forced to organize this edition as a virtual conference.

We do hope that, soon, there will be another chance to host you all in Trentino-Alto Adige. The virtual Workshop has been planned to make an online conference, with a virtual environment where the attendees can present their papers, and can be engaged interacting in all sessions and activities. A special thanks to the organizing team, who professionally addressed this issue.

The MetroAgriFor Technical Program consists of 69 oral presentations scheduled over three days. Presentations are organized in a General session and 10 special sessions.

Special sessions aim to create a focus on specific topics, where researchers can make knowledge, familiarize, exchange ideas, and build cooperation.

A Ph.D. session supports students, or Ph.D. who have completed their Ph.D. thesis within the last 12 months, to present their work to a broad audience in the Smart Agriculture community. A special thanks to the Special Sessions chairs for their precious contribution to the organization and paper selection and all the Technical Program Committee members.

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



Technically extended versions of presented papers can be submitted to the Special Issues of MDPI Sensors Journal and Biosystems Engineering.

During the three days of the Workshop, attendees have the possibility to follow four tutorials exploring different fields of interest:

- “Advances in sensor technologies for in-field monitoring of plant’s water-stress”, Dinko Oletic, University in Zagreb, Croatia;
- “Precision measuring needs for monitoring and automated applications in a Smart Agriculture perspective”, Fabrizio Mazzetto, Free University of Bozen-Bolzano, Italy;
- “Hands on Machine Learning at Nano-scale for Precision Agriculture Using Terahertz Sensing”, Qammer H. Abbasi, University of Glasgow, UK;
- “Long range wireless networks and IoT: novel technologies and future outlook for an effective precision agriculture”, Raffaele Giuffreda, Fabio Antonelli, FBK: ICT - Fondazione Bruno Kessler, Italy;
- “From fruit recognition to fruit growth monitoring: an overview of the field applications”, Luigi Manfrini, University of Bologna, Italy.

MetroAgriFor 2020 is honored to have experts in smart agriculture and forestry as Invited Speakers. Professor Paolo Lugli, Rector at the Free University of Bozen-Bolzano, will open this 2020 IEEE International Workshop with a lecture about “*The impact of nanotechnology on sensing: critical review and perspectives*”.

Professor Luca Corelli Grappadelli, Full Professor at the Department of Agricultural and Food Sciences, University of Bologna, will open the second day of work with a talk about “*Precision Orchard Management: Challenges and Opportunities*”.

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

A dedicated event entitled “*Towards in-field application of acoustic emissions in water-stress monitoring*” will close the technical program of MetroAgriFor 2020.

To recognize the most outstanding paper presented at the annual IEEE International Workshop on Metrology for Agriculture and Forestry, 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 Agriculture and Forestry. We sincerely want to thank all the sponsors and the patronages who made this event possible.

The 2020 IEEE International Workshop on Metrology for Agriculture and Forestry is about to begin. Metrologists, agriculture, forestry, food experts, and engineers, enjoy the Workshop!

November 2020

Annachiara Berardinelli

Davide Brunelli

Pasquale Daponte

Dario Petri

MetroAgriFor2020 General Chairs

Message form the Program Chairs

Welcome to MetroAgriFor 2020, the 2020 IEEE International Workshop on Metrology for Agriculture and Forestry, held virtually due to the COVID-19 pandemic on 4-6 November 2020. MetroAgriFor 2020 is organized by the University of Trento (Italy), and before the pandemic, it was planned to be held in Trento. In its two previous editions, MetroAgriFor was held in Portici (2019) and Ancona (2018) and established itself as an important world forum for discussing the latest advances in metrology for agriculture and forestry.

The Technical Program of MetroAgriFor 2020 has 69 papers divided into 16 sessions distributed over the three days of the workshop, among which one general session, one special session for Ph.D. students, and nine special sessions on specific themes. The general session and four special sessions have two parts. Special sessions aim at creating mini-workshops on specific topics where 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. MetroAgriFor launched a call for special sessions and received a variety of different proposals from the session chairs.

1. General Session (1.1 and 2.7)
2. Special Session for Ph.D. Students (1.4)
3. Special Session on Mitigation Strategies to Reduce Gaseous Emissions from Livestock Buildings and Manure Stores (2.1)
4. Special Session on Integrated Water Management for Agriculture (PART II): Architectures, Platforms, and Sustainability (1.2 and 1.3)
5. Innovative Data Analysis Solutions in the Agri-Food Sector (2.2. and 2.3)
6. Special Session on Smart Systems in Agricultural, Livestock and Food-Processing Facilities (2.4)
7. Special Session on Integrated Water Management for Agriculture (PART I): Sensing, Modeling, and Data Integration (1.5 and 1.6)
8. Special Session on Innovative Robotics Solutions and Autonomous Tasks in Agriculture (2.5 and 1.7)
9. Special Session on Precision Horticulture (2.6)
10. Special Session on Agricultural Meteorology for Water Resilience in Agroecosystems (3.7)
11. Special Session on Sensors, Instruments and Methodologies for Beverage Quality Assessment (1.8)

We gratefully acknowledge the hard work of the Technical Program and Organizing Committees in the process of reviewing the papers and helping to shape the program and other activities, such as keynotes and tutorials. The International Program Committee is composed of 64 internal experts in the area of agriculture and forestry measurements. Also, we thank the dozens of reviewers who accepted to review papers in their specific expertise. Finally, we especially thank authors who honored the third edition of



MetroAgriFor, submitting high-quality contributions with their research results. All these people played an important role in making this workshop to come through.

We wish all participants a very enjoyable and professionally fruitful experience at MetroAgriFor 2020 in its fully virtual format. And hope to meet you all in person soon, hopefully in MetroAgriFor 2021.

Thanks to you all for your participation.

November 2020

Carlos Kamienski, Federal University of ABC (UFABC) - Brazil

Nunzio Isidoro, Polytechnic University of Marche, Italy

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MetroAgriFor 2020 Plenary Speakers

Wednesday, November 4, 2020 - 10.00 CET

The Impact of Nanotechnology on Sensing: Critical Review and Perspectives

Paolo Lugli

Libera Università di Bolzano, Italy

ABSTRACT

Over the last decades, nanotechnology has strongly impacted the scientific world and affected the way we live and produce. The talk will focus on the area of sensing, showing the main advances that nanotechnology has introduced. In particular, the emerging field of flexible and printed electronics will be discussed, which has brought valuable alternatives and applications with respect to conventional electronics and which can be very appealing from a sustainability point of view.

SPEAKERS BIOGRAPHY

Paolo Lugli graduated in Physics at the University of Modena, Italy, in 1979. In 1981 he joined Colorado State University, Fort Collins, CO, where he received his Master of Science in 1982 and his Ph.D. in 1985, both in Electrical Engineering. From 1988 to 1993 he was Associate Professor of "Solid State Physics" at the "Engineering Faculty" of the 2nd University of Rome "Tor Vergata". In 1993 he was appointed as Full Professor of "Optoelectronics" at the same University. In 2002 he joined the Technical University of Munich where he was appointed head of the newly created Institute for Nanoelectronics. From 2015 to 2016 he was Dean of the Department of Electrical and Computer Engineering at TUM. In January 2017 he became Rector of the Free University of Bozen-Bolzano in Bolzano, Italy. His current research interests involve printed electronics, nanoimprint lithography, the modeling, fabrication and characterization of organic devices for electronics and optoelectronics applications, the design of circuits and architectures for nanostructures and nanodevices, the numerical simulation of microwave semiconductor devices, and the theoretical study of transport processes in nanostructures. He is author of more than 450 scientific papers and co-author of the books "The Monte Carlo Modelling for Semiconductor Device Simulations" (Springer, 1989) and "High Speed Optical Communications" (Kluwer Academic, 1999). He served as General Chairman of the IEEE International Conference on Nanotechnology held in Munich in 2004 and as Program Chair of the same conference held in Rome in 2015. He is IEEE Fellow and member of the German National Academy of Science and Engineering (ACATECH).



Thursday, November 5, 2020 - 09:00 CET

Precision Orchard Management: Challenges and Opportunities

Luca Corelli Grappadelli

University of Bologna, Italy

ABSTRACT

Fruit growing presents specific challenges to automation of management, because trees are not uniformly distributed within the orchard, their canopies have changing dimensions and density, and fruit are not uniformly distributed within the canopy. This partly explains why Precision Orchard Management (POM) is a fairly young, albeit strongly growing, discipline. To be effective, POM requires sensors, actuators, and artificial intelligence solutions in an IoT configuration. While this sounds simple, it really isn't. A survey of problems, examples of existing solutions and future directions will be given.

SPEAKER BIOGRAPHY

Luca Corelli Grappadelli is full Professor of Tree Physiology and related disciplines at the Department of Agricultural and Food Sciences of the University of Bologna.

He holds degrees from Bologna and Clemson University, SC (USA).

He was a Fulbright Scholar (Class 1984) and twice (1987 & 1992) a NATO Fellow. He has spent 3 years in the US, studying and working at Clemson and Cornell Universities. He is also a Veski Foundation (Melbourne, Australia) Sustainable Agricultural Fellow (2016).

He has taught graduate and undergraduate courses in Tree Physiology, Arboriculture, Fruit Growing, Precision Fruit Growing, Viticulture.

His lab focuses on tree/light interactions and fruit growth physiology, instrument development and technology transfer, precision fruit growing. Main crops are apple, peach, kiwifruit, sweet cherry, pear, plum.

For 26 years, he has been very active in profiling the European Fruit Sector at the EU Commission in Brussels, in pursue of increased funding for the Sector. He has been involved in the coordination of 5 multi-year EU-funded projects, for a total of ca 25 million euro contributed grants in the last 11 years.

He has authored/co-authored ca 200 scientific papers, book chapters, growers and general public articles. He has participated to ca 100 scientific meetings worldwide and presented a number of keynote lectures at scientific meetings as well as many invited lectures at growers meetings around the World.

He has taught short courses on Tree Ecophysiology in Finland, Portugal, Spain, Argentina and New Zealand. He has been advisor/co-advisor to about 50 MSc and PhD students.





MetroAgriFor 2020 Tutorials

Wednesday, November 4, 2020 - 14.00 CET

Advances in sensor technologies for in-field monitoring of plant's water-stress

Dinko Oletic

University of Zagreb, Croatia

ABSTRACT

To optimize usage of water resources utilized for irrigation, direct plant-based measurements become increasingly important in determining the exact water-demand. Plant-physiology has made significant progress in understanding vascular plant's water transport mechanisms and plant's physiological responses to seasonal droughts, including their defense strategies, characteristic water-stress symptoms, and vulnerability-thresholds defining points of no return. However, experimental plant-hydraulic research often requires instrumentation impractical for field-deployments in precision agriculture. Trying to bridge this gap between laboratory and field, this session explores emerging sensor technologies and instrumentation enabling autonomous, non-invasive, low-power monitoring of key plant-hydraulic quantities, useful for integration in future precision-irrigation systems. We will focus on thermal sap-flow measurement techniques, and on passive ultrasonic monitoring of xylem embolization processes.

SPEAKER BIOGRAPHY

Dr. **Dinko Oletic** got his PhD from University in Zagreb, Croatia in 2016. He's currently a postdoctoral researcher at University of Zagreb, Faculty of Electrical Engineering and Computing. His research interests include design of low-power electronics for autonomous sensor systems, and embedded signal processing, in application domains of agriculture and environmental research. In collaboration with an international interdisciplinary team of botanists, agricultural engineers, and nanotechnology experts, Dr. Oletic currently designs next-generation ultra-low-power MEMS sensors for measurement of plant water-stress in precision agriculture.



Thursday, November 5, 2020 - 14.30 CET

Precision measuring needs for monitoring and automated applications in a Smart Agriculture perspective

Fabrizio Mazzetto

Free University of Bozen-Bolzano, Italy

ABSTRACT

Smart Agriculture (SA) has many aspects in common with Industry 4.0. These are primarily to be found in the cognitive approaches of Knowledge Management 4.0 (KM4.0), which underlines the need to use Integrated Information Systems (IIS) to manage all the activity areas of any production system, agriculture and forestry included. Thus, the tutorial firstly introduces a conceptual model by which is useful to frame the designing approach for an IIS. This must follow a so-called “infological” approach (say, decision-oriented), rather than the opposite “datalogical” approach (say, data-oriented), unfortunately still nowadays largely diffuse form many reasons in the agricultural world. Some practical application will be presented and discussed in merit to this aspect. Details on measuring approaching to be treated within a IIS will be then described distinguishing between monitoring and automated control tasks. The influence of interpretation models (even named “inference engines”) required by many measuring systems will be discussed through some case studies, as well. New certification requirements for such systems will be finally introduced.

SPEAKER BIOGRAPHY

Prof. **Fabrizio Mazzetto**, MSc in Agricultural Sciences (1983) and PhD in Agricultural Engineering (1990), both at University of Milan (Italy). Now Full Professor of Farm Machinery and Mechanization at the Free University of Bolzano. His main research topics are related to: a) development of new prototypes for mountain contexts; b) ICT application to supply information management tasks of farm and forestry processes; c) development of precision agriculture and forestry techniques, d) rural energy applications. Past FAO-UNDP energy consultant and coordinator several national/international research projects. Now, member of the “Accademia dei Georgofili” of Florence and President of the 7th Section of the Italian Society of Agricultural Engineering, for ICT applications in agriculture. He is responsible of the new AgriForestry Innovation Lab at the NOI-TechPark of Bolzano dealing also with new approaches in the certification issues of farm machinery.





Thursday, November 5, 2020 - 17.10 CET

Hands on Machine Learning at Nano-scale for Precision Agriculture Using Terahertz Sensing

Qammer H. Abbasi

School of Engineering, JWS, University of Glasgow

ABSTRACT

Advancement in nanotechnology has made it possible to manufacture sensors, circuits and devices measuring only nano-meters in size. This development is creating an extraordinary opportunity to observe, interact, and optimize physical systems from the very bottom. Wireless communication and networking at nanoscale, however, faces new challenges not encountered in conventional sensor networks. For example, nanoscale antenna call for wireless communication in the Terahertz band, which encounters new path loss and noise phenomena posing significant challenges for many target applications of such networking. Nanoscale computing and communication is a new and rapidly growing field of research promoting collaboration between wireless networking, nanotechnology, and other fundamental disciplines. However, the research is in its early stages to realize communication and networking at the nanoscale. The tutorial will present the opportunities, challenges, and recent advancements of this new and growing inter-disciplinary field explicitly in agricultural technology domains and will give some examples for machine learning in combination of terahertz sensing for plant health monitoring proactively.

SPEAKER BIOGRAPHY

Qammer H. Abbasi (SM 16) received the B.Sc. and M.Sc. degrees in electronics and telecommunication engineering from the University of Engineering and Technology (UET), Lahore, Pakistan, and the Ph.D. degree in electronic and electrical engineering from the Queen Mary University of London (QMUL), U.K., in 2012. In 2012, he was a Postdoctoral Research Assistant with the Antenna and Electromagnetics Group, QMUL. He is currently a Senior Lecturer (Associate Professor) with the James Watt School of Engineering, University of Glasgow, U.K and researcher investigator with Scotland 5G Center. He has contributed to over



250 leading international technical journal and peer reviewed conference papers, and eight books. He received several recognitions for his research, which include appearance on BBC, STV, dawnnews, local and international newspapers, cover of MDPI journal, most downloaded articles, U.K. exceptional talent endorsement by Royal Academy of Engineering, National Talent Pool Award by Pakistan, International Young Scientist Award by NSFC China, URSI Young Scientist Award, National Interest Waiver by USA, four best paper awards, and best representative image of an outcome by QNRF. He is an Associate Editor for the IEEE JOURNAL OF ELECTROMAGNETICS, RF AND MICROWAVES IN MEDICINE AND BIOLOGY, the IEEE SENSORS JOURNAL, IEEE OPEN ACCESS ANTENNA AND PROPAGATION, IEEE ACCESS and acted as a guest editor for numerous special issues in top notch journals.

Friday, November 6, 2020 - 09.00 CET

Long range wireless networks and IoT: novel technologies and future outlook for an effective precision agriculture

Raffaele Giaffreda

Fabio Antonelli

FBK: ICT - Fondazione Bruno Kessler

ABSTRACT

This tutorial will give an overview of the long range wireless networks (LPWAN) available to collect data from sensors and reaching actuators deployed in the fields while implementing digital agriculture solutions. It will focus on the role IoT devices can play in creating more precise forecasting models and it will report from extensive technology-transfer and experimentation activities where LPWAN networks and IoT have been used to support growers with water management in various cultivations spanning from grapes and apples to horticultural products such as aubergines, cucumbers, potatoes and peppers. The tutorial will conclude with a future outlook on the agritech sector having to face climate-change and water-scarcity related challenges.

SPEAKERS BIOGRAPHY

Raffaele Giaffreda is a Chief IoT Scientist at FBK and Chief Innovation Officer at TESSA Agritech srl, Italy. A graduate from Politecnico Torino (Italy) and University College of London (UK), he has worked in telecom R&D environment since the beginning of his career, focusing in the last decade on IoT, AgriTech and related technology-transfer activities. In his role, he is now responsible for setting research and innovation directions, acquisition of funding and for the execution of a number of collaborative projects and technology transfer initiatives in the IoT and agriculture domain. He is the Principal Investigator of EIT Climate KIC project SAPIENCE focusing on incentivising virtuous and sustainable practices in the agricultural domain. As an experienced speaker and chair of IoT related events, he serves as an EU reviewer, TPC in a number of international conferences and writes as a columnist for the IEEE IoT Magazine and he is the Editor in Chief of the IEEE IoT Newsletter.





Fabio Antonelli is head of OpenIoT Research unit (Open Platforms and Enabling Technologies for the Internet of Things) at Fondazione Bruno Kessler. With a master's degree in Electronics Engineering at Politecnico di Milano, he worked for more than 15 years in the telco sector (within Alcatel and Telecom Italia groups) gaining extensive knowledge in experimental research, design, software development and management of ICT projects. More recently, in Fondazione Bruno Kessler, his interests have shifted on applied research in multimedia networking, architectures and platforms for the Internet of Things, with special focus on Industry 4.0 and AgriTech, where he has contributed and coordinated applied research activities in different European research projects in the Future Internet, Multimedia and Internet of Things domains.



Friday, November 6, 2020 - 11.40 CET

From fruit recognition to fruit growth monitoring: an overview of the field applications

Luigi Manfrini

University of Bologna, Italy

ABSTRACT

Information on fruit status and orchard yield are extremely relevant for plant ecophysiology and for selecting the appropriate correct management and market decisions. A state of the art focus on fruit recognition and growth monitoring based on machine vision systems, and proximal sensors will be presented. Each of them is used as an implementing tool for different decision support systems to achieve a precise, efficient, and environmentally friendly management of field operation.

SPEAKERS BIOGRAPHY

Adjunct Professor and pomology and nursery management lecturer at the University of Bologna. His research focuses on application of new technologies and precision managements coupled with the effects of the environment on fruit tree physiology with the aim to develop new strategies to improve orchards sustainability maintaining high level of quality and yields. Currently involved in national and international projects addressing issues related to precision management implementation, sustainable fruit production and efficient resources use. Secretary of the EUFRIN Working Group on "Decision Support Systems". Author of more than 60 publications in scientific and professional journals, PhD in fruit orchard management (since 2009) and M. Sci. in Agricultural Sciences and technologies (since 2004).



MetroAgriFor 2020 Workshop

Friday, November 6, 2020 - 12.30 CET



Towards in-field application of acoustic emissions in water-stress monitoring

Vedran Bilas

University of Zagreb, Croatia

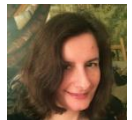
ABSTRACT

The on-plant low-power sensing solutions become important in optimising water usage in precision irrigation of woody plants, especially in the karst regions. This workshop gives insights in recent achievements and future research and development for bringing plant acoustic emissions based water stress monitoring to the field use. The topic will be presented from different perspectives by members of an international interdisciplinary team of botanists, agricultural and electronic engineers, and nanotechnology experts collaborating within project SENSIRRIKA Advanced sensor systems for precision irrigation in karst landscape, funded by the Croatian Science Foundation.

Sounds of stress or a lot of noise? Introduction to acoustic emission testing of plants to monitor drought stress

Sabine Rosner

BOKU Vienna, Austria



SENSIRRIKA - An IoT node for acoustic emissions based on-plant water stress monitoring

Dinko Oletić

University of Zagreb, Croatia



Next-generation ultra-low-power MEMS sensors for detection of ultrasonic xylem emissions

Emile Martincic

Centre de Nanosciences et de Nanotechnologies, University Paris-Saclay, France





MetroAgriFor 2020 Awards

Best Conference Paper Award

The **Best Conference Paper Award** is sponsored by Sensors Journal. The award will consist of a certificate and a prize money amounting to 500 CHF.



Basis for Judging: Technical merit, originality, potential impact on the field, clarity of the written paper, and quality of the oral or other presentation.

Best Paper Presented by a Young Researcher

A certificate will be given for the **best papers authored and presented by researchers** younger than 35 years in age.

Basis for Judging: Technical merit, originality, potential impact on the field, clarity of the written paper, and quality of the oral or other presentation.

Best Paper presented by a Woman

A certificate will be given for the **best paper authored and presented by a woman**.

The Best Paper Presented by a Woman is sponsored by **IEEE Women in Engineering - Italy Section Affinity Group**.



MetroAgriFor 2020 Patronages

The logo for MIPAAF features the word "mipaaf" in a stylized, lowercase font. The letters are green and blue, with a slight 3D effect.

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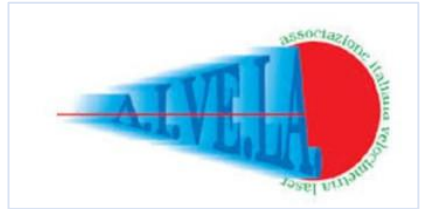


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Program Schedule - November 4, 2020

2020 IEEE INTERNATIONAL WORKSHOP ON METROLOGY FOR AGRICULTURE AND FORESTRY WEDNESDAY, NOVEMBER 4, 2020		
09:30 - 10:00 CET	OPENING CEREMONY	
10:00 - 10:50 CET	INVITED SPEAKER - Paolo Lugli, <i>Libera Università di Bolzano, Italy</i> <i>The impact of nanotechnology on sensing: critical review and perspectives</i>	
	Virtual Room #1	Virtual Room #2
11:00 - 13:00 CET	Session 1.1 - General Session - PART 1	Session 2.1 - Special Session on Mitigation Strategies to Reduce Gaseous Emissions from Livestock Buildings and Manure Stores
14:00 - 14:50 CET	TUTORIAL SESSION #1 - Dinko Oletic, <i>University in Zagreb, Croatia</i> <i>Advances in sensor technologies for in-field monitoring of plant's water-stress</i>	
	Virtual Room #1	Virtual Room #2
15:00 - 16:20 CET	Session 1.2 - Special Session on Integrated Water Management for Agriculture (PART II): Architectures, Platforms and Sustainability - PART 1	Session 2.2 - Innovative Data Analysis Solutions in the Agri-Food Sector - PART 1
16:30 - 17:50 CET	Session 1.3 - Special Session on Integrated Water Management for Agriculture (PART II): Architectures, Platforms and Sustainability - PART 2	Session 2.3 - Innovative Data Analysis Solutions in the Agri-Food Sector - PART 2

Program Schedule - November 5, 2020

2020 IEEE INTERNATIONAL WORKSHOP ON METROLOGY FOR AGRICULTURE AND FORESTRY THURSDAY, NOVEMBER 5, 2020		
09:00 - 09:50 CET	INVITED SPEAKER - Luca Corelli Grappadelli, University of Bologna, Italy <i>Precision Orchard Management: Challenges and Opportunities</i>	
	Virtual Room #1	Virtual Room #2
10:00 - 11:20 CET	Session 1.4 - Special Session for Ph.D Students	Session 2.4 - Special Session on Smart Systems in Agricultural, Livestock and Food-Processing Facilities
11:30 - 13:10 CET	Session 1.5 - Special Session on Integrated Water Management for Agriculture (PART I): Sensing, Modeling, and Data Integration - PART 1	Session 2.5 - Special Session on Innovative Robotics Solutions and Autonomous Tasks in Agriculture - PART 1
14:30 - 15:20 CET	TUTORIAL SESSION #2 - Fabrizio Mazzetto, Free University of Bozen-Bolzano, Italy <i>Precision measuring needs for monitoring and automated applications in a Smart Agriculture perspective</i>	
	Virtual Room #1	Virtual Room #2
15:30 - 17:10 CET	Session 1.6 - Special Session on Integrated Water Management for Agriculture (PART I): Sensing, Modeling, and Data Integration - PART 2	Session 2.6 - Special Session on Precision Horticulture
17:30 - 18:20 CET	TUTORIAL SESSION #3 - Qammer H. Abbasi, University of Glasgow, UK <i>Hands on Machine Learning at Nano-scale for Precision Agriculture Using Terahertz Sensing</i>	



Program Schedule - November 6, 2020

2020 IEEE INTERNATIONAL WORKSHOP ON METROLOGY FOR AGRICULTURE AND FORESTRY FRIDAY, NOVEMBER 6, 2020			
09:00 - 09:50 CET	TUTORIAL SESSION #4 - Raffaele Giaffreda, Fabio Antonelli, FBK-ICT - Fondazione Bruno Kessler <i>Long range wireless networks and IoT: novel technologies and future outlook for an effective precision agriculture</i>		
	Virtual Room #1	Virtual Room #2	Virtual Room #3
10:00 - 11:00 CET	Session 1.7 - Special Session on Innovative Robotics Solutions and Autonomous Tasks in Agriculture - PART 2	Session 2.7 - Special Session on Sensors, Instruments and Methodologies for Beverage Quality Assessment	Session 3.7 - Special Session on Agricultural Meteorology for Water Resilience in Agroecosystems
11:00 - 11:40 CET	Session 1.8 - General Session - PART 2	WineGrover Precision Agriculture System to limit the impact on the environment, on health and on air quality of grape production Eng. Eduardo De Francesco, SeTeL Group	
11:40 - 12:30 CET	TUTORIAL SESSION #5 - Luigi Manfrini, University of Bologna, Italy <i>From fruit recognition to fruit growth monitoring: an overview of the field applications</i>		
12:30 - 13:20 CET	IEEE MetroAgriFor 2020 - Workshop Towards in-field application of acoustic emissions in water-stress monitoring		
13:20 - 13:40 CET	CLOSING AND AWARD CEREMONY		

Technical Sessions - Wednesday, November 4

09:30 - 10:00 CET

OPENING SESSION

Room: *Virtual Room #1*

10:00 - 10:50 CET

PLENARY SESSION

Room: *Virtual Room #1*

Chairs: Fabrizio Mazzetto, *Libera Università di Bolzano, Italy*
Davide Brunelli, *University of Trento, Italy*

**The impact of nanotechnology on sensing:
critical review and perspectives**

Paolo Lugli, *Libera Università di Bolzano, Italy*

11:00 - 13:00 CET

SESSION 1.1 - General Session - PART 1

Room: *Virtual Room #1*

Chairs: Carlos Alberto Kamienski, *Federal University of ABC (UFABC), Brasil*
Matteo Nardello, *University of Trento, Italy*
Luigi Manfrini, *University of Bologna, Italy*



- 11:00 Preliminary Design of a Remotely Piloted Aircraft System for Crop-Spraying on Vineyards**
Nicoletta Bloise, Politecnico di Torino, Italy
Manuel Carreño Ruiz, Politecnico di Torino, Italy
Domenic D'Ambrosio, Politecnico di Torino, Italy
Giorgio Guglieri, Politecnico di Torino, Italy
- 11:20 Neural networks for Pest Detection in Precision Agriculture**
Andrea Segalla, University of Trento, Italy
Gianluca Fiacco, University of Trento, Italy
Luca Tramarin, University of Trento, Italy
Matteo Nardello, University of Trento, Italy
Davide Brunelli, University of Trento, Italy
- 11:40 Reinforcement Learning for Connected Autonomous Vehicle Localization via UAVs**
Enrico Testi, University of Bologna, Italy
Elia Favarelli, University of Bologna, Italy
Andrea Giorgetti, University of Bologna, Italy
- 12:00 A Low-Cost and High-Accuracy Non-Invasive System for the Monitoring of Fruit Growth**
Lorenzo Mistral Peppi, University of Bologna, Italy
Matteo Zauli, University of Bologna, Italy
Luigi Manfrini, University of Bologna, Italy
Pier Andrea Traverso, University of Bologna, Italy
Luca Corelli Grappadelli, University of Bologna, Italy
Luca De Marchi, University of Bologna, Italy
- 12:20 Energy-neutral weather stations for precision agriculture: challenges and approaches**
Padma Balaji Leelavinodhan, University of Trento, OpenIoT Research Unit, FBK, Italy
Fabio Antonelli, OpenIoT Research Unit, FBK, Italy
Massimo Vecchio, OpenIoT Research Unit, FBK, Italy
Andrea Maestrini, OpenIoT Research Unit, FBK, Italy

12:40 Relationships among behavior, climate and milk production in a dairy cattle farm in Northern Italy

Daniela Lovarelli, University of Milan, Italy
Alberto Tamburini, University of Milan, Italy
Gabriele Mattachini, University of Milan, Italy
Maddalena Zucali, University of Milan, Italy
Elisabetta Riva, University of Milan, Italy
Giorgio Provolo, University of Milan, Italy
Marcella Guarino, University of Milan, Italy

11:00 - 13:00 CET

Session 2.1 - Special Session on Mitigation Strategies to Reduce Gaseous Emissions from Livestock Buildings and Manure Stores

Room: *Virtual Room #2*

Chairs: Stefania Pindozi, *University of Naples Federico II, Italy*
Daniele Torreggiani, *University of Bologna, Italy*

11:00 Release of ammonia, particulate matter and nitrogen oxides during the Covid-19 quarantine: what is the role of livestock activities?

Daniela Lovarelli, University of Milan, Italy
Cecilia Conti, University of Milan, Italy
Alberto Finzi, University of Milan, Italy
Jacopo Bacenetti, University of Milan, Italy
Marcella Guarino, University of Milan, Italy

11:20 Effect of mitigation techniques on ammonia emissions and nutrients recovery: the role of fertigation with digestate

Viviana Guido, University of Milan, Italy
Alberto Finzi, University of Milan, Italy
Pietro Piazzi, University of Milan, Italy
Omar Ferrari, University of Milan, Italy
Celeste Righi Ricco, University of Milan, Italy
Elisabetta Riva, University of Milan, Italy
Giorgio Provolo, University of Milan, Italy



11:40 Is the biochar an effective floating cover for manure storage to reduce ammonia emissions, adsorbing nitrogen at the same time?

Ester Scotto di Perta, University of Naples Federico II, Italy
Paola Giudicianni, National Research Council, Italy
Antonio Mautone, University of Naples Federico II, Italy
Stefano Caro, Aalto University, Finland
Elena Cervelli, University of Naples Federico II, Italy
Raffaele Ragucci, National Research Council, Italy
Stefania Pindozi, University of Naples Federico II, Italy

12:00 Addition of powdery sulfur to pig slurry to reduce NH₃ and GHG emissions after mechanical separation

Jacopo Maffia, University of Turin, Italy
Fabrizio Gioelli, University of Turin, Italy
Luca Rollè, University of Turin, Italy
Gianfranco Airoidi, University of Turin, Italy
Paolo Balsari, University of Turin, Italy
Elio Dinuccio, University of Turin, Italy

12:20 Ammonia stripping from buffalo manure digestate for future nitrogen upcycling into bio-based products

Silvio Matassa, University of Naples Federico II, University of Cassino, Italy
Stefano Papirio, University of Naples Federico II, Italy
Giovanni Esposito, University of Naples Federico II, Italy
Francesco Pirozzi, University of Naples Federico II, Italy

12:40 Application of nitrification inhibitor on soil to reduce NH₃ and N₂O emission after slurry spreading

Jacopo Maffia, University of Turin, Italy
Luca Rollé, University of Turin, Italy
Simone Pelissetti, Uptofarm s.r.l., Italy
Francesco Vocino, Uptofarm s.r.l., Italy
Marcin Dzikowski, Corteva Agriscience Munich, Germany
Matteo Ceruti, Corteva Agriscience Cremona, Germany
Elio Dinuccio, University of Turin, Italy

14:00 - 14:50 CET

TUTORIAL - Session #1

Room: *Virtual Room #1*

Chairs: Carlos Alberto Kamienski, *Federal University of ABC (UFABC), Brasil*
Davide Brunelli, *University of Trento, Italy*
Matteo Nardello, *University of Trento, Italy*

**Advances in sensor technologies for in-field monitoring
of plant's water-stress**

Dinko Oletic, *University in Zagreb, Croatia*

15:00 - 16:20 CET

**Session 1.2 - Special Session on Integrated Water Management for
Agriculture (PART II): Architectures, Platforms and Sustainability - PART 1**

Room: *Virtual Room #1*

Chairs: Luca Roffia, *University of Bologna, Italy*
Cristiano Aguzzi, *University of Bologna, Italy*

**15:00 A Nearest Neighbors based Data Filter for Fog Computing in IoT
Smart Agriculture**

Franklin Magalhães Ribeiro Jr, *Federal University of ABC, Federal Institute of Maranhão, Brazil*
Ronaldo Prati, *Federal University of ABC, Brazil*
Reinaldo Bianchi, *Centro Universitário FEI, Brazil*
Carlos Kamienski, *Federal University of ABC, Brazil*

15:20 IoT-based Measurement for Smart Agriculture

Alexandre Heideker, *Federal University of the ABC, Brazil*
Dener Ottolini, *Federal University of the ABC, Brazil*
Ivan Zyrianoff, *Federal University of the ABC, Brazil*
André Torre Neto, *Brazilian Agricultural Research Corporation - Embrapa, Brazil*
Tullio Salmon Cinotti, *University of Bologna, Italy*
Carlos Kamienski, *Federal University of the ABC, Brazil*

**15:40 Understanding the tradeoffs of LoRaWAN for IoT-based Smart Irrigation**

Bruno Queté, Federal University of ABC, Brazil

Alexandre Heideker, Federal University of ABC, Brazil

Ivan Zyrianoff, Federal University of ABC, Brazil

Dener Ottolini, Federal University of ABC, Brazil

João Henrique Kleinschmidt, Federal University of ABC, Brazil

Juha-Pekka Soininen, VTT Technical Research Centre, Finland

Carlos Kamienski, Federal University of ABC, Brazil

16:00 Enhancing Soil Measurements with a Multi-Depth Sensor for IoT-based Smart Irrigation

André Torre-Neto, Embrapa Instrumentation, Brazil

Jeferson Rodrigues Cotrim, Federal University of ABC, Brazil

João Henrique Kleinschmidt, Federal University of ABC, Brazil

Carlos Kamienski, Federal University of ABC, Brazil

Marcos Cezar Visoli, Embrapa Agricultural Informatics, Brazil

15:00 - 16:20 CET**Session 2.2 - Innovative Data Analysis Solutions in the Agri-Food Sector - PART 1**

Room: *Virtual Room #2*

Chair: *Chiara Cevoli, University of Bologna, Italy*

15:00 Analysis of performances of a commercial threedimensional (3D) reconstruction camera

Domenico Giora, University of Padova, Italy

Andrea Pezzuolo, University of Padova, Italy

Diego Tomasi, CREA-Council for Agricultural Research and Economics, Italy

Francesco Marinello, University of Padova, Italy

Luigi Sartori, University of Padova, Italy

15:20 A data-driven methodology to assess the accumulation risk in agricultural insurance contracts

Andrea Marini, Idea-Re S.r.l., Italy

Loris Francesco Termitte, Agrosit S.r.l., Italy

Massimiliano Proietti, Idea-Re S.r.l., Italy
Alberto Garinei, Guglielmo Marconi University, Italy
Gianluca Ferrari, Radarmeteo S.r.l., Italy
Marcello Marconi, Guglielmo Marconi University, Italy

15:40 Simply Time Domain Reflectometry system for food analysis

Eleonora Iaccheri, University of Bologna, Italy
Annachiara Berardinelli, University of Trento, Italy
Luigi Ragni, University of Bologna, Italy

16:00 In-field Vis/NIR hyperspectral imaging to measure soluble solids content of wine grape berries during ripening

Alessandro Benelli, University of Bologna, Italy
Chiara Cevoli, University of Bologna, Italy
Angelo Fabbri, University of Bologna, Italy

16:30 - 17:50 CET

Session 1.3 - Special Session on Integrated Water Management for Agriculture (PART II): Architectures, Platforms and Sustainability - PART 2

Room: *Virtual Room #1*

Chairs: Luca Roffia, *University of Bologna, Italy*
Cristiano Aguzzi, *University of Bologna, Italy*

16:30 e-SmallFarmer - A solution for small farming

Diogo Pinto, Polytechnic Institute of Braganca, Portugal
Rui Alves, Polytechnic Institute of Braganca, Portugal
Paulo Matos, Polytechnic Institute of Braganca, Portugal
Duarte Pousa, Polytechnic Institute of Braganca, Portugal

16:50 The SWAMP Farmer App for IoT-based Smart Water Status Monitoring and Irrigation Control

Ramide Augusto Sales Dantas, Federal Institute of Pernambuco (IFPE), Brazil
Milton Vasconcelos da Gama Neto, Federal Institute of Pernambuco (IFPE), Brazil
Ivan Dimitry Zyrianoff, Federal University of ABC, Brazil
Carlos Alberto Kamienski, Federal University of ABC, Brazil



17:10 Enabling Context Aware Tuning of Low Power Sensors for Smart Agriculture

Simone Sindaco, University of Bologna, Italy
Stefania Nanni, Lepida ScpA, Italy
Cristiano Aguzzi, University of Bologna, Italy
Luca Roffia, University of Bologna, Italy
Tullio Salmon Cinotti, University of Bologna, Italy

17:30 Implementing the Sustainable Development Goals with a digital platform: experiences from the vitivinicultural sector

Giorgia Bucci, Università Politecnica delle Marche, Italy
Deborah Bentivoglio, Università Politecnica delle Marche, Italy
Matteo Belletti, Università Politecnica delle Marche, Italy
Adele Finco, Università Politecnica delle Marche, Italy
Emiliano Anceschi, Gruppo Filippetti, Italy

16:30 - 17:30 CET

Session 2.3 - Innovative Data Analysis Solutions in the Agri-Food Sector - PART 2

Room: *Virtual Room #2*

Chair: *Chiara Cevoli, University of Bologna, Italy*

16:30 Vis/NIR hyperspectral imaging to assess freshness of sardines (Sardina pilchardus)

Leonardo Franceschelli, University of Bologna, Italy
Chiara Cevoli, University of Bologna, Italy
Alessandro Benelli, University of Bologna, Italy
Eleonora Iaccheri, University of Bologna, Italy
Marco Tartagni, University of Bologna, Italy
Annachiara Berardinelli, University of Trento, Italy

16:50 Tomato diseases Classification Based on VGG and Transfer Learning

Leina Aversano, University of Sannio, Italy
Mario Luca Bernardi, University of Sannio, Italy
Marta Cimitile, Unitelma Sapienza, Italy
Martina Iammarino, University of Sannio, Italy
Stefano Rondinella, CERICT Information Communication Tech., Italy

17:10 Computer Vision Technology for Quality Monitoring in Smart Drying System

Roberto Moschetti, University of Tuscia, Italy

Swathi Sirisha Nallan Chakravartula, University of Tuscia, Italy

Andrea Bandiera, University of Tuscia, Italy

Giacomo Bedini, University of Tuscia, Italy

Riccardo Massantini, University of Tuscia, Italy

17:30 Improving GHG flux monitoring in agricultural soil through the AGRESTIC prototype: a focus on the assessment of data quality

Iride Volpi, Scuola Superiore Sant'Anna, Italy

Simona Bosco, Scuola Superiore Sant'Anna, Italy

Diego Guidotti, AEDIT srl, Italy

Michele Mammini, AEDIT srl, Italy

Simone Neri, West Systems srl, Italy

Giorgio Virgili, West Systems srl, Italy

Pierluigi Meriggi, Horta srl, Italy

Alberto Mantino, Scuola Superiore Sant'Anna, Italy

Patricia Laville, INRA AgroParisTech, France

Giorgio Ragaglino, Scuola Superiore Sant'Anna, Italy



Technical Sessions - Thursday, November 5

09:00 - 09:50 CET

PLENARY SESSION

Room: *Virtual Room #1*

Chairs: Annachiara Berardinelli, *University of Trento, Italy*
Davide Brunelli, *University of Trento, Italy*

Precision Orchard Management: Challenges and Opportunities

Luca Corelli Grappadelli, *University of Bologna, Italy*

10:00 - 11:20 CET

Session 1.4 - Special Session for Ph.D Students

Room: *Virtual Room #1*

Chairs: Pasqualina Sacco, *Fraunhofer Italia, Italy*
Annachiara Berardinelli, *University of Trento, Italy*

10:00 Dimension fitting of wheat spikes in dense 3D point clouds based on the adaptive k-means algorithm with dynamic perspectives

Fuli Wang, *University of Essex, United Kingdom*

Vishwanathan Mohan, *University of Essex, United Kingdom*

Andrew Thompson, *National Physical Laboratory, United Kingdom*

Richard Dudley, *National Physical Laboratory, United Kingdom*

10:20 Solar Irradiance Measuring System based on PIC Microcontroller

Fekkak Bouazza, *LSEI USTB, ALgeria*

Loukriz Abdelhamid, *Polytechnic School, Algeria*

Rekioua Djamila, *Université de Béjaia, Algeria*

10:40 Effects of reed beds management on the hydrodynamic behaviour of vegetated open channels

Giuseppe Francesco Cesare Lama, University of Naples Federico II, Italy
Giovanni Battista Chirico, University of Naples Federico II, Italy

11:00 Vis/NIR hyperspectral imaging technology in predicting the quality properties of three fruit cultivars during production and storage

Alessandro Benelli, University of Bologna, Italy
Angelo Fabbri, University of Bologna, Italy

10:00 - 11:20 CET

Session 2.4 - Special Session on Smart Systems in Agricultural, Livestock and Food-Processing Facilities

Room: *Virtual Room #2*

Chairs: Alberto Barbaresi, *University of Bologna, Italy*
Andrea Pezzuolo, *University of Padova, Italy*

10:00 Smart and cheap scale for estimating live-fish biomass in offshore aquaculture

Eugenio Damiano, MEGA Materials s.r.l., Italy
Carlo Bibbiani, University of Pisa, Italy
Baldassare Fronte, University of Pisa, Italy
Alberto Di Lieto, University of Pisa, Italy

10:20 A Smart Monitoring System for a Future Smarter Dairy Farming

Marco Bovo, University of Bologna, Italy
Stefano Benni, University of Bologna, Italy
Alberto Barbaresi, University of Bologna, Italy
Enrica Santolini, University of Bologna, Italy
Miki Agrusti, University of Bologna, Italy
Daniele Torreggiani, University of Bologna, Italy
Patrizia Tassinari, University of Bologna, Italy

10:40 Non-contact feed weight estimation by RFID technology in cow-feed alley

Andrea Pezzuolo, University of Padova, Italy
Hao Guo, China Agricultural University, China



Stefano Guercini, University of Padova, Italy
 Francesco Marinello, University of Padova, Italy

11:00 A Smart Monitoring System for Self-sufficient Integrated Multi-Trophic AquaPonic

Alberto Barbaresi, University of Bologna, Italy
 Carlo Bibbiani, University of Pisa, Italy
 Marco Bovo, University of Bologna, Italy
 Steafano Benni, University of Bologna, Italy
 Enrica Santolini, University of Bologna, Italy
 Patrizia Tassinari, University of Bologna, Italy
 Miki Agrusti, University of Bologna, Italy
 Daniele Torreggiani, University of Bologna, Italy

11:30 - 13:10 CET

Session 1.5 - Special Session on Integrated Water Management for Agriculture (PART I): Sensing, Modeling, and Data Integration - PART 1

Room: *Virtual Room #1*

Chairs: Gabriele Baroni, *University of Bologna, Italy*
 Lorenzo Carmelo Zingali, *University of Bologna, Italy*
 Giovanni Battista Chirico, *University of Naples, Italy*

11:30 Calibration equation and field test of a capacitive soil moisture sensor

Gilberto Souza, Centro Universitario FEI, Brazil
 Brenno Tondato de Faria, Centro Universitario FEI, Brazil
 Rafael Gomes Alves, Centro Universitario FEI, Brazil
 Fabio Lima, Centro Universitario FEI, Brazil
 Plinio Thomaz Aquino-Jr, Centro Universitario FEI, Brazil
 Juha-Pekka Soinen, VTT Technical Research Centre of Finland, Finland

11:50 Using a gamma-ray spectrometer for soil moisture monitoring: development of the the gamma Soil Moisture Sensor (gSMS)

Steven van der Veeke, University of Groningen, the Netherlands
 Ronald Koomans, Medusa Radiometrics B.V., the Netherlands
 Han Limburg, Medusa Radiometrics B.V., the Netherlands

12:10 Discriminating irrigation and rainfall with proximal gamma-ray spectroscopy

Andrea Serafini, University of Ferrara, INFN, Italy
Matteo Albéri, University of Ferrara, INFN, Italy
Enrico Chiarelli, University of Ferrara, INFN, Italy
Michele Montuschi, University of Ferrara, INFN, Italy
Kassandra Giulia Cristina Raptis, University of Ferrara, INFN, Italy
Virginia Strati, University of Ferrara, INFN, Italy
Fabio Mantovani, University of Ferrara, INFN, Italy

12:30 Towards the optimization of a scintillator-based neutron detector for large non-invasive soil moisture estimation

Luca Stevanato, University of Padova, Italy
Matteo Polo, University of Padova, Italy
Marcello Lunardon, University of Padova, Italy
Francesco Marinello, University of Padova, Italy
Sandra Moretto, University of Padova, Italy
Gabriele Baroni, University of Bologna, Italy

12:50 Mapping near-surface soil moisture in a Mediterranean agroforestry ecosystem using Cosmic-Ray Neutron Probe and Sentinel-1 Data

Aida Taghavi Bayat, University of Würzburg, Germany
Sarah Schönbrodt-Stitt, University of Würzburg, Germany
Paolo Nasta, University of Napoli Federico II, Italy
Nima Ahmadian, University of Halle-Wittenberg, Germany
Christopher Conrad, University of Halle-Wittenberg, Germany
Heye R. Bogen, Forschungszentrum Jülich GmbH, Germany
Harry Vereecken, Forschungszentrum Jülich GmbH, Germany
Jannis Jakobi, Forschungszentrum Jülich GmbH, Germany
Roland Baatz, Forschungszentrum Jülich GmbH, Germany
Nunzio Romano, University of Napoli Federico II, Italy

11:30 - 13:10 CET

Session 2.5 - Special Session on Innovative Robotics Solutions and Autonomous Tasks in Agriculture - PART 1

Room: *Virtual Room #2*

Chairs: Lorenzo Marconi, *University of Bologna, Italy*
Dario Mengoli, *University of Bologna, Italy*



11:30 Design Concept and Modelling of a Tracked UGV for Orchard Precision Agriculture

Roberto Tazzari, University of Bologna, Italy
Dario Mengoli, University of Bologna, Italy
Lorenzo Marconi, University of Bologna, Italy

11:50 Development of new system and methodology for the assessment of stressed and missing plants in vineyards: preliminary study

Gabriele Daglio, Free Univeristy of Bolzano, Italy
Damiano Zampieri, Free Univeristy of Bolzano, Italy
Raimondo Gallo, Free Univeristy of Bolzano, Italy
Fabrizio Mazzetto, Free Univeristy of Bolzano, Italy

12:10 Evaluation of Virtual Methods for Training Neural Networks in Agricultural Applications

Jorge Luis Jiménez Aparicio, RWTH Aachen University, Germany
Jorn Thieling, RWTH Aachen University, Germany
Jurgen Roßmann, RWTH Aachen University, Germany
Markus Robert, IAV GmbH, Germany
Rudiger Bosdorf, IAV GmbH, Germany

12:30 Cooperative Agricultural Operations of Aerial and Ground Unmanned Vehicles

Martina Mammarella, National Research Council, Italy
Lorenzo Comba, National Research Council, Università degli Studi di Torino, Italy
Alessandro Biglia, Università degli Studi di Torino, Italy
Fabrizio Dabbene, National Research Council, Italy
Paolo Gay, Università degli Studi di Torino, Italy

12:50 Sensor-fusion and deep neural networks for autonomous UAV navigation within orchards

Kushtrim Bresilla, University of Bologna, Italy
Gianmarco Bortolotti, University of Bologna, Italy
Alexandra Boini, University of Bologna, Italy
Giulio Perulli, University of Bologna, Italy
Brunella Morandi, University of Bologna, Italy
Luca Corelli Grappadelli, University of Bologna, Italy
Luigi Manfrini, University of Bologna, Italy

14:30 - 15:20 CET

TUTORIAL - Session #2

Room: *Virtual Room #1*

Chairs: Kushtrim Bresilla, *University of Bologna, Italy*
Annachiara Berardinelli, *University of Trento, Italy*

Precision measuring needs for monitoring and automated applications in a Smart Agriculture perspective

Fabrizio Mazzetto, *Free University of Bozen-Bolzano, Italy*

15:30 - 17:30 CET

Session 1.6 - Special Session on Integrated Water Management for Agriculture (PART I): Sensing, Modeling, and Data Integration - PART 2

Room: *Virtual Room #1*

Chairs: Gabriele Baroni, *University of Bologna, Italy*
Lorenzo Carmelo Zingali, *University of Bologna, Italy*
Giovanni Battista Chirico, *University of Naples, Italy*

15:30 Water spray detection for smart irrigation systems with Mask R-CNN and UAV footage

Caio K. G. Albuquerque, *Federal University of ABC (UFABC), Brazil*
Sergio Polimante, *Federal University of ABC (UFABC), Brazil*
André Torre-Neto, *Brazilian Agricultural Research Corporation (EMBRAPA), Brazil*
Ronaldo C. Prati, *Federal University of ABC (UFABC), Brazil*

15:50 Future rainfall scenarios for the assessment of water availability in Italy

Roberta Padulano, *Centro Euro-Mediterraneo sui Cambiamenti Climatici, Italy*
Giuseppe Francesco Cesare Lama, *University of Naples Federico II, Italy*
Guido Rianna, *Centro Euro-Mediterraneo sui Cambiamenti Climatici, Italy*
Monia Santini, *Centro Euro-Mediterraneo sui Cambiamenti Climatici, Italy*
Marco Mancini, *Centro Euro-Mediterraneo sui Cambiamenti Climatici, Italy*
Mirko Stojiljkovic, *Centro Euro-Mediterraneo sui Cambiamenti Climatici, Italy*



- 16:10 Sensitivity of the agro-hydrological model CRITERIA-1D to the Leaf Area Index parameter**
Tamara Ricchi, University of Bologna, Italy
Vincenzo Alagna, University of Bologna, Italy
Giulia Villani, Arpa, SIMC, Italy
Fausto Tomei, Arpa, SIMC, Italy
Attilio Toscano, University of Bologna, Italy
Gabriele Baroni, University of Bologna, Italy
- 16:30 Irrigation scheduling of tomato crop by combining Sentinel-2 imagery with an agro-hydrological model**
Giovanni Battista Chirico, University of Naples Federico II, Italy
Maria Rivoli, University of Naples Federico II, Italy
Anna Dalla Marta, University of Florence, Italy
Salvatore Falanga Bolognesi, Ariespace s.r.l., Italy
Guido D'Urso, University of Naples Federico II, Italy
- 16:50 Smart Water Management in Agriculture: a Proposal for an Optimal Scheduling Formulation of a Gravity Water Distribution System**
Vittorio Latorre, University of Bologna, Italy
Lorenzo Carmelo Zingali, University of Bologna, Italy
Cristiana Bragalli, University of Bologna, Italy
Alessio Domeneghetti, University of Bologna, Italy
Armando Brath, University of Bologna, Italy
- 17:10 Low cost center pivot irrigation monitoring systems based on IoT and LoRaWAN technologies**
Diego Mateos Matilla, University of Salamanca, Spain
Álvaro Lozano Murciego, University of Salamanca, Spain
Diego Manuel Jiménez Bravo, University of Salamanca, Spain
André Sales Mendes, University of Salamanca, Spain
Valderi Reis Quietinho Leithardt, Instituto Politécnico de Portalegre, Portugal

15:30 - 17:30 CET

Session 2.6 - Special Session on Precision Horticulture

Room: *Virtual Room #2*

Chairs: Manuela Zude-Sasse, *Leibniz-Institut für Agrartechnik und Bioökonomie*
Lav Ramchandra Khot, *Washington State University, USA*

15:30 Spatiotemporal water use mapping of a commercial apple orchard using UAS based spectral imagery

Abhilash K. Chandel, Washington State University, USA
Lav R. Khot, Washington State University, USA
Claudio O. Stöckle, Washington State University, USA
R. Troy Peters, Washington State University, USA
Steve Mantle, Washington State University, USA

15:50 Internet of Things enabled crop physiology sensing system for abiotic crop stress management in apple and sweet cherry

Rakesh Ranjan, Washington State University, USA
Rajeev Sinha, Washington State University, USA
Lav R. Khot, Washington State University, USA
R. Troy Peters, Washington State University, USA
Melba R. Salazar-Gutierrez, Washington State University, USA

16:10 In-situ detection of apple fruit using a 2D LiDAR laser scanner

Nikos Tsoulias, Leibniz Institute for Agricultural Engineering and Bioeconomy, Germany
George Xanthopoulos, University of Athens, Greece
Spyros Fountas, University of Athens, Greece
Manuela Zude-Sasse, Leibniz Institute for Agricultural Engineering and Bioeconomy, Germany

16:30 Mapping the fruit bearing capacity in a commercial apple (*Malus x domestica* BORKH.) orchard

Martin Penzel, Leibniz Institute for Agricultural Engineering and Bioeconomy, Germany
Nikos Tsoulias, Leibniz Institute for Agricultural Engineering and Bioeconomy, Germany
Werner B. Herppich, Leibniz Institute for Agricultural Engineering and Bioeconomy, Germany



Cornelia Weltzien, Leibniz Institute for Agricultural Engineering and Bioeconomy,
Germany

Manuela Zude-Sasse, Leibniz Institute for Agricultural Engineering and
Bioeconomy, Germany

16:50 Towards rapid detection and mapping of powdery mildew in apple orchards

Abhilash K. Chandel, Washington State University, USA

Lav R. Khot, Washington State University, USA

Bernardita C. Sallato, Washington State University, USA

17:10 A mobile thermal-RGB imaging tool for mapping crop water stress of grapevines

Basavaraj R. Amogi, Washington State University, USA

Abhilash K. Chandel, Washington State University, USA

Lav R. Khot, Washington State University, USA

Pete W. Jacoby, Washington State University, USA

17:30 - 18:20 CET

TUTORIAL - Session #3

Room: *Virtual Room #1*

Chairs: Kushtrim Bresilla, *University of Bologna, Italy*

Annachiara Berardinelli, *University of Trento, Italy*

**Hands on Machine Learning at Nano-scale for Precision Agriculture
Using Terahertz Sensing**

Qammer H. Abbasi, *University of Glasgow, UK*

Technical Sessions - Friday, November 6

09:00 - 09:50 CET

TUTORIAL - Session #4

Room: *Virtual Room #1*

Chairs: Davide Brunelli, *University of Trento, Italy*
Matteo Nardello, *University of Trento, Italy*

Long range wireless networks and IoT: novel technologies and future outlook for an effective precision agriculture

Raffaele Giaffreda, Fabio Antonelli, *FBK: ICT - Fondazione Bruno Kessler*

10:00 - 11:00 CET

Session 1.7 - Special Session on Innovative Robotics Solutions and Autonomous Tasks in Agriculture - PART 2

Room: *Virtual Room #1*

Chairs: Lorenzo Marconi, *University of Bologna, Italy*
Dario Mengoli, *University of Bologna, Italy*

10:00 Methodology for Plant Specific Cultivation through a Plant Identification pipeline

Matteo Pantano, Siemens AG, Germany

Tobias Kamps, Siemens AG, Germany

Solomon Pizzocaro, Politecnico di Milano, Italy

Giorgio Pantano, Azienda Agricola Giorgio Pantano, Italy

Matteo Corno, Politecnico di Milano, Italy

Sergio Savaresi, Politecnico di Milano, Italy



10:20 Autonomous Robotic Platform for Precision Orchard Management: Architecture and Software Perspective

Dario Mengoli, University of Bologna, Italy
Roberto Tazzari, University of Bologna, Italy
Lorenzo Marconi, University of Bologna, Italy

10:40 Convolutional Neural Networks for Detection of Storage Disorders on 'Abbé Fétel' pears

Alessandro Bonora, University of Bologna, Italy
Eleonora Trevisani, University of Bologna, Italy
Kustrim Bresilla, University of Bologna, Italy
Luca Corelli Grappadelli, University of Bologna, Italy
Gianmarco Bortolotti, University of Bologna, Italy
Luigi Manfrini, University of Bologna, Italy

10:00 - 11:00 CET

Session 2.7 - Special Session on Sensors, Instruments and Methodologies for Beverage Quality Assessment

Room: *Virtual Room #2*

Chairs: Domenico Di Caro, *Spring Off s.r.l., Italy*
Consolatina Liguori, *University of Salerno, Italy*

10:00 Characterization of the main physico-chemical parameters in three styles of craft beer

Loredana Liguori, University of Salerno, Italy
Giovanni De Francesco, University of Perugia, Italy
Giuseppe Perretti, University of Perugia, Italy
Donatella Albanese, University of Salerno, Italy

10:20 pH strip reader for beer samples based on image analysis

Salvatore Dello Iacono, University of Salerno, Italy
Adriana Erra, Birring start-up innovativa s.r.l., Italy
Antonio Pietrosanto, University of Salerno, Italy
Domenico Di Caro, Spring Off s.r.l., Italy
Consolatina Liguori, University of Salerno, Italy

10:40 Impedimetric label – free immunosensor for rapid detection of Ochratoxin A in beer and wine

Francesca Malvano, University of Salerno, Italy
Donatella Albanese, University of Salerno, Italy
Roberto Pilloton, University of Salerno, Italy

10:00 - 11:00 CET

Session 3.7 - Special Session on Agricultural Meteorology for Water Resilience in Agroecosystems

Room: *Virtual Room #3*

Chairs: Filiberto Altobelli, *CREA, Italy*

Anna Dalla Marta, *University of Florence, Italy*

Giulio Castelli, *University of Florence, Italy*

10:00 Ploovium: a decision support system for increasing water use efficiency of irrigated crops

Andrea Martelli, Soonapse s.r.l. (SME), Italy
Filiberto Altobelli, Research Centre for Agricultural Policies and Bioeconomy, Italy
Anna Dalla Marta, University of Florence, Italy
Marco Ciarletti, Soonapse s.r.l. (SME), Italy

10:20 Performance of different rice varieties under drip irrigation

Stefano Monaco, Council for Agricultural Research and Economics, Italy
Paolo Bottazzi, Terre Regionali Toscane, Italy
Filiberto Altobelli, Council for Agricultural Research and Economics, Italy

10:40 Integrating UAV and satellite data to assess the effects of agroforestry on microclimate in Dodoma region, Tanzania

Lorenzo Villani, University of Florence, Italy
Giulio Castelli, University of Florence, Italy
Francesco Sambalino, MetaMeta Research, The Netherlands
Lucas Allan Almeida Oliveira, Federal University of Viçosa, Brazil
Elena Bresci, University of Florence, Italy



11:00 - 11:40 CET

Session 1.8 - General Session - PART 2

Room: *Virtual Room #1*

Chairs: Annachiara Berardinelli, *University of Trento, Italy*
Sihem Dabbou, *University of Trento, Italy*

11:00 On-the-go variable rate fertilizer application on vineyard using a proximal spectral sensor

Marco Sozzi, University of Padova, Italy

Enrico Bernardi, University of Padova, Italy

Ahmed Kayad, University of Padova, Italy

Francesco Marinello, University of Padova, Italy

Davide Boscaro, Council for Agricultural Research and Economics-Research Centre for Viticulture and Enology, Italy

Alessia Cogato, University of Padova, Italy

Franco Gasparini, University of Padova, Italy

Diego Tomasi, Council for Agricultural Research and Economics-Research Centre for Viticulture and Enology, Italy

11:20 AI at the Edge: a Smart Gateway for Greenhouse Air Temperature Forecasting

Gaia Codeluppi, University of Parma, Italy

Antonio Cilfone, University of Parma, Italy

Luca Davoli, University of Parma, Italy

Gianluigi Ferrari, University of Parma, Italy

11:00 - 11:40 CET

Room: *Virtual Room #1*

Chair: Matteo Nardello, *University of Trento, Italy*

WineGRover

Precision Agriculture System to limit the impact on the environment, on health and on air quality of grape production

Eng. Eduardo De Francesco, *SeTeL Group*

11:40 - 12:30 CET

TUTORIAL - Session #5

Room: *Virtual Room #1*

Chairs: Giovanni Battista Chirico, *University of Naples Federico II, Italy*
Annachiara Berardinelli, *University of Trento, Italy*

**From fruit recognition to fruit growth monitoring:
an overview of the field applications**

Luigi Manfrini, *University of Bologna, Italy*

12:20 - 13:20 CET

IEEE METROAGRIFOR – WORKSHOP

**Towards in-field application of acoustic emissions
in water-stress monitoring**

Room: *Virtual Room #1*

Chairs: Vedran Bilas, *University of Zagreb, Croatia*
Davide Brunelli, *University of Trento, Italy*

The on-plant low-power sensing solutions become important in optimising water usage in precision irrigation of woody plants, especially in the karst regions. This workshop gives insights in recent achievements and future research and development for bringing plant acoustic emissions based water stress monitoring to the field use. The topic will be presented from different perspectives by members of an international interdisciplinary team of botanists, agricultural and electronic engineers, and nanotechnology experts collaborating within project SENSIRRIKA Advanced sensor systems for precision irrigation in karst landscape, funded by the Croatian Science Foundation.

Sounds of stress or a lot of noise? Introduction to acoustic emission testing of plants to monitor drought stress

Sabine Rosner, *BOKU Vienna, Austria*

SENSIRRIKA - An IoT node for acoustic emissions based on-plant water stress monitoring

Dinko Oletić, *University of Zagreb, Croatia*



Next-generation ultra-low-power MEMS sensors for detection of ultrasonic xylem emissions

Emile Martincic, *Centre de Nanosciences et de Nanotechnologies, University Paris-Saclay, France*

13:20 - 13:40 CET

CLOSING AND AWARD CEREMONY

Room: *Virtual Room #1*