INTERNATIONAL CONFERENCE ON SMART AND SUSTAINABLE TECHNOLOGIES

Timetable A: SpliTech2023 Program

June 20, 2023, IoT Day, University of Split, FESB, Virtual Access | TIME: 8:30 – 17:00

June 21, 2023, Hotel Elaphusa, Bol (island of Brač), Virtual Access

TIME	BRAC 1	HVAR	KORCULA
08:00	REGISTRATION		
08:30-09:00		IoT Symposium:OPENING	RFID & EM for IoT Symposium: OPENING
09:00-10:30	Invited: M. Santamouris **BD1:** Decarbonization strategies in buildings	**IoT1:** Session on IoT-aware Solutions and Research projects on One-Health and Safety ecosystems	**RFID1**: Special Session on RFID and IoT electronic and electromagnetic augmented devices and systems for sustainability, wellness, industry, and safety
10:30-11:00	Coffee Break		
11:00-11:30	Keynote: Ultan Mc Carty, "The Electronic transformation of AgriFood Systems" *(BRAČ 1)*		
11:30-13:00	Invited: T. Theodosiou **BD2:** Energy efficiency in buildings	**IoT2:** Special Session on Cybersecurity and IoT	**RFID2**: IEEE-CRFID Workshop on Flexible and Printable Technologies in Electronics and Electromagnetics (WFPE)
13:00-14:00	Lunch		
14:00-14:30	Keynote: Will Whittow,"3D printed antennas, metamaterials, and metasurfaces for microwave application" *(BRAČ 1)*		
14:30-16:00	Meet the Editors	**IoT3:** Session on IoT technologies and use cases	**RFID3**: Wearable, conformal and flexible antennas for RFID/IoT
16:00-16:30	Coffee Break		
16:30-17:00	Keynote: Ivica Galić, "Defining the safety of pressure equipment in energy applications using XFEM"		
17:00-18:30	Invited: P. Fokaides **BD3:** Nzeb and high-performance buildings	**IoT4:** Session on BigData and Machine Learning Applications	**RFID4**: Future Trends of RFID Technology for Society and Industry Toward green IoT Devices
19:00-21:00	GUIDED TOUR		

June 22, 2023, Hotel Elaphusa, Bol (island of Brač), Virtual Access

TIME	BRAČ 1	HVAR	KORČULA
09:00-10:30	Invited: F. Ascione **BD4:** Energy and buildings	**IoT5:** Special Session on AI and Deep Learning applied to Smart environment	**RFID5**: Artificial intelligence (AI)-enhanced edge sensing and decision-making for electromagnetic devices
10:30-11:00	Keynote: Liming Luke Chen, "Hybrid Human Artificial Intelligence (HHAI): Concept, Evolution and Application"		
11:00-11:30	Coffee Break		
11:30-13:30	**OPENING CEREMONY AND PLENARY TALKS (BRAČ 1)** ***HENRIK LUND*** *"Resilient and Fully Decarbonized Smart Renewable Energy Systems.",* ***ANDREA MASSA*** *"Towards a Smart EM Environment (SEME) - Perspectives, Recipes, and Future Trends"*		
13:30-14:30	Lunch		
14:30-15:00	Keynote: Vladimir Blasko, "Practical Aspects and Trends in the Development and Design of Electrical Drives".		
15:00-15:30	Keynote: Thomas M. Jahns,"The Promising Future of Integrated Motor Drives in Tomorrow's E-Mobility Applications".		
15:30-17:00	**BD5:** Advanced energy systems and technologies in buildings		
21:00	CONFERENCE DINNER AND COCKTAILS		

June 23, 2023, Hotel Elaphusa, Bol (island of Brač), Virtual Access

TIME	BRAČ 1	HVAR	KORČULA
09:00-10:30	**P1:** Professional papers session I	**H1:** Health I	**TPS IoT:** Technical short papers IoT
10:30-11:00	Coffee Break		
11:00-12:30	**P2:** Professional papers session II	**H2:** Health II	**TPS EM:** Technical short papers engineering modelling
12:30-15:00	Lunch		

Timetable B: SpliTech2023 Program

June 20, 2023, IoT Day, University of Split, FESB, Virtual Access | TIME: 8:30 – 17:00

June 21, 2023, Hotel Elaphusa, Bol (island of Brač), Virtual Access

TIME	VIS	ŠOLTA	BRAČ 2
08:00	REGISTRATION		
09:00-10:30	**EM1:** Engineering modelling I	**SC1:** Smart City I	**E1:** Energy systems and processes I
10:30-11:00	Coffee Break		
11:00-11:30	Keynote: Ultan Mc Carthy, "The Electronic transformation of AgriFood Systems" *(BRAČ 1)*		
11:30-13:00	**EM2:** Engineering modelling II	**SC2:** Smart City II	**E2**: Renewable energy systems and energy technologies
13:00-14:00	Lunch		
14:00-14:30	Keynote: Will Whittow, "3D printed antennas, metamaterials, and metasurfaces for microwave application" *(BRAČ 1)*		
14:30-16:00	**EM3:** Engineering modelling in energy systems	**SML1**: Symposium Statistics and ML in Electronics I	**E3:** Energy efficiency and energy modelling
16:00-16:30	Coffee Break		
16:30-17:00	Keynote: Ivica Galić,"Defining the safety of pressure equipment in energy applications using XFEM"		
17:00-18:30	**EM4:** Engineering modelling III	**SML2:** Symposium Statistics and ML in Electronics II	**E4**: Energy systems and processes II
19:00-21:00	GUIDED TOUR		

June 22, 2023, Hotel Elaphusa, Bol (island of Brač), Virtual Access

TIME	VIS	ŠOLTA	BRAČ 2
09:00-10:30	**CS1:** Citizen Science session I	**WF1**: Wildfires Track I	**WSP:** RES HEAT WORKSHOP
10:30-11:00	Keynote: Liming Luke Chen, "Hybrid Human Artificial Intelligence (HHAI): Concept, Evolution and Application"		
11:00-11:30	Coffee Break		
11:30-13:30	**OPENING CEREMONY AND PLENARY TALKS (BRAČ 1)** ***HENRIK LUND**, "Resilient and Fully Decarbonized Smart Renewable Energy Systems.",* ***ANDREA MASSA** "Towards a Smart EM Environment (SEME) - Perspectives, Recipes, and Future Trends"*		
13:30-14:30	Lunch		
14:30-15:00	Keynote: Vladimir Blasko, "Practical Aspects and Trends in the Development and Design of Electrical Drives".		
15:00-15:30	Keynote: Thomas M. Jahns,"The Promising Future of Integrated Motor Drives in Tomorrow's E-Mobility Applications".		
15:30-17:00	**CS2:** Citizen Science session II	**WF2**: Wildfires Track II	**WSP:** FSES: Flexible and smart energy systems to decarbonise buildings (15:30-17:30)
21:00	CONFERENCE DINNER AND COCKTAILS		

June 23, 2023, Hotel Elaphusa, Bol (island of Brač), Virtual Access

TIME/HALL	VIS	ŠOLTA	BRAČ 2
09:00-10:30	**TUTORIJAL**: Human Exposure to Electromagnetic Fields	**PS:** Professional short papers	
10:30-11:00	Coffee Break		
11:00-12:30	**SDN:** Smart Distributed Electrical Network	**PV:** Photovoltatronic	
12:30-15:00	Lunch		

Symposium on IoT organizer: L. Patrono
Symposium on RFID & EM for IoT organizer: L. Catarinucci
Symposium on Statistics and Machine Learning in Electronics organizers: M. B. Marinov, S. Hensel, M. Ivanova
Symposium on Mitigation and Adaptation Strategies towards Decarbonization of Built Environment organizers: M. Santamouris
Symposium on Photovoltatronics organizer: P. Manganiello, M. Muttillo
Special session: The Wildfires track organizers: Lj. Šerić, I. Gitas, M. Bugarić
Special session: Smart Distributed Electrical Network: Opportunities and Challenges for Integration of Renewable Energy Systems organizers: M. L. Kolhe, N. J. Johannesen
Special session: Enabling Citizen Science with emerging technologies to foster pro-environmental behaviour organizers: D. C. Mansilla, D. López de Ipiña
Special session: Wireless Power Transfer - Honour on the 80th anniversary of Nikola Tesla Death organizers: D. Poljak, Z. Blažević
Workshop: RESHeat organizer: P. Oclon
Workshop: Meet the editors Moderator: Sandro Nižetić Speakers: H. Lund, A. Papadopoulos, P. Oclon, M. Arici
Tutorials: Human Exposure to Electromagnetic Fields organizers: D. Poljak, M. Cvetković

IoT O: IoT opening

Advancing Sustainability Impact Assessment: A Comprehensive Tool for Low Emissions Zone Management

Eduardo B. Fernandez (Florida Atlantic University, USA)

Low emissions zones (LEZs) have emerged as a key strategy in addressing urban air pollution and reducing greenhouse gas emissions. To effectively manage and enforce LEZs, optimization of mobility, intelligent transport systems, multimodal mobility, and mobility as a service must be considered as objectives to be reached. In the same direction, public authorities have included in their strategic plans to make their city "more sustainable and smarter. In this sense, a comprehensive toot that integrates advanced technologies and data-driven approaches is essential. To overcome this limitation, Libelium proposes in this work a LEZ management software for smart decission making. It integrates various components such as real-time monitoring, data analytics, air quality modeling, and KPIs computation. Our solutions utilize a combination of sensors, cameras, and communication networks to collect real-time data on vehicle emissions, traffic patterns, and compliance levels within the designated low emissions zones. This paper shows promising results in this context validated in five European cities - Paris, Helsinki, Amsterdam, Stavanger, and Tallinn - obtaining a CO2eq emissions reduction up to 86 % in the best scenarios. In addition, the dispersion models can achieve a high resolution at a street level. For this reason, the tool for low emissions zone management presents a comprehensive and integrated approach to monitor, enforce, and evaluate LEZs effectively. The tool enables authorities to effectively combat urban air pollution and reduce emissions by leveraging real-time monitoring, data analytics, and sustainability impact assessment. Implementing such a tool has the potential to create cleaner and healthier urban environments, enhance transportation sustainability, and improve the overall quality of life for citizens.

BD 1: Decarbonization strategies in buildings

Weights of embodied energy and carbon emissions in an energy retrofit of the building envelope: Assessment for a Mediterranean residential building

Teresa Iovane (Università degli Studi di Napoli Federico II, Italy); Fabrizio Ascione and Nicola Bianco (Università degli studi di Napoli Federico II, Italy); Margherita Mastellone (Università degli Studi di Napoli Federico II, Italy); Manuela Almeida and Ricardo Mateus (University of Minho Guimarães Portugal, Portugal)

Europe's commitment to reduce energy consumption and CO2 emissions by 2050 led to a proposal to amend the EPBD in December 2021. This proposal introduces the environmental footprint assessment for new buildings involving all phases of their life cycle. The life cycle approach, however, could provide valid suggestions and results even if applied to energy renovation interventions. In this study, the LCA methodology - according to the variant cradle-to-gate with options - is used to investigate the energy and emissions consumed and produced for the energy-oriented retrofit of both opaque and transparent building envelope of a residential building, in the Mediterranean area. The analysis shows that the solutions that allow maximum energy savings in the operational phase of the building differ from those characterized by minimal energy impact from a life cycle perspective. At the same time, however, the latter enable an acceptable operational energy saving and a higher total reduction of energy demands. In detail, the solution that allows maximum energy savings in the operational phase, equal to about 39.4%, has a weight of the embedded energy of 7.1%. The solution with the minimum weight of the incorporated energy, equal to about 5.5%, allows an operating energy saving of 39.1%.

From consumers to prosumers: the rise of Energy Communities and their role in the energy transition

Giuseppe Aruta (Università degli Studi di Napoli Federico II, Italy); Fabrizio Ascione (Università degli studi di Napoli Federico II, Italy); Nicola Bianco (University of Naples, Italy); Luisa Bindi (University of Naples Federico II, Italy); Filippo De Rossi (Università degli Studi di Napoli Federico II, Italy); Giacomo Manniti (University of Naples Federico II, Italy)

This study aims to be an overview of energy communities, analyzing the energy context, with environmental and climate problems, that have led to the need to develop smart and sustainable solutions for a new social model of energy self-production. The concept of energy community contains important objectives for the sustainable evolution of cities, firstly the spread of renewable energy. Exploring the methodologies and approaches used in the literature, conclusions were drawn to be able to manage and understand the functioning of zero-impact energy systems, defined as nearly-zero energy districts (nZED), where energy is designed to be shared. To overcome the boundaries of the individual building and consider the influence of the surrounding urban context, starting from the concept of a smart city and the limits of the model itself, the importance of having an overview of the urban area is defined, and citizens themselves to cooperate in the design and management of energy systems and energy production, thus considering the concept of selection of energy flows. By defining the concept of the energy community, the state of the art in Europe is explained, by analyzing real cases and classifying the according to technical characteristics, types of modeling/optimization approach and methodology used to assess the performance of the energy community. The evaluation of the reviewed articles is useful for the phase of pre-conceptional analysis of the future energy community of Bagnoli (Naples, Italy), aimed at the redevelopment of the ex-industrial area to make it renewable and sustainable.

Identifying Promising Domains of Decarbonization Technologies: an Improved Methodology

Paulo Moisés Almeida Costa (ESTGV & ESTGV - IPV, Portugal); Paulo Tomé (Travessa Principe Perfeito Lote B 17 A, Portugal); Bruno F. C. Almeida (IPV & ESTGV, Portugal); Nuno Bento (Instituto Universitario de Lisboa (ISCTE-IUL), DINAMIA'CET, Portugal); António Costa Duarte (ESTGV, Portugal)

The planet's average temperature has increased steadily over the last few decades, with potentially disastrous consequences. This phenomenon is mainly related to carbon dioxide emissions associated with energy use in human activities.

Aware of this reality, humanity has sought ways to mitigate the effects of global warming, namely measures to decarbonize the economies. The scientific community has been particularly active, producing intensive research and evaluating potential decarbonizing technologies and strategies.

This article proposes an improved methodology based on two readily available text-mining software able to identify the most relevant domains of decarbonizing technologies presented in scientific papers, research projects and patents. The improvements in the methodology include the definition of an approach to obtain a final rank of the domains of technologies and an enhanced procedure to construct the semantic dictionary, a critical component for the bibliometric analysis. Moreover, a more robust and comprehensive search string was defined to reconcile the particularities of the used text-mining software. The proposed methodology was applied to the 2011-2021 period, and the results were analyzed considering different points of view. The decarbonization technologies domains identified were categorized more comprehensively, allowing a better understanding of the scientific community's focus.

Analysis of energy standards for low-income housing throughout the 21st century: A focus on reducing cooling loads in Mexico

Claudia Eréndira Vázquez-Torres (Autonomous University of Yucatán, Mexico); José Gabriel Hernández-Pérez, Bassam Ali and Luis Ricalde Castellanos (Autonomous University of Yucatan, Mexico)

Developing countries like Mexico have implemented energy policies to reduce summer cooling loads and mitigate climate change. This study analysed the energy policies for housing for the economically and socially vulnerable population. A numerical method was used with experimental validation in social housing in central Mexico; to evaluate compliance with energy standards, currently mandatory, throughout the 21st century and to determine early adaptation strategies. The current scenario (2023) and two future projections (2050 and 2100) were quantified using the climate model developed by the Intergovernmental Panel on Climate Change. Three climate change scenarios of the Representative Concentration Pathways were used in the future projections. As a result, the analysis of the current and future scenarios showed pathways towards an equitable energy transition focused on anticipating climate change and optimising existing resources for the most vulnerable population.

Social housing as an open issue of energy consumption in the building sector in Europe: a case study in Berlin

Fabrizio Ascione and Nicola Bianco (Università degli studi di Napoli Federico II, Italy); Olaf Böttcher (Federal Institute for Research on Building Urban Affairs and Spatial Development, Germany); Aniello Cappiello and Margherita Mastellone (Università degli Studi di Napoli Federico II, Italy); Gerardo Maria Mauro (Università degli studi del Sannio, Italy); Jana Mühle (Federal Institute for Research on Building Urban Affairs and Spatial Development, Germany); Francesco Tariello (Università degli studi del Molise, Italy)

The decarbonization goal by 2050, as set by Directive 844/2018, is an ambitious objective that requires a big effort. The strategy to act on the building sector includes the construction of new highly efficient buildings and the energy refurbishment of the existing ones. This study focuses on the renovation of social housing buildings, which are a wide component of the existing building stock, and in most cases, present poor energy performances. The investigation focuses on the role that social housing plays in the European building stock, from an energy point of view, and through significant examples, review the strategies adopted to improve their energy performances. A significant case study in Berlin, representative of both German and even European social housing, was investigated by selecting energy efficiency measures to improve its performance. In a final configuration that combines different energy efficiency measures, a heating thermal energy saving of 88% was obtained. The study includes a technical economic analysis of the proposed energy efficiency interventions and shows how some of them are not economically convenient without governmental incentives.

E1: Energy systems and processes I

Design and analysis of a solid oxide fuel cell based novel polygeneration system with power-ejector refrigeration and multi-stage flash desalination

Onder Kizilkan (Isparta University of Applied Sciences, Turkey); Sandro Nizetic (University of Split, FESB, Croatia)

In this study, a novel integrated poly-generation system with solid oxide fuel cell (SOFC) was proposed for power generation, refrigeration, desalination and heating purposes. The combined system consisted of a power-ejector refrigeration cycle (PERC), a multi-stage flash (MSF) desalination unit for fresh water production and a hot water preparation unit for domestic applications. For the performance assessment of the system, thermodynamic analyzes are conducted in order to determine the system characteristics. Moreover, parametric analysis are performed in order to investigate the effects of major system parameters on the system performance and the results are discussed in detail.

Multi-Attribute Approach in Product Design during Group Decision Support Making Process

Krešimir Osman (Zagreb University of Applied Sciences, Croatia); Mato Perić (University of North, Croatia)

The research objective of this article was to develop a multi-attribute approach as a tool for group decision-making processes based on the modular function deployment method (MFD) and fuzzy AHP method. The first method is used to develop possible product alternatives. The second is used to evaluate the alternatives and select the best one. This approach allows for decision-makers, who are in different locations, to participate in group decisions over the Internet. It also allows for finite choice alternatives that are best in terms of the overall goal. Various priorities should be considered when determining the overall plan. Not only should it consider the desired objectives but also various criteria that enter into the decision-making process through a system of characteristic values. The resulting complexity of the evaluation task requires an approach that, on the one hand, makes it possible to assign a weighting profile to the individual sub-goals and thus shift priorities, but on the other hand also ensures that very different criteria are considered. Since the AHP method can handle complexity, while fuzzy logic allows dealing with uncertainty factors, the proposed method combines these techniques in an integrated approach. The verification of the research results was carried out on a real example of a complex technical system - an air-cooled chiller.

Energy analysis of microwave heating process of corn straw particles in a microwave chamber

Longfei Cui, Wenke Zhao and Yaning Zhang (Harbin Institute of Technology, China)

Microwave treatment of biomass has a wide range of applications, and the study of its microwave heating performance and energy analysis is important for an in-depth understanding of the microwave treatment of biomass. In this study, the effects of particle sizes (0.075, 0.125, 0.200, 0.355 and 0.600 mm), feeding loads (10, 16, 22, 28, and 34 g) and microwave powers (400, 450, 500, 550, and 600 W) on the microwave heating performances of corn straw particles were investigated, and the process was quantitatively described from the aspect of energy analysis. The results showed that smaller particle size, higher feeding load and higher microwave power could result in higher heating rate and higher energy efficiency of corn straw particles.

New energy storage design methods

Aneta Kalbarczyk (Warsaw University of Technology & Solid Energy Group, Poland); Aldona Zalewska and Michał Marzantowicz (Warsaw University of Technology, Poland); Michał Kalbarczyk (Solid Energy Group Sp z o. o Ełk, Poland)

The article presents works related to the design and implementation of a new energy storage for a single-family house of 8 kWh. In order to choose the design of a new warehouse for a given application, Research Team have defined parameters such as: energy and power density, warehouse response time, lifetime, size, rate of return on investment, additional equipment, storage efficiency, energy consumption profile, energy tariff. Then is has been defined main

problems that we would like to focus and based on these we prepared technological challenges that help to choose the best way to face this problems. In the next step we will be work on selected challenges: safety cathode, modern electrolyte and BMS (battery management system).

Towards a Smart Operation - Novel Grey-box Modelling of Ultra-low Temperature Freezing Chambers

Tao Huang, Peder Bacher and Jan Kloppenborg Møller (Technical University of Denmark, Denmark)

A reliable dynamic model is essential for securing the quality of perishable contents and improving the high energy consumption of Ultra-low temperature (ULT) freezers in a smart digital way. This study develops a novel grey-box approach for modelling the heat dynamics of the ULT freezing chamber. The modelling approach is based on stochastic differential equations and fed only with costless data measured by embedded temperature sensors in the particular freezer under study. The unknown parameters are estimated using the maximum likelihood method based on data from regular operation periods. A novel model that describes the nonlinear heat transfer between the local evaporator and chamber is proposed. This nonlinear model is able to compensate for the biased measurements from the embedded temperature probe and adapt to changes in the local cooling intensity. Two freezers with different operation patterns are modelled. The results prove that the established models perform well in predicting the chamber temperature, which is the backbone of reliable applications. Despite compromised physical interpretability, the developed modelling approach eases the modelling procedure and is expected to greatly promote the potential of practical implementations of grey-box models in future intelligent surveillance and operation of ULT freezers.

A novel approach to efficient biodiesel production using waste cooking oil

Marina Corral-Bobadilla and Ruben Lostado-Lorza (University of La Rioja, Spain); Fátima Somovilla-Gómez (Universidad de La Rioja, Spain); Saúl Iñiguez Macedo and Celia Sabando-Fraile (University of La Rioja, Spain)

The use of renewable energy sources has been recognized as a practical solution that may be able to satisfy the world's energy needs without adding to the environmental damage caused by the use of fossil fuels. In this work, artificial intelligence (AI) was used to analyze and improve the impacts of five factors, including reaction temperature, oil-to-alcohol ratio, reaction time, catalyst concentration, and stirring rate, and genetic algorithms (GA) were used to optimize the process parameters. The results showed that at the optimum conditions of 28°C reaction temperature, 1:6.78 methanol to oil ratio, 523 rpm stirring rate, 20.157 s reaction duration, and 1.004 catalyst concentration, the transesterification process achieved the highest biodiesel yield (97.76%). The findings showed that the model and recent studies are mostly in agreement, and waste cooking oil can be thought of as a possible oil source for biodiesel synthesis.

EM1: Engineering modelling I

New analytic model for torsion with shear influence of thin-walled composite beams with symmetrical open sections

Marko Vukasović, Branka Bužančić Primorac and Karla Delić (University of Split, Croatia)

New analytic model for torsion with shear influence of thin-walled laminated composite beams with symmetrical open cross-sections is developed. Beams assembled of balanced laminates with symmetric lay-up and constant elastic properties over the cross-section area are considered. Solutions for the stresses and displacements with shear influence are presented in closed analytic form. Influence of shear on normal stresses and angular displacements is investigated with respect to the fiber orientations in laminates. Beams with different boundary conditions, subjected to transverse load reduced to the principal pole (shear center), are assumed. The results obtained for the beams with low aspect ratios are compared with the finite element solutions utilizing shell elements. Excellent agreement between analytical and numerical results is obtained.

Eccentric compressive load on short pultruded wide flange beam

Radoslav Pavazza, Frane Vlak, Marko Vukasović and Branka Bužančić Primorac (University of Split, Croatia)

In this paper, the simple closed form solutions for the normal stress and displacements of short thin-walled pultruded wide flange beam subjected to eccentric partially distributed axial load are presented. Due to eccentric compressive load, the beam is subjected to compression, bending in two principal planes and torsion simultaneously. Theory of bending and theory of torsion of open cross sections with influence of shear are utilized in the static analysis of the beam-column to obtain analytical expressions for the normal stress. Also, translational and rotational displacements are defined using classical Vlasov solution and deflections and angle of torsion are augmented with additional components due to shear in bending and torsion. The analytical solutions according to Vlasov and those obtained with theory of bending and torsion with influence of shear are compared to the finite element method solutions obtained by using shell finite elements. It is proved that the shear effect must be taken into analysis of short thin-walled beams for this type of the problems.

An Efficient Stochastic Modeling of Transmitted Power Density in Two-layered Planar Tissue Exposed to Incident Plane Wave

Anna Šušnjara (University of Split & FESB, Croatia); Dragan Poljak (University of Split, Croatia); Marin Galić (Centar za Mjerenja u Okolisu, Croatia)

The paper presents the stochastic analysis of the transmitted power density (TPD) in a two-layered planar tissue model (skin + fat and skin + muscle), exposed to a plane wave incidence at 10, 30 and 90 GHz. Electric field, specific absorption rate (SAR) and TPD are computed analytically. Furthermore, tissues' permittivities and conductivities are modelled as uniformly distributed random variables. Uncertainty from the input parameter set is propagated to output electric field, SAR and TPD by means of stochastic collocation method. Stochastic mean and confidence intervals for output parameters are computed. Additionally, ANOVA sensitivity analysis is carried out thus evaluating the impact of the input parameters' variations on TPD confidence interval width.

Wireless Power Transfer by using Thin Wire Antennas Case of Dipole Antennas in Free Space

Dragan Poljak (University of Split, Croatia)

The paper deals with wireless power transfer (WPT) between two parallel dipole antennas in free space. The analysis is carried out in the near field zone by solving the corresponding coupled integro-differential equations of Pocklington type by using SuzANA code. The power transfer efficiency (PTE) factor is calculated as the ratio of power at the center of receiving and transmitting antenna, respectively by using Norton equivalent circuit of the antenna. Some illustrative numerical results for PTE are presented for the case of unloaded and loaded receiving antenna, respectively.

Some Notes on Tesla Coil Design and Power Transfer Performances

Zoran Blažević (University of Split, Croatia)

In this paper, we revisit the Tesla Coil, a device that had the pivotal role in the development of radio. The analysis is conducted on the basis of the antenna theory, and the feasibility for its application to wireless power transfer is tested by experiment. It is shown that Tesla coil can very well be used for an efficient transmission of electrical energy without wires at small and mid-ranges.

IoT1: Session on IoT-aware Solutions and Research projects on One-Health and Safety ecosystems

ElectroSense: a Low-cost Wearable Potentiostat for Real-time Monitoring of Glucose Level

Antonio V Radogna (University of Salento, Italy); Luca Francioso (CNR- Institute for Microelectronics and Microsystems, Italy); Elisa Sciurti, Daniele Bellisario and Vanessa Esposito (CNR-IMM, Italy); Giuseppe Grassi (University of Salento, Italy)

In this paper, a wireless potentiostat code-named ElectroSense, for electrochemical sensors, will be presented. The system is devoted to real-time detection of glucose in wearable medical applications. Differently from other state-of-the-art works, which generate the measurement signal through discrete digital-to-analog converters (DACs) or, alternatively, through integrated DACs in high-end microcontrollers, in this work a DAC from filtered pulse width modulated (PWM) signals is adopted. The ubiquitous presence of integrated PWM peripherals in cheap microcontrollers, which generally also integrate the analog-to-digital converter (ADC), enables both the generation and acquisition of measurement signals on a single low-end microcontroller. As a result, the system's production costs, the power consumption, and the overall size are greatly reduced. All these features allow the system's adoption in healthcare Internet-of-things (IoT) ecosystems. The circuit schematic of the ElectroSense potentiostat will be presented in detail, exploiting advantages and drawbacks of the PWM-DAC approach. After a description of the adopted electrochemical sensing technology, experimental measurements through both amperometry and voltammetry modes, will prove the efficacy of the proposed electronic system for real-time measurements of glucose in wearable medical applications.

Design and development of an IoT learning system for health-related applications

Milovan Medojevic (The Institute for Artificial Intelligence Research and Development of Serbia & EnergyPulse DOO, Serbia); Marko Vasiljević-Toskić (University of Novi Sad, Serbia); Dubravko Culibrk (The Institute for Artificial Intelligence Research and Development of Serbia, Serbia); Petar Solic (University of Split & FESB, Croatia); Toni Perkovic (University of Split, FESB, Croatia); Milana Medojevic (University of Novi Sad, Serbia)

This paper provides relevant outcomes regarding the design and development of an IoT learning system, aimed to stimulate learning by doing while offering IoT deployment in medical science and related practices toward health monitoring and diagnostics. The system is conceptualized as a through-hole module integration board that enables data acquisition regarding body temperature, heart rate, and the saturation of oxygen in the blood, accompanied by psychrometric parameters of the environment in which the measurement is performed. The paper provides an overview in terms of favoring the development of digital technologies curriculums due to the importance and influences it might have on future experts. Last but not least, technical specifications, schematics, and overall system appearance are enclosed in detail. Finally, possible applications in process engineering and thermo-energetics are discussed as well.

Evaluation of a Telemergency Service for Older People Living at Home: A Study Protocol

Elena Casabona (University of Turin, Italy); Sara Campagna and Paola Di Giulio (University of Torino, Italy); Valerio Dimonte (Università degli Studi di Torino, Italy); Angela Castello (University of Torino, Italy); Dante Viotti (G. Agnelli Ville Roddolo Nursing Home, Italy)

Ageing is a significant challenge for public health and healthcare systems worldwide, as it is associated with an increased risk of falls, disability, cognitive impairment and comorbidities. Among the technologies for fall detection, Personal Emergency Response Systems (PERS) are the most used and enable to detect and report potentially dangerous situations at home. However, more studies are necessary to understand who can best benefit from these devices. For this purpose, a retrospective cohort study will be conducted to describe a telemergency service offered by a remote control system delivered by a for-profit company in identifying home falls of elderly subjects using a PERS. All users who sent an alarm from December 2020 to December 2022 will be included. Socio-demographic and health information collected at the patients' entry will be extracted from the medical records to describe the characteristics of the subjects requesting the service. The incidence and dynamics of falls will be collected. The characteristics of users who received partial or complete reimbursement of the service will be compared with those who purchased the service privately.

An IoT-aware system for remote monitoring of patients with chronic heart failure

Ilaria Sergi, Teodoro Montanaro and Angela-Tafadzwa Shumba (University of Salento, Italy); Alessia Bramanti, Michele Ciccarelli and Albino Carrizzo (University of Salerno, Italy); Paolo Visconti (University of Salento, Italy); Massimo De Vittorio (Istituto Italiano di Tecnologia, Italy); Luigi Patrono (University of Salento, Italy)

The COVID-19 pandemic has highlighted the importance of remote patient monitoring, particularly for those suffering from chronic illnesses. Such individuals require continuous monitoring to ensure the stability of their condition and prevent complications. However, traditional methods of patient monitoring can be invasive, time-consuming, and often result in patients feeling limited in their daily activities. The development of intelligent monitoring systems based on Internet of Things technologies has the potential to revolutionize the way chronic illness is managed. These systems can be integrated with wearable/portable devices and other sensors to track vital signs in real-time. This information can then be transmitted to healthcare providers for review, allowing for early detection of any changes or potential issues. The benefits of such systems are numerous. They provide patients with increased freedom and mobility, as they no longer need to visit a healthcare facility for regular check-ups. They also reduce the workload for healthcare providers, freeing up time for more critical cases. Furthermore, they can result in cost savings for healthcare systems by reducing the need for hospitalization. This work introduces the SMARTCARE project that aims to develop an integrated monitoring system consisting of hardware and software components that can make the various phases of managing a patient with chronic heart failure (prevention, diagnosis, therapy, follow-up) more efficient. The paper provides the main information on the project and presents and describes the system architecture of the proposed solution.

An IoT-based Platform for Remote Monitoring of Patients with Heart Failure: an Overview of Integrable Devices

Ilaria Sergi, Teodoro Montanaro, Angela-Tafadzwa Shumba, Roberto de Fazio, Paolo Visconti and Luigi Patrono (University of Salento, Italy)

The paper reports a survey of wearable/portable devices on the market and in the scientific literature to support diagnosing patients with chronic heart diseases. As a part of eHealth and Telehealth systems, such devices remotely and discreetly acquire the patient's data and transmit them to dedicated cloud applications and portals. This activity constitutes the starting point for the subsequent development of the wearable devices and telemedicine platform under study in the SMART CARE project. The acquired parameters, architecture, and main specifications of each analyzed device are discussed, highlighting their strengths and limitations; particular attention was paid to their sensing section, considering the used sensors, electrodes' typology, as well as their integration inside the device. Besides, the operating modalities and implemented algorithms are argued, as well as the implemented processing approach and architecture of the supporting telemedicine infrastructure. Furthermore, a comparative analysis of discussed wearable/portable devices is introduced, comparing them from the point of view of detected parameters, application body area, performance, availability of wireless connections, etc. In this way, the features, functionalities, and architectures of the devices developed in the SMART CARE project are outlined.

Advising chatbot for high school in smart cities

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A smart sustainable city is an innovative city that use a smart technology and smart education besides other ecosystem's drivers in order to improve the quality of life. Several smart applications are developed by using different artificial intelligence models to enhance the education. A chatbot is considered as one of these advanced technologies that can be deployed in schools to enhance the education and learning processes in smart cities. However, high schools are the most crucial stage in student's life as they have higher stress levels regarding their future compared to other students. They need advices more than others do, for example, they need help to find the best-fit universities and courses that can fit with their interests and goals, however, most previous studies focused on providing chatbots for supporting the matriculated and new incoming students at universities. Therefore, to fill this gap, this study aims to develop a novel chatbot for supporting students in high schools particularly by using the Multinomial Naive-Bayes and Random Forest algorithms, which can be, able to understand the natural language of students' enquiries and accordingly, the intention class for each question will be predicted. The data in this study is comprised of 505 questions, which were obtained from multiple resources such as students' blogs, schools' counsellors, students, parents as well as from schools & universities' websites. The results in this study shows that the performance of the chatbot is improved by using the techniques of pre-processing and the feature extractions such as CountVectorizers and TF-IDF. Moreover, the results show that the Random Forest classifier performed better than Multinomial Naive-Bayes in all metrics. The performance of the models is checked by using different metrics such as accuracy, precision, recall and F1-score and all show high scores with exceeding 90%. However, the accuracy of Multinomial Naive-Bayes classifier achieved higher score when using CountVectorizers compared to using the TF-IDF. In the future work, this result will be investigated by re-evaluated the model with using a large corpus with students' enquiries.

RFID1: Special Session on RFID and IoT electronic and electromagnetic augmented devices and systems for sustainability, wellness, industry, and safety

RFID Portable System For Sensing Applications

Sonia Gomez and Almudena Rivadeneyra (University of Granada, Spain); José F. Salmerón (University of Granada & ECSens, Spain); Victor Toral and Francisco Romero (University of Granada, Spain)

This paper presents a RFID system aimed at sensing applications. The device is able to read chipless tags based on LC tanks, whose resonance frequency is modified due a capacitance change caused by the parameter to be measured. A new approach in the reading process is presented based on a PLL which allows higher precision measurements. To test the performance of the designed device a printed and flexible tag has been used, which opens the door to a wide variety of applications where reading printed antennas is a need.

Self-sensing antenna for soil moisture

Maja Škiljo and Roko Radanović (University of Split, Croatia); Toni Perkovic (University of Split, FESB, Croatia); Zoran Blažević (University of Split, Croatia); Petar Solic (University of Split & FESB, Croatia)

This paper deals with the application of soil moisture estimation based on received signal strength using low-power LoRa-based soil moisture sensing device. The proposed antenna design is a type of inverted F antenna printed in a form of letters 'B', 'C' and 'N' (as for beacon, BCN antenna) and tuned with a capacitor in the infinite loamy ground with varying properties. The electric field results show its distribution above the ground due to the moisture content variation, and the measurements results give the comparison between the proposed printed antenna and the helical LoRA antenna. It is shown that a difference of cca 13 dB between the dry and the highest moisture level (40 %) can be achieved in simulations, whereas in measurements, where the signal strength difference is measured from 10 % to 50 %, the difference is cca 6-7 dB. The results imply that this approach can be most effective in summer period, in which smart irrigation monitoring is crucial due to droughts, sudden downfalls and the necessity of water consumption management.

An IoT sensor platform for LED-based optical spectroscopy

Andrea Ria, Andrea Motroni, Francesco Gagliardi, Massimo Piotto and Paolo Bruschi (University of Pisa, Italy)

Custom CMOS integrated circuits and commercial LEDs can be combined to build a compact system aimed at performing optical spectroscopy with reduced cost and low area consumption. This work presents a LED-based device capable of detecting different fingerprints of reflected or diffused light, employing LEDs for both transmitting (i.e., light source) and receiving (i.e., photo-detector) purposes. Two recently proposed low-power mixed-signal integrated circuits are employed, paving the way for an IoT device powered by a single battery cell. Experimental tests were conducted to evaluate the sensing capability of the proposed system.

Robot-based UHF-RFID joint SAR localization and tag sensing

Andrea Motroni, Andrea Ria, Glauco Cecchi and Paolo Nepa (University of Pisa, Italy)

The sensing capabilities of Radio Frequency IDentification (RFID) devices have steadily improved in recent years to the extent of enabling passive wireless sensing. Automatic and reliable monitoring of the environment can then be achieved by deploying passive RFID sensor tags in the area of interest that can measure multiple physical parameters. Mobile RFID systems assisted by robots may be a good candidate to perform localization and sensor data collection of these devices with improved automatizing. This paper presents a mobile robot-aided system for localizing and reading RFID sensor tags information. The robot motion allows exploiting the well-known SAR (Synthetic Aperture Radar) for accurate tag positioning. The system can operate with commercial hardware and it is demonstrated by means of experiments in a realistic scenario.

Extracting the ID Code of a Time/Frequency Chipless-RFID Tag with Only One Power Splitter Output

Amirhossein Karami-Horestani (CIMITEC, Departament d'Enginyeria Electrònica & Universitat Autònoma de Barcelona, Spain); Ferran Paredes (Universitat Autonoma de Barcelona, Spain); Ferran Martín (Universidad autónoma de Barcelona, Spain)

In this paper, a time/frequency domain chipless-RFID system, working in near-field is presented. The reader is based on a microstrip power splitter and the tag consists of two columns of split ring resonators (SRRs) etched in a dielectric substrate. The SRRs are designed in five different sizes (lengths), corresponding to five different resonance frequencies. As a result, the tag is able to encode more than 2 bits per resonator, and since there are two resonators per row, the tag can encode 4.9 bits of information per row. Reading the identification (ID) code of the tag is carried out by displacing it at short vertical distance (airgap) over the reader (power splitter), with the tag columns crossing the output power splitter branches. The proposed system encodes the information in frequency, provided that there are five resonator sizes, each one associated to a different resonance frequency. For tag reading, five different harmonic signals, tuned to the resonance frequencies of resonators, are sequentially injected to the input port of the power splitter. The bits are read sequentially, row by row, in a time division multiplexing scheme, where resonator size (and hence the ID) is identified from the envelope of the amplitude modulated (AM) signal for each harmonic at the output ports of the splitter. Thus, the proposed system is a hybrid time/frequency domain chipless-RFID system. The most important aspect of this contribution concerns the fact that only one of the output ports of the power splitter is needed to read the tag´s ID code, since the reflected signals contain the information of the two tag chains. Finally, in this paper, a proof-of concept demonstrator of this approach is presented.

SC1: Smart City I

Presentation and comparison of methods for evaluating the recyclability of electrotechnical products

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The constant expansion of the market and the consequent increase in production requirements, lead to an increase in the amount of waste and energy consumption. Nowadays, great attention is paid to waste management, i.e. waste reduction, and public awareness of the impact of human activities on the environment is increasing. With regard to the development or improvement of existing products, it is very important to be able to assess the recyclability of similar products. A whole range of quantitative methods has been developed to make it possible. This paper presents two methods that are commonly used as quantitative indicators of product recyclability: the product structure analysis method and the method of expressing the potential recyclability of products. In the examples of determining the recyclability of low-voltage switchgear, the recyclability of three complex low-voltage electrotechnical products is presented. The following products were selected for this purpose: fuse switches disconnector, digital timer and single-phase isolation transformer. In order to determine the recyclability of a single product, it must be disassembled into its individual parts and the mass of each element has to be measured. Based on the examples, conclusions were drawn out about the recyclability of these products and possible modifications to their architecture were suggested to increase the recyclability. In addition, an overview of the used methods and their comparison with the advantages and disadvantages of each method is given.

A Standards-based Approach for Cross-Domain Modelling of Smart City System Architectures

Goran Lastro (Salzburg University of Applied Sciences, Austria); Jounes-Alexander Gross DI (University of Applied Science Salzburg, Austria); Christian Neureiter (Salzburg University of Applied Sciences, Austria)

The inherent complexity of systems in the domain of smart cities demands a suitable modelling framework to facilitate development and interdisciplinary communication. In the domain of smart grids, the Smart Grid Architecture Model (SGAM) framework provided means for coping with complexity whilst supporting a cross-disciplinary understanding of modelled systems. Similar approaches exist for the automotive and industry domains. As a complex smart city system may combine various application domains, interoperability between applied modelling frameworks is imperative to simplify cross-domain collaboration. Therefore, to be suitable, a modelling framework needs to target the concerns of stakeholders from the smart city, whilst simultaneously enabling interoperability between all connected application domains. The presented approach is a standards-based systems engineering framework, implemented as Domain Specific Language (DSL) and based upon the Smart City Reference Architecture Methodology (SCRAM). Moreover, the DSL is used to model a particular system solution to evaluate its applicability.

Smart and Urban Innovation Policies' Risks of Gentrification: a Focus on Venice

Brian Franco Guilhelm Fabregue (University of Zurich & Retreeb Company, Switzerland)

The aim of this article is to offer a comprehensive perspective on the current situation of the city of Venice, observing the socio-cultural processes taking place in it. This is done through the development of a careful and in-depth analysis of the literature regarding the gentrification process directly connected to the implementation of smart and innovative policies within an urban context. In fact, it is found that the city of Venice is undergoing profound changes mainly driven by economic drivers supported by local policies, although some stakeholders are organising themselves to mitigate the trend.

FARM: A Prototype DSS Tool for Agriculture

Evangelia Vanezi, Maria Anastasiou, Christos Mettouris and Aliki Kallenou (University of Cyprus, Cyprus); Marijana Dimitrova (Inter-Edu, Macedonia, the former Yugoslav Republic of); George Angelos Papadopoulos (University of Cyprus, Cyprus)

Agriculture is a field that needs to be supported by technological tools. Digitalization in agriculture is the future of farming, and such support is a vital component of economic, social and environmental sustainability. Digital tools can assist, not only big farming ventures, but also small companies or individuals. Decision Support Systems (DSS) aim to reinforce decision analysis and decision-making. Such tools can allow farmers to better monitor the health of their livestock and crops. In the Erasmus+ Project FARM, we investigated the needs, drafted the specification, and designed a DSS tool with the aim to help in achieving better efficiency and improving the quality of decision-making in agriculture. We present our methodology, including a questionnaire survey for collecting the requirements, creating the design of the system database and system architecture, and developing the prototype tool in two levels, i.e., low fidelity and high fidelity. We conclude with a discussion of the prototype validation.

Towards an automated security-by-design approach in automotive system-of-systems architectures

Boris Brankovic (University of Applied Sciences Salzburg, Austria); Katharina Polanec (Salzburg University of Applied Sciences, Austria)

The development of future autonomous vehicles will become a challenging task, especially concerning the integration into a Smart City context. Nowadays, vehicles must communicate with the surrounding environment to provide efficient driving features that prevent crashing and thus save passenger lives. However, the constant information exchange with the vicinity leads to growing attack surfaces of vehicles, which endangers the functional safety of vehicles in

particular. Security-by-design seems to be a promising approach to overcoming security challenges and will become essential for the development of automotive architectures in the future. Therefore, the standard ISO-21434 was invented providing guidelines on how to tackle cybersecurity in the automotive context. One proposed method by this standard is the Threat Analysis and Risk Assessment (TARA) process used for analyzing cybersecurity threats. Nevertheless, no tools or approaches exist that provide full automation of the TARA process from an ISO-21434 perspective. Therefore, this paper proposes a concept to automate the TARA method by combining the security pattern engineering process with the Automotive Reference Architecture Model (ARAM) to enable a multi-layered security-by-design approach for the development of secure System-of-Systems (SoS) architectures in conformity with ISO-21434.

BD2: Energy efficiency in buildings

Sensitivity analysis about the effectiveness of the energy efficiency measures for residential building under the Italian incentive opportunities

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COVID-19 pandemic has increased the attention on the criticalities of the building sector: poor investment, low retrofit rate, higher energy consumptions due to longer time inside the home for the smart-working. The strategic plan put in place by Italy to face this crisis aimed at environmental sustainability, was based on a tax deduction of 110% (divided into 5 annual quotas) aimed at promoting energy efficiency measures for existing buildings, even for fulfilling the new requirements of the energy efficiency in buildings and cities provided by the Directive EU 844/2018. This investigation, employing semi-stationary approach based on real case study and data, proposes a critical analysis of several passive and active energy efficiency measures for residential buildings, belonging to different climates. Considering the energy, and economic indicators, it is shown how it is really important to provide funding program for boosting the diffusion of energy efficiency measures. Indeed, also if the combination of measures on the building envelope and the HVAC system allows important energy saving (-60% -80%) the investment cost is still very high and the tenants may not be interested in the effects of a sustainable intervention if pay-back period is too high. It is also notable that, with a semi-steady state approach.

Improving the cooling performance of an Opaque Ventilated Facade using an Airflow Network Model for the Mediterranean climate

Aikaterina Karanafti, Theodoros Theodosiou and Katerina Tsikaloudaki (Aristotle University of Thessaloniki, Greece)

Conventional building techniques appear inadequate to face the upcoming climate change effects and ensure a comfortable indoor environment for the occupants without the excessive operation of the HVAC systems. Nevertheless, dynamic insulation concept promises energy mitigation along with inhabitants' satisfaction by varying the envelope's thermal resistance when the prevailing climatic conditions are beneficial. Opaque Ventilated Facades (OVFs) lack the extensive research that Double Skin Facades (DSFs) have received. To this direction, this study aims to examine the influence of the cavity's characteristics on the OVF's performance for the Mediterranean climate. The EnergyPlus dynamic simulation tool with the integrated Airflow Network Model is adapted for the OVF and building simulation. Parameters like the cavity's height, width and its position on the envelope's stratification are extensively evaluated for a typical multi-storey residential building, while the building's overall energy performance is compared with a conventional solution along with the usual OVF construction method locating the cavity on the outer cross-section side protecting it with an exterior opaque film. The results reveal the OVF's superiority to the usual envelope and the current OVF construction practice, while the optimum design solution is highlighted.

Comparative Analysis of Energy Efficiency Policies for Existing Building by Countries

Suin Lee (Korea Institute of Civil Engineering and Building Technology, Korea (South)); Jae-Sik Kang (Korea Institute of Civil Engineering and Building Technology(KICT), Korea (South)); Hyun-Jung Choi and Hosang Ahn (Korea Institute of Civil Engineering and Building Technology, Korea (South))

In response to the international demand for reducing greenhouse gas emissions, the South Korean government officially declared a plan to achieve carbon neutrality by 2050 through the 88.1% reduction in greenhouse gas emissions compared to 2018 levels. The building sector, which accounts for 7% (24.6% when including indirect emissions) of the country's total greenhouse gas emissions in 2018, was compared to the policies of major countries on energy efficiency for existing buildings and policies for supporting energy performance improvements for old public buildings. As a result, the following improvement directions were derived: 1. the need for quantitative goal-setting, 2. establishment of management strategies for project participants, 3. verification of energy performance after completion, 4. improvement of understanding among non-experts (residents, local government officials), and 5. expansion of accessibility for non-experts to activate policies. In the future, we need to investigate the latest policies of various countries to utilize them as basic data for the effective operation of South Korea's public building green modeling projects.

Simulation of EU building stock energy performance through artificial neural networks

Ana Veljkovic (European Commission, Joint Research Centre, Italy); Daniel A. Pohoryles and Dionysios A. Bournas (European Commission Joint Research Centre, Italy)

This study proposes an efficient solution for accurate and reliable space heating energy demand simulation of the EU building stock. It relies on an artificial neural network model trained on building energy model simulations using a minimal number of input parameters. The performance parameters and the energy demand simulations showed a high accuracy and robustness of the developed tool, with a potential to be further used in assessing the impact of building renovation in the future.

E2: Renewable energy systems and energy technologies

Photovoltaic-thermal system coupled with ice bank

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The rise in renewable energy capacities is crucial to reach general energy transition goals. The photovoltaic-thermal systems (PVT) are one of the market-available technologies that utilize solar energy for the production of heat and electricity. The overall performance of the PVT systems mainly depends on the

specific design of the PVT collector and climate circumstances. In this work, the performance of the PVT system, coupled with the ice bank was experimentally analyzed in Mediterranean climate operating circumstances (city of Split, Croatia). The results indicated that the ice bank approach can slightly increase the production of electricity, however, it can significantly increase the overall efficiency of the PVT system thanks to the generation of usable heat. During the considered day, the developed PVT-PCM system collected 594 Wh of thermal energy, alongside 1210.2 Wh of electrical energy. The results are limited to short-term performance monitoring, i.e. the long-term experimental analysis is needed to get more precise data regarding the overall performance of the examined setup.

Optimal Land Suitability Based on GIS Tools for Solar PV Farms

Kacem Gairaa (URAER EPST CDER, Algeria); Mawloud Guermoui (University of Batna, Algeria); Mohammed Zaiani, Sabrina Belaid and Said Benkaciali (URAER EPST CDER, Algeria)

Currently, the energy policy in Algeria emphasizes the diversification of energy sources and encourages the penetration of other sources such as solar energy in the energy mix, in order to gradually minimize the use of conventional energies and to ensure their exploitation for other decades. However, massive development of solar PV power plants and their efficiency depend essentially on the degree of compliance with technical criteria, such as the choice of the site where the plant to be installed. The evaluation of site-suitability is then considered a complex task, where multiple criteria inherent to the territory, are involved. This paper gives a state of the art of optimal land suitability for PV farms, based on GIS techniques. Several criteria were reviewed for optimal site selection. The limiting factors that hinder the installation of large-scale power plants have also been indicated.

Analysis of PV and EV Chargers Integration Impact on Radial LV Distribution Network

Marina Dubravac, Zvonimir Šimić and Danijel Topić (J. J. Strossmayer University of Osijek, Croatia); Goran Knežević and Kresimir Fekete (FERIT Osijek, Croatia)

Recently, there is more and more integration of photovoltaics (PV) and chargers for electric vehicles (EV) in existing low-voltage (LV) distribution networks. Integration of PVs and EV chargers individually can have a negative effect on the electrical variables of radial distribution networks such as voltages, loading of network elements, losses, etc. However, their simultaneous operation mitigates the negative impact caused by their individual integration. In this paper, different levels of PVs and EV chargers integration are considered and their effect on voltages, loading of cables, losses, as well as power exchange with the external network is studied. Simulation scenarios are implemented in DIgSILENT PowerFactory and power flows are analyzed. According to obtained results, the worst scenarios present two marginal scenarios - without PVs and 100% EV chargers and 100% PVs and without EV chargers. Values of observed parameters in these scenarios have the highest deviations from rated values. In the scenario with 50% PV and 25% EV chargers integration, voltage deviation from rated voltage, loading of cables and losses have the lowest value.

A Sizing and Techno-Economic Analysis for Local Hybrid Microgrid

Marija Mandić (KONČAR - Electrical Engineering Institute Ltd. & University of Zagreb, Croatia); Motalleb Miri, Mario Barišić and Iva Popović (KONČAR - Electrical Engineering Institute Ltd., Croatia)

Concerns about climate change and global warming are increasing, and it seems that hydrogen will be one of the keys as a potential energy carrier in energy systems. In this paper, a techno-economic analysis has been carried out for a small-scale hybrid microgrid powered exclusively by renewable energy sources (RES) and operating continuously without CO2 emissions. The goal is to produce green hydrogen using electrolysis technology powered by solar and wind energy. When surplus electricity is available, it is used to charge the batteries and/or power electrolyzers to produce hydrogen, which will be stored in a tank. The hydrogen will then be converted to electrical energy using fuel cell (FC) technology when solar energy is insufficient to meet electricity needs, ensuring continuous supply to meet long-term autonomy requirements. The sizing of the photovoltaic (PV) cells, batteries, electrolyzers, FC and hydrogen tank have been studied with the objective of obtaining a fully autonomous hybrid microgrid. The architecture and schematic of the optimized component sizing are illustrated in this paper. Using HOMER software, several strategies and scenarios have been tested and the optimized solution is defined and presented.

Modification and testing of the microinverter development kit for the purpose of connecting the battery system

Luka Šimunović and Danijel Jolevski (University of Split, Croatia); Damir Jakus (University of Split & Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, Croatia); Josip Vasilj (University of Split, Croatia)

This paper presents the testing of the modified TMDSSOLARUINVKIT solar microinverter development kit manufactured by Texas Instruments. The microinverter consists of two linked converters, one connected to the photovoltaic panel and one to the electrical grid. It is intended for connecting low-power photovoltaic panels to the electrical grid. This paper describes hardware (HW) and software (SW) modifications that were necessary in order to connect the battery system to the platform. In addition to necessary HW and SW modifications, a supervisory control and data acquisition (SCADA) graphical user interface was designed for process control and monitoring. Experimental results demonstrating the possibilities of the modified platform are reported in the paper.

Frosting performances of the metal heat-transfer surface for the air-source heat pump in Harbin

Xiaoya Cao, Wenke Zhao, Yaning Zhang and Kaihan Xie (Harbin Institute of Technology, China)

The frost formation on the metal heat-transfer surface of the air-source heat pump dramatically weaken the system capacity. In this study, a frost formation experimental system based on the metal heat-transfer surface was implemented in the severely cold region of China, Harbin. The frosting performances including frost layer thickness and mass as affected by the ambient temperature, metal-surface temperature, and relative humidity were compared and analyzed, and the Response Surface Method was applied to analyze the significance degrees of experimental parameters. The results reveal that when the ambient temperature gradually decreased from 4 oC to -10 oC, the frost layer thickness and mass on the copper surface decreased. When the metal-surface temperature gradually decreased from -10 oC to -25 oC, the thickness and mass of the frost layer on the copper surface gradually increased. When the relative humidity gradually rose from 50% to 90%, the thickness and mass of the frost layer on the copper surface increased. The significance rank of experimental parameters for the frost layer mass were the metal-surface temperature > humidity > ambient temperature.

EM2: Engineering modelling II

Pipeline risk factors analysis using the Pierce correlation coefficient method and the random forest importance factor method

Ziqing Ning, Bohong Wang, Shicheng Li and Xiaoye Jia (Zhejiang Ocean University, China); Shuyi Xie (Tubular Goods and Equipment Mate-rials CNPC Tubular Goods Research Institute, China); Jianqin Zheng (China University of Petroleum, China)

The safety of pipelines has become one of the key issues in academia and industry, as it ensures that oil and gas can be transported properly. With the development of data science, many methods have been developed to handle a large amount of operational data and to understand the impact of various factors on pipeline safety. Weld failure is related to many factors, and identifying their correlation helps to grasp weld information better, develop maintenance strategies in advance, and improve weld management. In this study, two methods for studying correlations of failure factors of girth welds were studied, the Pierce correlation coefficient method and the random forest importance coefficient method. Factors such as reworking, whether connector, whether crossing, and pipe section length, are considered. The magnitude of the impact of each factor on pipeline safety can be judged to ensure that the hard requirements of each factor are met during the pipeline development process, while reducing the probability of risk to the pipeline. A case study of a gas trunk line in China was studied to test the method. Relevance of key elements such as welding technology, reworking, internal inspection, and geological hazards to the detection of non-destructive defects in pipelines were analyzed. The results show that correlation analysis of pipeline-related factors can provide guidance for pipeline safety and help reduce pipeline risks.

Modal and experimental analysis of floating floors

Mario Malić, Željan Lozina, Damir Sedlar and Josipa Sarac (University of Split, Croatia)

This paper investigates the appropriate modelling techniques and assumptions to determine the finite element modelling procedure for floating floors which are used on the ships. For this purpose, several features were analysed: (1) choice of finite elements (solid, shell and their combinations), (2) interfaces between the structure and the insulating material. The effect of these two items on numerical modal parameters such as natural frequencies and mode shapes are presented. To verify a numerical model, an experimental modal analysis was performed, where experimental modal parameters were determined. Finally, difference in natural frequencies between experimental and numerical parameters were reported.

Measurement of sound transmission loss of floating floors

Josipa Sarac, Damir Sedlar, Mario Malić and Željan Lozina (University of Split, Croatia)

The sound transmission loss of several materials was measured by using an impedance tube. The impedance tube system designed for the testing consisted of an upstream tube, a sample-holder section and a downstream tube. The transfer function method was used in measuring and calculating the sound transmission loss. Results are presented graphically and compared to each other. Sound reduction index was determined for each material.

Design and control based on the concept of an inverted pendulum

Damir Sedlar (University of Split, Croatia); Andrea Bosnjak (FESB, Croatia)

The availability of affordable electronic components has made the learning of experiment-based control theory accessible to a wide population. In this paper, the concept of an inverted pendulum on a self-balancing robot will be experimentally demonstrated. The self-balancing robot is mathematically modeled through equilibrium equations, and a PID controller is used to control the tilt angle. The conducted experiment and measurements show that this approach gave useful and efficient results.

Generalized finite difference method and advective problems

Željan Lozina and Damir Sedlar (University of Split, Croatia)

The generalized finite difference method is applied to the advection problem. An optimization regarding choice of RBF function has been performed. Theoretical problems in 1D and 2D have been solved and presented.

A Prediction Approach for Small Healthcare Dataset

Nuha Ahmed Salman (Babylon, Iraq); Saad Talib Hasson (University of Babylon & College of Information Technology, Iraq)

Small dataset prediction is a challenging task in machine learning, particularly in cases where the number of samples is limited or the number of features is high. The problem arises because the model may overfit the data or not capture the true underlying patterns in the data. To address this challenge, various methods have been developed, including regularization techniques, data augmentation, and transfer learning. Regularization techniques such as Lasso, Ridge, and Elastic Net can help prevent overfitting by penalizing large weights. Data augmentation techniques such as image rotations, translations, and flips can be used to increase the effective size of the training set. Transfer learning techniques, on the other hand, enable models to learn from similar datasets and transfer that knowledge to the target dataset. Predicting outcomes or making informed decisions based on small datasets can be challenging. Small datasets can result in biased or incomplete models, making it difficult to make accurate predictions.

IoT2: Special Session on Cybersecurity and IoT

FeDef: A Federated Defense Framework Using Cooperative Moving Target Defense

Chao Feng (University of Zurich, Switzerland); Jan von der Assen (University of Zurich UZH, Switzerland); Alberto Huertas Celdrán (University of Zürich UZH, Switzerland & University of Murcia, Spain); Steven Näf (University of Zurich, Switzerland); Gérôme Bovet (Armasuisse, Switzerland); Burkhard Stiller (University of Zürich, Switzerland)

With the growing concerns about cybersattacks on IoT devices, many different cybersecurity solutions have been introduced. Among them, the Moving Target Defense (MTD) paradigm aims to reduce the likelihood of a successful threat event by changing the attack surface proactively or reactively. While proactive approaches degrade the quality of service, reactive ones cannot prevent attacks. Thus, this work proposes FeDef, a federated and cooperative framework able to deploy reactively and proactively MTD techniques on resource-constrained devices affected by command and control-based malware. The performance of FeDef has been evaluated in a scenario composed of several devices infected with Bashlite. Multiple experiments have demonstrated the improvement in terms of system-wide infection time, service disruption, and resource consumption. Results show that FeDef can be implemented with limited resources and minimal impact on network and service availability.

Watching against the Unseen: AI-powered Approach to Detect Attacks on Critical Infrastructure

Domenico Lofù (Polytechnic University of Bari, Italy); Andrea Pazienza, Agostino Abbatecola, Eufemia Lella, Nicola Macchiarulo and Pietro Noviello (Exprivia SpA, Italy)

The increasing convergence of OT networks into IT communications poses critical infrastructures to new threats that may cause huge hazards. The study of protection mechanisms and the development of security systems capable of preventing such attacks is of paramount importance nowadays. Besides formally defining the model representing the intertwining of IT and OT networks of a Chemical Industry, we prove the ability to detect different types of attacks with good results experimentally by implementing an Intrusion Detection System (IDS) based on Deep Learning (DL) that achieves an accuracy of 87, 19%.

A Gateway-based MUD Architecture to Enhance Smart Home Security

Fulvio Corno and Luca Mannella (Politecnico di Torino, Italy)

Smart home systems, including consumer-grade Internet of Things (IoT) devices, are in a dangerous situation. On the one hand, the number of smart homes is increasing. On the other hand, the devices in these dwellings are often affected by vulnerabilities that could be exploited to generate massive attacks (like the famous Mirai Botnet). To mitigate the issue of having compromised devices involved in such attacks, the Internet Engineering Task Force (IETF) recently proposed a new standard: the Manufacturer Usage Description (MUD). Unfortunately, even if this standard has attracted many scholars, it is not yet very deployed in real-world scenarios.

The main contribution of this paper is to propose a slightly extended version of the MUD architecture. This architecture is centered around a smart home gateway (SHG) that can be extended through the contributions of plug-in developers. Indeed, our proposed approach allows developers to specify the network connections required by their plug-ins. These requirements will then be processed to generate a consolidated gateway-level MUD file exposed by the SHG itself. Thus, thanks to this solution and developers' intervention, even devices that are not natively "MUD-enabled" would be protected by the MUD standard if integrated through a proper plug-in. Moreover, these requirements are expressed in a transparent way for the device itself.

To demonstrate the feasibility of this approach, we realized a proof-of-concept for a widespread open-source smart home gateway: Home Assistant.

Digital Forensics Investigation Models: Current State and Analysis

Malinka Ivanova and Svetlin Stefanov (Technical University of Sofia, Bulgaria)

A digital forensics investigation (DFI) is characterized with activities related to search, identification, collection, analysis of digital evidences as all activities should be documented in a given format. Different models and methodologies are proposed to facilitate DFI, trying to describe procedures and activities performed by the investigator. Continuous technological development leads to the emergence of new sophisticated attacks, which also requires new approaches to be taken to crime scene investigation. In this paper a summary and analysis of contemporary achievements in DFI is performed to outline the current state of DFI development and to draw challenging issues and trending research topics. A conceptual model generalizing current state in DFI models is also presented.

Exploiting the DICE specification to ensure strong identity and integrity of IoT devices

Enrico Bravi, Silvia Sisinni and Antonio Lioy (Politecnico di Torino, Italy)

IoT devices are becoming widely used in several contexts, and nowadays billions of devices are deployed in different scenarios where some of them are very critical from the privacy and functionalities points of view. For these reasons, it becomes very important to guarantee some security capabilities in order to assert the correct behavior of the devices. One approach to provide these characteristics is Device Attestation which permits to verify the integrity status in order to ascertain the trustworthiness of the devices. This paper proposes a solution that permits to identify and attest devices in a dynamic context, such as Smart Cities or Smart Homes, where unknown devices can connect to the network and perform several actions. The proposed security schema is based on the Device Identity Composition Engine (DICE) proposed by the Trusted Computing Group (TCG) which permits to implement the concept of Hardware Root of Trust on IoT devices with minimal silicon requirements.

Improving the Robustness of DNNs-based Network Intrusion Detection Systems through Adversarial Training

Eufemia Lella, Nicola Macchiarulo and Andrea Pazienza (Exprivia SpA, Italy); Domenico Lofù (Polytechnic University of Bari, Italy); Agostino Abbatecola and Pietro Noviello (Exprivia SpA, Italy)

The increasing number and variety of cyber attacks in recent years have made intrusion detection systems (IDS) a critical component of computer network defense to monitor network traffic and identify malicious activities. Machine learning (ML) and deep learning (DL) techniques have been increasingly used in anomaly-based network IDS (NIDS) to detect new and unknown attacks, but they have been proven to be vulnerable to adversarial attacks, which can significantly reduce the detection system performance. In this paper we investigate the robustness of a DNNs-based NIDS, implemented for the Secure Safe Apulia Progect, against adversarial untargeted white box attacks. We employ Fast Gradient Sign Method (FGSM) and Projected Gradient Descent (PGD) as adversarial attacks to evaluate the decrease in model accuracy. The results show that adversarial training is an effective defense strategy against these types of attacks allowing the model to achieve F1 score values of 93%, 99%, 85%, 83% respectively, for the classification of benign instances, Backdooor, Ransomware and XSS malicous instances. This work aims to contribute to the challenge of handling adversary attacks in the domain of NIDS, in which research is still moving its first steps.

RFID2: IEEE-CRFID Workshop on Flexible and Printable Technologies in Electronics and Electromagnetics (WFPE)

Addressing the Effects of UHF RFID Tag Crumpling

Kevin Neumann (AirCode UG, Germany); Daniel Erni (University of Duisburg-Essen, Germany); Niels Benson (AirCode, Germany)

Modern designs for RFID tags are often built on flexible substrates to ensure a wide scope of applications. However, these designs neglect the effects of mechanical substrate deformation, and typically only consider flat surfaces. We demonstrate how bending or crumpling can affect the tag performance by e.g. shifting the resonant frequency. This is achieved by analyzing the most common and fundamental devices, namely a resonant antenna (a patch) and a transmission line (a microstrip), in a simulation environment which allows for arbitrary mechanical deformation. Successfully describing the effects of the

substrate's mechanical deformation on the tag's performance will allow this to be taken into account in the design and enable truly flexible and even crumpleable electronics.

Tensile strength, elastic modulus and thermal conductivity of 3D-Printed components using bronze/PLA filament

Marina Corral-Bobadilla, Ruben Lostado-Lorza and Saúl Iñiguez Macedo (University of La Rioja, Spain); Fátima Somovilla-Gómez (Universidad de La Rioja, Spain); Celia Sabando-Fraile (University of La Rioja, Spain)

This paper demostrates how bronze-polylactic acid (PLA) filament material can be utilized as a starting material to create complicated metal structures utilizing cost-effective fused deposition modeling (FDM) technology. Tensile strength, elastic modulus and thermal conductivity were determined for two printing parameter configurations and for two debinding and sintering heating curves. The debinding and sintering process was carried out in a muffle furnace in order to obtain components with interesting mechanical and thermal properties. Infill print and wall print speed of 30 mm/s and 15 mm/s when rectilinear pattern is considered are recommended when the debinding and sintering temperatures are also 184ºC and 858ºC respectively. The tensile strength values obtained for the three specimens tested (108.34 MPa, 98.75 MPa and 106.84 MPa) when the printing parameters and temperatures mentioned above were considered. Considerable values for elastic modulus were also obtained for these specimens (15.37 GPa, 14.92 GPa and 15.12 GPa) while the values obtained for the thermal conductivity were respectively 84.32 W/m.K, 83.53 W/m.K and 80.21 W/m.K. The findings of this research are crucial for the practical use of bronze filament in engineering since the measured tensile strength, elastic modulus and thermal conductivities show modest values when they are compared with cast bronze specimens.

Upper Bound Performances of Laser-Induced Graphene Dipoles in the UHF Band

Alessio Mostaccio, Gaetano Marrocco and Gianni Antonelli (University of Rome Tor Vergata, Italy); Eugenio Martinelli (Tor Vergata University of Rome, Italy); Andrea Salvia (University of Roma Tor Vergata, Italy)

Laser ablation can easily create graphene traces through the photothermal conversion of polymeric films. The so-obtained graphene, known as Laser-Induced Graphene (LIG), is eco-friendly, biocompatible and easy to produce, making it a promising option for creating flexible and conformable electronics for environmentally friendly and cost-effective communication over short to medium distances.

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Since LIG conductivity is significantly lower than that of standard conductors, the radiation efficiency of a LIG-antenna does not increase in a

The results showed that the lasing parameters that affect the properties of LIG only have an impact on the maximum radiation efficiency, and part
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Wideband 3D-Printed Cylindrical DRAs Exploiting Customizable Permittivity Variation in Radial Direction

Francesco P. Chietera (University of Salento, Italy); Riccardo Colella (University of Salento, Italy & National Research Council (CNR), Italy); Luca Catarinucci (University of Salento, Italy)

One of the main constraints in designing RF devices that leverage on the use of multiple materials with different permittivity is related to the physical properties of the materials available for the realization. Often, the optimal design is sacrificed in the name of feasibility. In this work, a new method for tailoring the effective permittivity of a substrate for realizing DRA is presented. The method is tested with the designing and realization of an ultra-wideband Cylindrical DRA (CDRA) which exploits the well-known technique of applying stacked layers of materials with different permittivity to achieve a bandwidth improvement. Specifically, a CDRA, fed with a coaxial probe and operating between 3.1 GHz and 6.1 GHz, has been designed, realized, and tested exhibiting very good agreement with the simulations. If compared with the traditional one, the new design is more feasible, cost-effective, and customizable to tailor virtually any value of electrical permittivity smaller than that of the bulk material.

Textile-Based Game Controller Platform Through Combination of Bluetooth and Passive UHF RFID

Asif Shaikh (Tampere University, Finland); Sari Merilampi and Mirka Leino (Satakunta University of Applied Sciences, Finland); Shiva Jabari, Oguz Buruk, Juho Hamari and Johanna Virkki (Tampere University, Finland)

This study demonstrates an early prototype of a textile-based game controller platform combining Bluetooth and passive ultra-high frequency (UHF) radiofrequency identification (RFID) technologies. The developed system converts RFID input into Bluetooth signals, which can then be used as inputs for any applications. The system employs two serial communication channels: one with the computer and microcontroller and the other with the microcontroller and Bluetooth. When a user taps the textile RFID platform, data is sent from the software to the microcontroller, then from the microcontroller to a mobile phone with a game app prototype. As a preliminary test, the system is successfully controlled using three types of platform antenna designs. In addition to game controlling, these battery-free platforms can be integrated into clothing and furniture for controlling, e.g., smart home applications.

Lens Antenna Design Tool Based on Generalized Supershaped Formula: Preliminary Results

Alberto Facchini (Université Jean Monnet Saint-Etienne, France); Francesco P. Chietera (University of Salento, Italy); Riccardo Colella (University of Salento, Italy & National Research Council (CNR), Italy); Luca Catarinucci (University of Salento, Italy); Pietro Bia (Elettronica Group, Italy); Luciano Mescia (Polytechnic University of Bari, Italy)

In this work, a numerical tool for analysis and synthesis of a novel class of 3D dielectric lens antennas is presented. The lens antenna shape is modelled using a generalized superformula allowing additional degree of freedom. Thanks to the free parameters characterizing this formula, the lens geometry can be adjusted in a simple and analytical way. The numerical tool is based on the geometrical optics and tube tracing approximations as well as the physical optic approach. In this way, the multiple wave reflections within the lens region as well as the far field outside the lens can be calculated. Moreover, an efficient synthesis procedure based on swarm intelligence has been developed and integrated in the numerical code. Thanks to this design tool it is possible to identify the lens parameters yielding the optimal antenna characteristic and a desired radiation patterns with low computational burden.

SC2: Smart City II

Multi-objective Decision Support Tool for Sustainable Livestock Farming

Kamrul Islam Shahin (University of Southern Denmark, Denmark); Sanja Lazarova-Molnar (Karlsruhe Institute of Technology, Germany & University of Southern Denmark, Denmark); Parisa Niloofar (University of Southern Denmark, Denmark)

Livestock farming plays a key role in the global food system, the economy, and the livelihood of millions of people. One of the undesirable facts in livestock production is the still insufficient consideration of the related environmental sustainability. Globally, livestock production accounts for about 14.5% of total greenhouse gas (GHG) emissions. These emissions are significantly changing our atmosphere and their impact is increasing. The main causes of these emissions are inefficient land resource management, synthetic fertilizer application, enteric fermentation, manure-related, and animal breed. It is, therefore, important to apply appropriate farm planning and management strategies to reduce the emissions. To support the global effort, we developed an application that we introduce in this paper, FarmMOODSS, to estimate net emissions by calculating GHG emissions at the farm level. FarmMOODSS recommends an optimized feeding program for emission mitigation. A multi-objective optimization algorithm is applied for feed optimization, including an IoT data mining function. The tool is developed based on a dairy farm use case.

Smart sustainable daily life: Insights from across the social sciences

Emilie L Vrain and Charlie Wilson (University of Oxford, United Kingdom (Great Britain))

It is essential that a human-centred smart digital society is a sustainable society. As research is often conducted in disciplinary silos, there is a need for more holistic approaches. This paper is a step towards such advancements, reviewing multiple social science fields (such as digital anthropology, social practice theory and innovation adoption models) which study how ICTs have shaped daily life and why digitalisation has become so integral. Outlining such perspectives, we illustrate the different methods for understanding social aspects of digital daily life and how they can be applied to studying smart sustainable daily life. For example, through ethnography, time diaries and in-depth interviews. We highlight the importance of collecting detailed insights on digital use overtime; the sequences and patterns of activities in daily life; and rich contextual variables to account for the impact of broader social dynamics on human and computer interactions. Our review hopes to inform future integrated research seeking to couple work on the integration of smart technologies and energy systems into society with more foundational social science approaches.

Sustainability driven MaaS for rural areas

Ophelia Prillard (SINTEF Digital, Norway); Amela Karahasanovic (SINTEF, Norway); Alma Leora Culén (University of Oslo, Norway)

Good transport services are crucial for sustainable development in rural areas. This paper presents a sustainability driven Mobility-as-a-Service (MaaS) solution specifically designed for rural contexts. Our research focuses on identifying the transport planning needs of sparsely populated rural areas. We have developed and evaluated a transport planning tool that incorporates optimization technology while considering environmental factors. The tool offers new ways of interacting with the environmental optimization process, and our results suggest that it is beneficial for both policymakers and transport operators. The requirements and validation results we have identified could inform the design of MaaS planning tools for rural areas, especially in sparsely populated regions with limited transport resources and considerable distances to cover.

Development of Digital Competence Framework for Open Science

Neven Pintarić (University of Zadar, Croatia); Zeljka Tomasovic (University of Pula, Croatia)

Open Science enables access to research by ensuring cooperation, transparency, availability of scientific research results and the use of open research data. In order to realize the full potential, it is necessary to improve the existing digital competences of the future stakeholders of Open Science. Two research objectives were set for this paper. The first goal was related to identifying and defining domains and digital competences for the framework. The framework consists of a domain of generic digital competences and a domain of professional competences. Nine of the generic digital competences were taken into account, while the domain of professional competences is under development and only certain digital competences are indicated. The second objective is related to the evaluation of the domain of generic digital competences and the application of this domain in determining the levels of digital competences. The research was conducted on a convenience sample of the student population in Croatia. Further guidelines for the development of the framework and digital competences are presented.

ML-based Minimization of AoI in a Vehicular Communication Network

Suresh Chavhan (Indian Institute of Information Technology Raichur, India); Joel J. P. C. Rodrigues (Senac Fac of Ceará, Brazil & Instituto de Telecomunicações, Portugal); Prarthana Prabhakaran and Manish Kumar (Vellore Institute of Technology, India)

The self-driving cars have increased the need for better intelligent transportation systems. To facilitate the usage of these automated vehicles, very efficient real-time data monitoring in the network is required in the Intelligent Transportation System (ITS). In various applications of ITS, it is critical to maintaining the freshness of the information. Similarly, sensory devices on vehicles produce a huge amount of information in a short time, and half of the data received is redundant. Storing all the received information is a waste of time and resources. In this paper, we propose a system for better transfer of data between vehicles and the Road Side Unit (RSU) through Vehicle to Infrastructure (V2I) communication by Efficiently Minimizing the Age of Information. We propose a method to Efficiently Minimize the Age of Information by considering two factors, the delay, and throughput of a data packet to calculate the weighted sum of the AoI. We further use the Alpha-Beta pruning algorithm, an ML-based optimization algorithm to find an optimal solution. The proposed system is verified by simulating the proposed system in the OMNET++ network simulator and the reliability of its efficiency is concluded by comparing the computation time with another algorithm.

E3: Energy efficiency and energy modelling

Thermal optimization of 3D-printed block - Hot Box and heat flow meter experimental analysis

Tullio de Rubeis (University of L'Aquila, Italy); Annamaria Ciccozzi and Giovanni Pasqualoni (University of LAquila Italy, Italy); Domenica Paoletti and Dario Ambrosini (University of L'Aquila, Italy)

In Europe, the buildings sector is one of the major contributors to energy consumption, preceded, narrowly, by the transport sector and, among the various industrial sectors, it has experienced the least progress in construction techniques, which are still strongly based on manual work. For this reason, it is considered a low-tech sector. Therefore, searching for new construction techniques that can speed up processes, reduce waste material and ensure customization of built elements is crucial. Additive manufacturing represents a promising and increasingly developing approach worldwide, although less attention is paid to studying the thermal performance of 3D-printed building components. In this paper, the thermal performance of a 3D-printed block is studied. The block is made up of recyclable plastic material, i.e., polylactic acid (PLA), characterized by an internal honeycomb structure. The performance was

analyzed experimentally using a specially made Hot Box together with heat flow meter sensors and infrared thermography, assuming different orientations of the air cavities. The experimental campaigns were carried out by imposing steady-state, repeatable, and controlled conditions. The results obtained showed that the different orientation of the air cavities determines effects on heat transfer phenomena, with reductions of up to 7% in terms of thermal transmittance.

Numerical Analysis of the Natural Ventilation in a Greenhouse Under Saharan Climate Conditions

Salah Bezari (Applied Research Unit in Renewable Energies, Algeria); Mohamed Lebbi (Renewable Energies Applied Research Unit & University of Laghouat, Algeria); Ahmed Benchatti (University of Laghouat, Algeria); Azeddine Boutelhig (Applied Research Unit in Renewable Energies, Algeria)

This study aims to numerically model the natural laminar ventilation of the microclimate of a solar greenhouse. The distribution of air temperature and air velocity inside the solar greenhouse was studied numerically using ANSYS FLUENT software. The influence of the temperature difference on the air velocity filed and the temperature filed inside the greenhouse, skin friction coefficient were studied. The results indicate that heating the soil of the solar greenhouse affects the heat flux and its coefficient by increasing the temperature difference. The results also showed that natural ventilation is able to passively control the climate in the solar greenhouse

Modeling of Induction Fluid Heater via Transformer Equivalent Circuit

Alper Kelesoglu (Yalova University, Turkey); Halil Unver (Kirikkale University, Turkey); Umit Unver (Yalova University, Turkey)

In air conditioning systems where electrical energy is used as input, resistance and infrared heating systems are effectively used today. Due to its advantages, induction heating systems are a technology in the development stage as an alternative to these two technologies. In this study, the electromagnetic performance of an induction gas heater operating at grid frequency is investigated experimentally and theoretically. A mathematical method is developed to determine the conversion efficiency of electrical power to heat on the conductive material. The results obtained are compared with experimental findings.

Decarbonization trajectory in Cement Industry

Juhi Kamra and Ambica Prakash Mani (Graphic Era Deemed to be University, India); V M Tripathi (Graphic Era Hill University, India)

Combatting with climate change has surfaced as an inevitable war for the existence of the world and sustainability because of its various impacts on the environment, health and existence of various species. Climate change has become a global concern in today's scenario as it is a threat to sustainability because of which many international conventions such as United Nations Convention on Climate Change is taking place to curb its impact. The emission of various greenhouse gases is responsible for climate change and the most prominent gas amongst these is carbon dioxide. So, the world is coherently trying to curb the carbon emission which is prominently known as decarbonization. Industrial sector is the second largest contributing sector to carbon emission after power and cement industry amongst all the industries is a major Greenhouse gas emitting industry contributing 7% of total GHG emissions. So, this research paper tries to find out the various decarbonizing measures and potentials in cement industry to lead towards a sustainable future.

Day-ahead and intra-day forecasting of electric vehicle charging station energy consumption

Daria Matković (University of Zagreb, Croatia); Tomislav Capuder (Zagreb, Croatia); Ivan Sudic (University of Zagreb, Croatia)

This paper evaluates the performance of three forecasting algorithms, specifically Autoregressive Integrated Moving Average (ARIMA), Seasonal ARIMA (SARIMA), and Exponential Smoothing (ES), in forecasting energy consumption at the electric vehicle (EV) charging stations using real-world data. These complex models are compared with two naive models, which serve as benchmarks for evaluating whether the additional complexity in sophisticated models improves forecasting accuracy. To ensure generalization performance, forecasting algorithms are evaluated using four distinct engagement and location-based datasets. The first dataset consists of 256 charging stations located in Croatia, the second dataset includes 20 charging stations located in Zagreb, the third dataset includes 6 charging stations in Split and the last dataset consists of data recorded on the most visited charging station 'Zagreb-Autobusni'. Finally, all algorithms are compared utilizing three error metrics, including Mean Squared Error (MSE), Mean Absolute Error (MAE), and Root Mean Squared Error (RMSE). Additionally, the naive model's performance is compared with more complex forecasting algorithms to verify its appropriateness for use as a benchmark model in future research.

Local Energy and Flexibility Markets: State of the art and technological gap analysis

Stylianos Zikos (Centre for Research and Technology Hellas, Greece); Christos Malavazos and Ismini Dimitriadou (Hypertech S.A., Greece); Christos Timplalexis (Centre for Research and Technology Hellas, Greece); Gregorio Fernández (Fundacion CIRCE, Spain); Dimosthenis Ioannidis and Dimitrios Tzovaras (Centre for Research and Technology Hellas, Greece)

Local Energy Markets (LEMs) and Local Flexibility Markets (LFMs) are going to have a key role in modern electrical grids as past problems or restrictions have been overcome and Distributed Energy Resources (DERs) can be managed more efficiently allowing the implementation of novel services to DSOs and other actors. This study provides a review of cutting-edge technologies and solutions for enabling the implementation of Local Energy Markets and Local Flexibility Markets. The State of the Art literature review that is presented, is focused on Local Flexibility Markets architecture, peer-to-peer (P2P) technologies for energy trading, and algorithmic approaches for flexibility estimation and optimization. Furthermore, a technological gap analysis was conducted in order to identify possible gaps in the implementation of P2P energy trading and LFM platforms. To this end, the state of various ongoing and recent projects and solutions was analysed in respect of six different indicators. The results revealed a serious technological gap for almost all the specified indicators.

EM3: Engineering modelling in energy systems

Upscaling along-the-channel model to full-scale flow field for improved performance of PEM fuel cells

Klara Bonković and Željko Penga (University of Split, Croatia); Gojmir Radica (University of Split, FESB, Croatia)

Proton exchange membrane (PEM) fuel cells are considered to be the primary power source for future heavy duty automotive applications due to their favourable characteristics when compared to batteries. In this study, the influence of different channel and land ratio is investigated using Computational Fluid Dynamics (CFD) modelling for along-the-channel model, which is later upscaled to full-scale flow field size. Initially, fully humidified reactants are introduced into the channel, and polarization curves are recorded, with focus on high current density operation, where substantial amounts of liquid water are generated. Different land and channel ratio result in significantly different amounts of water removal from the diffusion layers to the channels. Additionally, the channel and land ratio also results in significantly different heat and mass transfer inside the cell which must be taken into consideration to determine the best

configuration for upscaling. The results outline the best configuration which is then upscaled to conventional flow field size with single serpentine, where the initial and optimized cases are mutually compared. The results outline the difference in the two approaches and outline the pros and cons of upscaling along-the-channel model on full-scale flow field size and indicate the possibility of using optimization for such approach to result in higher performance in a shorter amount of time.

Computational Fluid Dynamics study of the influence of number of channels on the performance of full-scale PEM fuel cell

Toni Škorlić (M. Getaldića 13, Croatia); Željko Penga (University of Split, Croatia); Gojmir Radica (University of Split, FESB, Croatia)

Proton exchange membrane fuel cells are gaining momentum in the automotive sector due to their favourable characteristics such as quick refuelling times, silent operation, high efficiency and clean energy production with only byproducts being heat and water. In this study, numerical models are developed using state-of-the-art Computational Fluid Dynamics modelling software for full-scale single PEM fuel cells with different flow fields. Commonly, for small scale fuel cells, such as 25 cm2, single serpentine is used for operation. The objective of this work was to see if the performance can be enhanced by increasing the number of channels, while it was also important to keep the dimensions of the channels feasible for manufacturing using CNC milling and the available drill bit sizes. The number of channels was increased from one to three and the relative humidity of the reactants was set to partially and fully humidified. The results of the simulations indicate considerable difference in the performance of the cells on elevated current densities, especially for the cases with lower relative humidity. The results of this study outline the requirement for development of standardized flow field for testing of small active area single cells in the future.

Numerical analysis of coolant flow field for maintaining the desired temperature profile along the PEM fuel cell

Tino Vidović (University of Split, FESB, Croatia); Željko Penga (University of Split, Croatia); Jure Penga and Gojmir Radica (University of Split, FESB, Croatia); Ivan Tolj (University of Split, Faculty of Elect. Eng., Mech. Eng. and Naval Arch., Croatia); Jakov Šimunović (Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, Croatia)

When it comes to replacing fossil fuels in the near future, proton exchange membrane (PEM) fuel cells are a viable option for reducing greenhouse gas emissions. Nevertheless, the high cost and complexity of PEM fuel cells are currently a significant barrier to commercialization. Most issues associated with PEM fuel cells operation could be avoided if high membrane hydration is achieved without the necessity for external humidification while preventing excessive water accumulation within the cell. One of the effective methods to achieve such an operation is a variable temperature flow field, based on maintaining non-uniform temperature along the flow field of the cell, thus manipulating the evaporation pressure along the flow field. In this study, the Computational Fluid Dynamics model is developed for a full-scale single cell of 50 cm2 with coolant channels. The objective of the study is to develop the flow field for coolant channels which will result in a uniform temperature gradient along the entire active area of the cell, thus enabling the application of the variable temperature flow field even when serpentine reactant channels are used. The results of this study indicate that it is possible to prescribe and maintain variable temperature flow fields for serpentine reactant flow fields, and the developed coolant flow field will be used as a basis to develop a new experimental setup and later to develop a small PEM fuel cell stack with higher performance when compared to standard isothermal operation.

Methods and equipment for analysis and diagnostics of marine engines

Petar Vrvilo (PFST, Croatia); Tino Vidović (University of Split, FESB, Croatia); Nikola Matulic (University of Split FESB, Croatia); Liane Roldo (PFST, Croatia); Gojmir Radica (University of Split, FESB, Croatia)

Monitoring the operation of the ship's systems, especially the main engine, has always been carried out by the ship's crew, whose reports were often not considered in a timely manner, resulting in engine and equipment failures. Technological development has enabled much more complex and faster monitoring of engine operation, especially with electronically controlled engines. Complex and fast monitoring using new technologies enables the recording of a large number of parameters in real time and their distribution to competent experts who do not necessarily have to stay on board but can be informed and active from the office on land. Analysis of parameters in real time enables an immediate reaction to anomalies, and timely intervention in order to prevent failure, i.e. increase the percentage of airworthiness of the ship during its working life. The paper explains the key components of a modern surveillance system and describes the process of analyzing remotely collected data.

Numerical Modelling of Radiative Heat Transfer in Heavy-Duty Engines for Improved Emission Predictions

Tomislav Mučalo, Filip Jurić and Milan Vujanović (University of Zagreb, Croatia)

Computer Fluid Dynamics (CFD) coupling with experimental research is widely utilised in improving internal combustion engines in terms of pollutant formation and energy efficiency. Recent studies showed that including radiative heat transfer in participating media for more accurate internal combustion emission predictions is necessary. Especially in heavy-duty engines due to their more significant dimensions than automotive engines. In this work, the discrete ordinates method (DOM) is employed with the finite volume method in AVL FIRETM CFD software. The absorptivity and emissivity are described with Weighted Sum of Gray Gases Method (WSGGM), which calculates the overall absorption coefficient using carbon dioxide, water vapour and soot absorption coefficient. This paper aims to evaluate the impact of radiative heat transfer on the thermal state of the media and the formation prediction of pollutants. The radiative heat transfer model is validated against mean pressure results inside an engine cylinder. Finally, pollutant formation curves are compared and analysed.

IoT3: Session on IoT technologies and use cases

An IoT-based Smart Agriculture Management System: Case Study in the Southern region of Senegal

Alioune Cisse, Ousmane Diallo and EL Malick Hadji Ndoye (University of Assane Seck of Ziguinchor, Senegal); Joel J. P. C. Rodrigues (Senac Fac of Ceará, Brazil & Instituto de Telecomunicações, Portugal); Mamadou Sy (University of Assane Seck of Ziguinchor, Senegal)

Agriculture has evolved in perfect correlation with modern technologies. Hence, the practices continue to evolve to be in step with the growing food needs. In addition, many factors push to reflect on the improvement of agriculture including climate change, soil decline (due to poor crop rotation), and the retention of natural resources. It is therefore in this context that many countries like Senegal, where agriculture remains traditional, particularly in its southern region, are directing their agricultural system towards intelligence to deal with the challenges of food self-sufficiency to accompany emergence. This paper proposes a real smart agriculture system prototype based on the Internet of Things (IoT) technologies, named MbaïMi. It allows farmers to have real-time advice so that

they can secure their decisions. the system can offer farmers a classification of the most suitable crops for a given field to allow the farmers to choose the seeds adapted to the soil for a better yield. Moreover, the application gives farmers who practice irrigated agriculture the possibility to rationally control the management of their water resources by irrigating at the right time when the soil and the crops demand it. The implementation and case studies for validation show that the application facilitates the daily hard work of the farmers in southern Senegal and helps to improve their yield, which is an innovation in the sector of agriculture in Senegal.

A Microservice-based Software Architecture to Enhance Collaboration among heterogenous stakeholders operating in the Research Domain

Giuseppe Del Fiore, Teodoro Montanaro and Ilaria Sergi (University of Salento, Italy); Nico Cardone (InfoTech Consults di Cardone Nico, Italy); Luca Matino (InfoTechConsults, Italy); Luigi Patrono (University of Salento, Italy)

Research centers or universities daily produce interesting research products thanks to their ecosystem of laboratories and small spin-offs, but this ecosystem frequently has purely academic vision and does not easily meet the demand of the productive world. At the same time, the productive world is more aware of the market needs and, although it always looks for new solutions to be designed in collaboration with the academic world, it lacks the necessary contacts and connections. This paper presents a microservice-based software architecture designed to facilitate connections between researchers and any stakeholder interested in research outcomes while also accelerating the digital transition towards a more sustainable and smart world. Within the paper, the proposed system architecture is described and functionally validated as a first step in the development of such a similar solution and to provide a useful hint for future works to researchers and experts interested in its application.

The combined use of IoT and Blockchain in Logistics: a comparative experiment

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In the last decades, thanks to their ubiquitousness, IoT devices have become part of our lives by introducing innovative services that simplify common activities and, therefore, enhance people daily activities and duties. In addition, their usefulness has been further amplified by the combination of the IoT services with various technologies and innovations. For instance, the Distributed Ledger Technologies (DLTs) and the blockchains are supporting the IoT domain with their useful services and properties, e.g., trust and automation, since some years. However, the increasing interest in such a combination and the race towards the most significant innovation in the sector is shifting the focus away from some of the most important issues and questions. One of them regards the usefulness of the adopted technologies and their effectiveness with respect to similar alternative solutions. For example, the most frequently used approach to save data in a DLT foresees the simultaneous use of an off-chain database to store the actual data, and the use of the DLT itself to guarantee some properties, e.g. to verify the provenance of such data. Such a common practice is adopted by almost every work on the domain but the real benefits brought by this approach are not usually measured. For this reason, the present paper is focused on a evaluation of two approaches: one based on the combination of DLT and off-chain databases, and the other one based only on the usage of the DLT. A realistic logistics use case has been introduced to compare the performances of each approach. The results demonstrated that the version with only DLT performs better than the version with an additional database for guaranteeing the same properties, e.g. immutability of the data extracted from the database.

A context-aware multiple Blockchain architecture for managing low memory device

Marco Fiore, Marina Mongiello and Giuseppe Acciani (Politecnico di Bari, Italy)

Blockchain technology constitutes a paradigm shift in the way we conceive distributed architectures. A Blockchain system lets us build platforms where data are immutable and tamper-proof, with some constraints on the throughput and the amount of memory required to store the ledger. This paper aims to solve the issue of memory and performance requirements developing a multiple Blockchain architecture that mixes the benefits deriving from a public and a private Blockchain. This kind of approach enables small sensors - with memory and performance constraints - to join the network without worrying about the amount of data to store. The development is proposed following a context-aware approach, to make the architecture scalable and easy to use in different scenarios.

Leveraging Internet of Things and Distributed Ledger Technology for Cold Chain Management in Freight Transportation

Valeria Vergine, Ilaria Sergi, Teodoro Montanaro and Angela-Tafadzwa Shumba (University of Salento, Italy); Fabrizio Benvenuto (Commedia srl); Luigi Patrono (University of Salento, Italy)

The management of the cold chain in transportation is a crucial issue as it affects the quality and safety of perishable goods such as food, pharmaceuticals, and medical supplies. To ensure proper temperature control and monitoring during transportation, the certification of data is essential. Traditional methods for data management, like paper-based records and manual processes, can be unreliable and cause errors, leading to potential food waste. The integration of Internet of Things and Distributed Ledger Technology (DLT) presents a promising solution for the challenges in cold chain management and can help to improve the overall efficiency of the process. Internet of Things devices can gather and transmit sensor data in real-time, while DLT can ensure the authenticity and immutability of the data. The combination of these technologies can offer a transparent and reliable solution for cold chain management, improving the safety and quality of perishable goods during transportation. Additionally, DLT eliminates the need for intermediaries, enabling direct exchange of data between stakeholders, leading to greater efficiency and accountability. In this paper, we propose a system architecture focused on the cold chain management in transportation that integrates Internet of Things and DLT. In such a system, the Internet of Things component provides real-time data collection whereas the DLT component ensures a secure data management.

Evaluation of passive OS fingerprinting methods using TCP/IP fields

Matej Hulák (Czech Technical University in Prague, Czech Republic); Václav Bartoš (CESNET, Czech Republic); Tomas Cejka (CESNET & CTU in Prague, FIT, Czech Republic)

An important part of network management is to keep knowledge about the connected devices. One of the tools that can provide such information in real-time is passive OS fingerprinting, in particular the method based on analyzing values of specific TCP/IP headers. The state-of-the-art approach is to use machine learning to create such OS classifier. In this paper, we focus on the evaluation of this approach from several perspectives. We took two existing public datasets and created a new one from our network and trained machine learning models to classify the 4 most common operation system families based on selected TCP/IP fields. We compare different models, discuss the need to round TTL values to avoid over-fitting, and test the transferability of models trained on data from different networks. Although TCP/IP-related characteristics of individual operating systems should be independent on where the device is located, our experiments show that a model trained in one network performs much worse in another one, making OS model creation more difficult in practice.

RFID3: Wearable, conformal and flexible antennas for RFID/IoT

A Dual-Band Textile Eighth Mode SIW Antenna for Wearable Applications

Giovanni Andrea Casula (Università di Cagliari, Italy); Giorgio Montisci and Giacomo Muntoni (University of Cagliari, Italy)

This work presents a compact dual band textile wearable antenna in substrate integrated waveguide (SIW) technology. The antenna is based on a SIW square cavity, and its small size has been achieved exploiting the magnetic field symmetry of the cavity, which allows to reduce its size to 1/8 of the full cavity with the so called "Eighth-mode SIW configuration". The presented dual band antenna is designed for Long Range (LoRa) applications, and its working frequency covers the European (863-870 MHz) and the North American (902-928 MHz) LoRa bands. The proposed wearable SIW antenna is compact, low-cost and relatively easy to fabricate. Moreover, its robustness and isolation with respect to the human body coupling are very good. The antenna design has been performed using CST Studio Suite, and the agreement between numerical and experimental result is satisfactory.

Comparison of Screen- and Inkjet-Printed Meshed Wideband Antennas for Conformal IoT Applications

Nicolas Claus (Ghent University & Imec, Belgium); Jo Verhaevert (Ghent University - imec, Belgium); Hendrik Rogier (Ghent University, Belgium)

An experimental comparison is presented between screen- and inkjet-printed realizations of a meshed coplanar waveguide (CPW)-fed planar monopole antenna that was proposed in an earlier publication. Several prototypes were manufactured on 125 µm-thick polyethylene terephthalate (PET) foil using silver nanoparticle (AgNP) ink. Additionally, the antenna's flexibility was studied by conducting measurements under cylindrical deformation, with various bending radii imposed under different orientations. It is shown that the geometrical accuracy of the printed mesh pattern and the surface roughness of the deposited ink layer depend on both the ink properties and the printing process, affecting the mesh strategy's effective ink reduction and the antenna's electrical performance. By optimizing the drop-to-drop distance parameters in the inkjet-printed process, ink reduction levels over 90% are achieved. Furthermore, measurements show that all antennas, either manufactured using screen or inkjet printing, exhibit excellent wideband operation, covering the IMT/LTE-1/n1 (1.92-2.17 GHz), LTE-40/n40 (2.30-2.40 GHz), 2.45 GHz industrial, scientific, and medical (ISM) (2.40-2.4835 GHz), IMT-E/LTE-7/n7 (2.50-2.69 GHz), and n78 5G (3.30-3.80 GHz) frequency bands. This performance is preserved both in flat deployment and under cylindrical deformation, demonstrating the antenna's great potential for cost-sensitive conformal Internet of Things (IoT) applications.

Punch-Needled Passive UHF RFID Tag Dipole Antennas - Design, Fabrication, and Initial Wireless Evaluation

Tiina Vuohijoki and Asif Shaikh (Tampere University, Finland); Sari Merilampi (Satakunta University of Applied Sciences, Finland); Tiina Ihalainen and Johanna Virkki (Tampere University, Finland)

This study presents design and fabrication as well as evaluates the initial performance of punch-needled passive UHF (Ultra high frequency) RFID (Radiofrequency identification) tag antennas. There are two different kinds of punch-needling techniques used: 1) by using conductive thread on the backside of the tag antenna and 2) by using conductive thread on both sides of the tag antenna. Both types of tag antennas were made with 100 % wool yarn onto Aida cloth and for conductive parts. The wireless performance of the tags was evaluated at the European frequency, where they achieved a maximum read range of over 1.2 meters. According to these preliminary results, it is potential to implement this construction method, which is especially interesting for home crafters, who are interested in making textile-integrated electronics of on their own. In further research, we inspect how to increase the read range of these punch-needled tags and explore other innovative home crafting manners to create passive UHF RFID tags from different types of materials.

A Textile-Based Wireless Power Transfer System Made of Slot Yagi-Uda Antennas for Wearable and Sensor Applications

Dieff Vital (The University of Illinois Chicago, USA)

This paper proposes a low-profile and sustainable novel misalignment-resilient wireless power transfer, harvesting, and sensing system (WPT-HSS) to operate at 433 MHz. The resonators used in the WPT-HSS were slot Yagi-Udas that exhibited an average wireless power transfer efficiency of 80% when the transmitting and receiving slot Yagi-Udas were misaligned considering three degrees of freedom with misalignment distances of up to 24 cm between their exciters. The low-profile characteristic, high efficiency, and resilience to misalignment make the proposed WPT-HSS appealing to IoT/IoMT applications. To the author, this is the first time a misalignment-resilient wireless power transfer system using slot Yagi-Udas has been proposed. This design can be a stepping stone for future sustainable IoT/IoMT designs.

Minimally invasive battery-less microcontroller enabled implantable NFC tag for healthcare sensing applications

Paul Taylor and John Batchelor (University of Kent, United Kingdom (Great Britain))

This paper presents a minimally invasive battery-less microcontroller enabled implant that utilizes near-field communication technology to both power and transfer data to and from the implanted device. The implant has been designed around a cylindrical glass vial for its housing, of the type found in pet and livestock identification. Requiring just an injector assembly for implantation it can be deemed as minimally invasive. The prototype tag incorporates a near-field communication front end, providing data transfer and power to a microcontroller and a light emitting diode array, with a maximum measured read range of about 5 mm off the skin surface. Although light technology can be used for neural stimulation here it is used as a proof of concept before enabling further sensing modalities. The tag is proposed for use as a wireless platform for patient health monitoring in both clinical and home environments using a smartphone as the reader. It could also have applications in general wellbeing monitoring or sports.

Conformal Millimeter-Wave Corrugated Substrate Integrated Waveguide Slot Array Antenna

Aakash Bansal, Chinthana J Panagamuwa and William Whittow (Loughborough University, United Kingdom (Great Britain))

The paper presents the effects on the performance of a leaky-wave antenna when curved cylindrically. A slot array antenna based leaky-wave architecture based on a corrugated substrate integrated waveguide (CSIW) guiding structure has been used for the study. The antenna is simulated on a thin substrate of height h = 0.254 mm for conformality and is shown to operate at 24 - 27 GHz for applications in millimeter-wave 5G and beyond. The change in antenna gain, beam angle and half-power beamwidth with the change in fold curvature has been highlighted.

SML1: Symposium Statistics and ML in Electronics I

Hand Gesture Recognition System with Finite State Machine for Remote Desktop Control

Robert Noparlik and Rafal Zdunek (Wroclaw University of Science and Technology, Poland)

Humans may interact with computers in many ways. One of them can be the communication through recognition and right interpretation of hand gestures. This study addresses the problem of remote desktop control through visual-based human-computer interaction that is based on hand gesture recognition. We designed and implemented the hand gesture recognition system that combines various machine learning-based technologies, including the MediaPipe Hands model for detection of keypoints on hands, and artificial neural network for classification of single static gestures. To recognize dynamic or group gestures that are assigned to command actions, we propose to use the system composed of finite state machines. The experiments demonstrated that our system can correctly recognizes a few group gestures for performing the following operations on the computer desktop: cursor movement, clicking, window dragging, full screen switch on/off, zooming in and out, window close, and active window switching.

Optimization of Bowl Feeders Structure for Arbitrary Parts with Machine Learning

Marin B. Marinov (Technical University of Sofia, Bulgaria)

Modern industrial production is heavily dependent on efficient workflow processes and automation. The steady flow of raw materials as well as the separation of vital parts and semi-finished products are at the core of these automated procedures. Commonly used systems for this work are bowl feeders, which separate the parts and material by a combination of mechanical vibration and friction. The production of these tools, especially the design of the ramping spiral, is delicate and time-consuming work, as the shape, slope, and material must be carefully adjusted for the corresponding parts. In this work, we propose an automated approach, making use of optimization procedures from artificial intelligence, to design the spiral ramps of the bowl feeders. Therefore, the whole system and considered parts are physically simulated and the optimized geometry is subsequently exported into a CAD system for the actual building, respectively printing. The employment of evolutionary optimization gives the need to develop a mathematical model for the whole setup and find an efficient representation of integral features.

Methods for Analysis of Manufacturing Process in Electronics

Malinka Ivanova, Nikolay Petkov and Roumiana Ilieva (Technical University of Sofia, Bulgaria)

During manufacturing processes in electronics a big amount of data is collected in order to be processed and analyzed. The obtained knowledge is used for improving the (sub) processes, avoiding failures in time and achieving products with high quality. Different data-driven technologies are implemented in smart production to facilitate decision making. The aim of the paper is to summarize and analyze the currently utilized methods for improving manufacturing processes in electronics through bibliometric analysis and detailed exploration of currently published scientific papers. A conceptual model is created as a result from the investigation, which reveals emergence of enhanced statistical methods and implementation of machine learning techniques. The increasing role of predictive analytics is proven not only through the performed summary, but also through creation of a predictive model in manufacturing based on surface mounting technology.

Literature review of key performance indicators for Supplier Quality Management in Automotive Electronics Industry

Petya Tihomirova Petkova (Technical University of Sofia, Bulgaria); Milena Petkova (University of Library Studies and Information Technologies Sofia, Bulgaria); Boyan Jekov and Eugenia Kovatcheva (ULSIT, Bulgaria)

Quality management in the electronic field is critical to ensuring that electronic products are manufactured to meet the needs and expectations of customers. It involves a set of practices and procedures designed to ensure that products meet defined quality standards and are produced consistently, with minimal defects. The goal of this paper is to find the most sufficient key performance indicators KPIs in the supply chain management system in automotive industry based on literature review of the research area, Automotive Standard IATF 16949 and KPIs used in worldwide electronics manufacturing company for automotive and household industry during the supplier evaluation process. For that purpose was applied two approaches - 1) "Weight to Correlation" in order to identified the most important KPIs separately from the reviewed literature, IATF Standard and the manufacturing company and 2) Principal Component Analysis PCA for the all criteria of KPIs pyramid of suppliers selection and evaluation process. The finally defined set of KPIs will be studied in future work via machine learning models for validation as most sufficient to predict the level of riskiness of new and already approved suppliers for automotive industry.

Applications of deep learning and artificial intelligence methods to smart edge devices and stereo cameras

Mauro Mazzei and Cosmo Capodiferro (CNR, Italian National Research Council IASI, Institute of Systems Analysis and Computer Science, Italy)

This paper describes how it is possible to realise a computer vision application that by means of edge computing and using devices optimised for artificial intelligence allows the distance of objects from a fixed point and the distance between two or more points of interest to be measured with a certain accuracy and within a certain range. This type of application can be useful in many fields where precise positioning, navigation and analysis of spatial data is required, such as agriculture, manufacturing and industrial automation, robotics, healthcare, surveillance, health and safety, construction and engineering, surveying and mapping, transport, sport and fitness. In this work, we used an Edge AI device with stereo cameras, a Luxonis OAK-D, equipped with Intel Myriad-X neural chip and an improved version of Luxonis DepthAI open-source library. Point of interests from which measure distance is established by either fixed point or a common object recognition task that neural chip can perform very efficiently with minimal power consumption.

BD3: Nzeb and high-performance buildings

Impact of glazing system on the energy performance of a nZEB under climate change scenarios

Antonio Gigante (University of Sannio, Italy); Rosa Francesca De Masi (Università degli Studi del Sannio, Italy); Michele Parrotta (University of Sannio, Italy); Nicoletta Del Regno (Università Degli Studi del Molise, Italy); Silvia Ruggiero (Università degli Studi del Sannio, Italy); Giuseppe Peter Vanoli (Università degli studi del Molise, Italy)

The paper is focused on the evaluation of how windows design influences the energy performance of a nearly zero energy building, including the effects of the climate change. The case study is a single-story dwelling built in Benevento (South Italy, Mediterranean climate) with high performance. With five-years monitored meteorological data, the typical meteorological year is defined. This climatic condition represents the reference scenario for evaluating the performance with different types of windows and for the definition of future medium and long term climate projections, generated using the CCWorldWeatherGen tool. From these comparisons, the resilience of the nearly zero energy building is evaluated in terms of variation of heating and cooling

energy demand and primary energy percentage difference (ΔPE). The results show that the selective, low-e clear double glazing may be able to better mitigate the summer overheating effect, with an increase of 23% in energy need for cooling at 2050.

H2 micro-cogeneration in buildings: from nZEBs to HZEBs. State of Art, with a novel experimental set-up

Fabrizio Ascione (Università degli studi di Napoli Federico II, Italy); Valentino Festa (University of Sannio, Italy); Giacomo Manniti (University of Naples Federico II, Italy); Silvia Ruggiero (Università degli Studi del Sannio, Italy); Francesco Tariello and Giuseppe Peter Vanoli (Università degli studi del Molise, Italy)

A new installation of hydrogen fuel cell in a net zero energy building is presented, to support the energy transition toward decarbonized and clean energy systems, included the building stock. The development of hydrogen technologies, both for the high electrical efficiency of small-medium size systems, and for the energy storage potential (in the presence, for example, of electricity surplus from renewables or from energy sharing) may have an important prospective for a low carbon future. In addition to technological challenges, the use of co-generated heat may be a possibility to be investigated, for (for example): a) operation of low temperature heating terminals (radiant panels), also through the use of storage tanks, b) domestic hot water purposes, c) interaction with heat pump evaporator in winter (also the ground temperature, in GSHP), d) winter pre-heating of conditioned air in air handling units, e) conditioned air summer post-heating. Surely, in a highly efficient built environment and renewable energy communities, scientific research on storages - thermal and electrical, daily and seasonal - is becoming increasingly central to compensate for the temporal "gaps" between conversion and use of energy. In this study, all these themes are discussed, by presenting, at the end, a novel installation in a real living lab building, and thus an example of transition from NZEBs to HZEBs.

Practical challenges towards data-driven applications in buildings: lessons-learned from two real-life case studies

John Clauß, Luis Caetano and Kristian Stenerud Skeie (SINTEF Community, Norway); Åsmund Bror Svinndal (Kiona AS, Norway)

Data-driven applications in buildings using AI and machine learning have generated a lot of interest, but scaling these applications is challenging due to the uniqueness of each building, including different systems and sensors, lack of standardized meta-information, loss of data, and errors in labels and metric units. Based on the case study, we outline six major challenges for real building implementation of data-driven services using predictive control as an example, provide detailed examples for these respective challenges and propose seven take-home messages for the reader with regards to application and development of data-driven services: i) The application of data-driven services is not trivial as each building is different, ii) Malfunctioning devices, stable communication and limitations of communication protocols are a major technical barrier for data-driven applications, iii) Know what you measure!, iv) Data-quality is of outmost importance, v) Integration can be complex, vi) Think scalability and vii) Identify user-friendly solutions that are easy to use and understand.

Innovative Construction Typologies for Ventilated Façades in the Mediterranean Region

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Heading towards sustainability and nearly zero energy buildings (nZEBs), the main obstacle that needs to be overcome is the energy consumption of the existing building stock accounting for 40% of the global energy consumption. Therefore, the main of the European Union is the reduction of the buildings' energy consumption, achieved be efficient and clean energy consumption for heating and cooling as well as by designing smarter buildings, with improved appliances and insulation materials. In this line of approach, new construction typologies are being developed focusing on decreased energy consumption. As part of the IF-ZEB research project, a family of intelligent facades are being established, based on innovative coating materials and the integration of ventilated facades in existing and new buildings, towards the vision of nZEBs. Scope of this paper is the detailed presentation of the constructed ventilated facades with innovative final coating materials along with their implementation to the Conservatory of Thessaloniki.

E4: Energy systems and processes II

Experimental study on the thermochemical reduction of supercritical CO2 by guaiacol

Hui Jin, Jiadela Kuanibieke and Yimeng Wei (Xian Jiaotong University China, China)

The continuous growth of CO2 emissions is one of the global problems facing humanity, and how to convert and exploit the stock of CO2 has become an urgent issue. Biomass as an activity of CO2 thermal reduction medium has become the focus of human attention in general. Supercritical CO2 (SCCO2) has the advantages of near-liquid density and high solubility, which can further strengthen the reduction process (T≥31.26 °C, P≥72.9 atm). This paper described a SCCO2 reduction method of guaiacol on an intermittent Kettle Reactor to investigate the effects of reaction temperature (400-700 °C), residence time (5-20 min) and reactant concentration (4 wt%-16 wt%) on the three-phase products. The experimental results indicated that the carbon gasification efficiency (CE) and hydrogen gasification efficiency (HE) were 43.7% and 56.7%, respectively, when the carbon dioxide consumption reached 16.15 mol/kg. As the temperature increased, the consumption of carbon dioxide increased and the concentration of reactants increased with opposite results.

Vapor-liquid equilibrium of H2/CO2 and H2/N2/CO2 mixture, the liquefaction technology related to the supercritical water gasification products

Hui Jin (Xian Jiaotong University China, China); Hongtu Wu (Xi'an Jiaotong University, China)

In this paper, the dew point and liquid phase composition of H2/CO2 and H2/CO2/N2 mixtures at phase equilibrium calculated by PR-BM equation and Van Der Waal mixing rule with commercial MATLAB software are introduced, it is of theoretical significance for the wide application of the products of supercritical water gasification. First, the results obtained by the self-programming code are verified with the experimental data. The absolute deviations of the mixtures are within the acceptable range, therefore, the model proposed in this paper can well predict the dew point of the mixtures composed of H2/CO2 or H2/CO2/N2.Afterwards, the dew point and the CO2 content in the liquid phase of common H2/CO2 and H2/CO2/N2 vapor mixtures in supercritical water gasification products were predicted, and a series of analysis and discussion were conducted on the predicted results.

Design and evaluation of an innovative double-flash geothermal power plant combined with reheat tCO2 Rankine cycle, Kalina cycle, desalination and H2 generation

Serpil Celik-Toker (Isparta University of Applied Sciences Isparta Turkey, Turkey); Onder Kizilkan (Isparta University of Applied Sciences, Turkey); Sandro Nizetic (University of Split, FESB, Croatia)

In this study, development and design of an innovative double-flash geothermal power plant (DFGPP) integrated with trancritical carbon dioxide (tCO2) Rankine cycle (RC), Kalina cycle (KC), desalination plant and H2 generation are carried out. The tCO2-RC is a reheat cycle in which the working fluid is reheated after the high pressure turbine to produce more energy in the low pressure CO2 turbine. Desalination process is a reverse osmosis (RO) type and the H2 is generated from PEM electrolyzer. The main goal of the research is to investigate the operational performance of the integrated system in terms of thermodynamics aspects. Furthermore, parametric analyses are also conducted in order to investigate the main system parameters on the system effectiveness, such as geothermal water temperature, flashing pressure, tCO2-RC pressures, RO inlet temperature, etc. From the outputs, it can be concluded that the combination of various processes with geothermal energy is a promisingly feasible.

Modified diatomite materials and their environmental application as a sorbent for inorganic ions

Michał Łach (Cracow University of Technology, Poland); Tomasz Bajda (AGH University of Science and Technology, Poland); Magdalena Szechyńska-Hebda (W. Szafer Institute of Botany Polish Academy of Sciences, Poland); Marek Hebda (Cracow University of Technology, Poland)

The research focused on the development of technology for the production of highly effective sorbents based on the mineral diatomite. Diatomite is found in various regions of the world. In Poland, geological analysis confirmed the presence of at least four large deposits of this raw material. Among them, an active diatomite earth mine is located in Jawornik Ruski in Podkarpacie. The amount of diatomite in this deposit is estimated at about 10 million tons, so its economic use may have an impact not only locally, but also globally. Recently diatomite material has been the subject of intensive scientific research aimed at its technological use, e.g. in industry, breeding, and agriculture. In order to achieve functional material, it is necessary to carry out a series of analyzes to develop appropriate processing parameters. The article presents the results of physicochemical analyzes of diatomite and its absorption properties against inorganic substances. The diatomite material can be successfully used to remove various types of spills and different hazardous substances from the environment. The results have also the economic importance, as the production of the best quality sorbents from locally available raw materials reduces transport costs, and thus the environmental impact. In addition, the production of high-efficient sorbents reduces the consumption of raw materials and the number of sorbents soaked in waste.

Valorization of corn straw for liquid hydrocarbon production via catalytic pyrolysis coupled with Phanerochaete chrysosporium pretreatment

Jiapeng Wang (SEU, China); Yaning Zhang (Harbin Institute of Technology, China)

A new method of pretreatment of corn straw with Phanerochaete chrysosporium combined with pyrolysis was proposed to improve the quality of bio-oil. The characterization results demonstrated that in fast pyrolysis, because of the enrichment of cellulose and the removal of lignin, the contents of acids, linear carbonyls, furans and sugars increased while the contents of phenols decreased. The total hydrocarbon and aromatics contents can significantly increase up to 34.37% and 30.59%, respectively, with 3 weeks pretreatment under catalytic pyrolysis. Meanwhile, due to the destruction of the biomass structure by microorganisms, the heavy bio-oil components of the biomass decreased, while the light bio-oil components increased. This method provides a new treatment idea for high quality utilization of biomass.

EM4: Engineering modelling III

Computational Electromagnetics with the RBF-FD Method

Andrej Kolar-Požun and Gregor Kosec (Jožef Stefan Institute, Slovenia)

One of the most popular methods employed in computational electromagnetics is the Finite Difference Time Domain (FDTD) method. We generalise it to a meshless setting using the Radial Basis Function generated Finite Difference (RBF-FD) method and investigate its properties on a simple test problem.

Long Short-Term Memory for Discharge Estimation in Coastal Neretva River

Anna Maria Mihel and Nino Krvavica (University of Rijeka, Croatia); Jonatan Lerga (University of Rijeka, Croatia & University of Rijeka, Center for Artificial Intelligence and Cybersecurity, Croatia)

Estimating discharge in tidal rivers presents a complex challenge, owing to their dynamic and ever-changing nature. These rivers are influenced by multiple factors, including tidal range, wind, atmospheric pressure, and freshwater inflows, causing frequent fluctuations in water levels and flow rates. Conventional methods for measuring discharge, such as current meters and stream gauges, are often inadequate for tidal rivers due to complex flow patterns and strong turbulence, leading to unreliable data. Hence, the requirements for a stable process of determining discharge increase. To resolve such a problem, we used k-Fold Grid Search Cross-Validation to optimize the performance of the Long Short-Term Memory (LSTM) model using simulated data from four water stage and a single discharge station in the Neretva River estuary in Croatia. Our model incorporates various hydrological variables to accurately predict discharge, overcoming the limitations of traditional measurement techniques and models. The results of the study showed that the LSTM model successfully estimated discharge values, even in scenarios of low and high flow, with satisfying accuracy. The comparison with a simple Multiple Linear Regression (MLR) model clearly shows the improvement in results for each category of discharge values by using LSTM model. Our study represents a significant step in predicting and managing discharge in tidal rivers, providing crucial insights for improved environmental and flood management practices.

Edge Detection Using Vector Quantization And Local Entropy Measures Applied To Spectrogram Component Extraction

Matej Abramović, Zeljka Tomasovic and Nicoletta Saulig (University of Pula, Croatia); Ivan Marasović (University, Croatia)

In this paper, an approach to detect edges of signal components in multicomponent, stationary and nonstationary signals, independent of their time or frequency support, by application of K-means algorithm and local entropy measures to the time-frequency (TF) plane is proposed. The approach is based on the use of a K-means algorithm as an edge detector rather than object detector, that can maintain continuity of the edge on stationary and nonstationary signal components. Local entropy measures are applied to select appropriate K-means class to represent the edge as well as to estimate the continuity of the edge. When common edge detectors are applied, the continuity of the edge can be compromised by different occurrences such as the lack of contrast in an image or the detector working in one direction, so different methods like smoothing filters or histogram equalisation are often used as a corrective measure.

The proposed K-means based method does not require additional smoothing or equalizing methods and no blurring or loss of information is present, which results in a robust method of detecting continuous edges of the useful information content in the time-frequency plane for both stationary and non-stationary signals. Since the K-means based algorithm does not depend on the contrast present in the image, the edges can se preserved in greater percent than commonly used edge detectors. Simulated signals are corrupted by different levels of Additive White Gaussian noise (AWGN) of 0dB, 3dB and 5dB. The results show the proposed method correctly detects components of an image with a continuous edge. The level of continuity of the proposed method is compared to the level of continuity of commonly used edge detectors, where results show the proposed method outperforms common edge detectors in case of non-stationary signals.

Simple Dosimetry Procedure for Human Exposure to a Field Radiated by a Vertical Dipole Antenna Above Lossy Half Space *Part 2: Calculation of Transmitted Power Density

Enida Cero Dinarević (FESB, Bosnia and Herzegovina); Dragan Poljak (University of Split, Croatia); Vicko Doric (University of Split, FESB, Croatia)

This paper deals with a simple procedure for the assessment of Specific Absorption Rate (SAR) and Transmitted Power Density (TPD) in the parallelepiped human body model exposed to a vertical dipole antenna above a lossy half space. The results are obtained by numerical/analytical evaluation of the field integrals with analytical model with far field approximation. Results obtained via different approximations agree satisfactorily under certain conditions.

A Developed Traffic Light Approach to Control Road Congestions in VANETs

Randa Mahdi Kadhim (University of Babylon, Iraq); Saad Talib Hasson (University of Babylon & College of Information Technology, Iraq)

Vehicular Ad Hoc Network (VANET) is a type of wireless network that allows communication among moving vehicles with the assistance of roadside units (RSU). Congestion in VANET refers to the situation where there are too many vehicles on certain parts of a road, causing a bottleneck in the flow of traffic. This congestion can lead to delays, increased travel time, and reduced overall network performance. In addition, congestion in VANET can also lead to a higher probability of collisions and accidents, as vehicles may be unable to communicate effectively with each other or with the infrastructure. Therefore, managing congestion is a critical issue in the design and operation of VANETs to improve the Intelligent Transport Systems (ITS) in an urban area. In this paper, an adaptive traffic light signal using the assistance of roadside units is proposed. Technology has been built depending on the density of vehicles in each of segment of the roads connected to the traffic lights at the intersections. A prediction is expected to calculate the congestion on its basis and open the road automatically when congestion occurs in any direction. The results showed that the proposed model makes a stable movement of vehicles to cross the intersections in urban environments.

Evaluating YOLOV5, YOLOV6, YOLOV7, and YOLOV8 in Underwater Environment: Is There Real improvement?

Boris Gašparović (University of Rijeka, Croatia); Goran Mausa (University of Rijeka, Faculty of Engineering & University of Rijeka, Center for Artificial Intelligence and Cybersecurity, Croatia); Josip Rukavina (Vectrino doo, Croatia); Jonatan Lerga (University of Rijeka, Croatia & University of Rijeka, Center for Artificial Intelligence and Cybersecurity, Croatia)

This paper compares several new implementations of the YOLO (You Only Look Once) object detection algorithms in harsh underwater environments. Using a dataset collected by a remotely operated vehicle (ROV), we evaluated the performance of YOLOv5, YOLOv6, YOLOv7, and YOLOv8 in detecting objects in challenging underwater conditions. We aimed to determine whether newer YOLO versions are superior to older ones and how much, in terms of object detection performance, for our underwater pipeline dataset. According to our findings, YOLOv5 achieved the highest mean Average Precision (mAP) score, followed by YOLOv7 and YOLOv6. When examining the precision-recall curves, YOLOv5 and YOLOv7 displayed the highest precision and recall values, respectively. Our comparison of the obtained results to those of our previous work using YOLOv4 demonstrates that each version of YOLO detectors provides significant improvement.

IoT4: Session on BigData and Machine Learning Applications

Augmenting Monitoring Infrastructure For Dynamic Software-Defined Networks

Jaroslav Pešek and Richard Plny (Czech Technical University in Prague, Czech Republic); Josef Koumar (Czech Technical University in Prague - FIT, Czech Republic & CESNET, Czech Republic); Kamil Jeřábek (Brno University of Technology, Czech Republic); Tomas Cejka (CESNET z. s. p. o., Czech Republic)

Software-Defined Networking (SDN) and virtual environment rise new challenges for network monitoring tools. The dynamic and flexible nature of these network technologies require adaptation of monitoring infrastructure to overcome challenges of analysis and interpretability of the monitored network traffic. This paper describes a concept of automatic on-demand deployment of monitoring probes and correlation of network data with infrastructure state and configuration in time. Such approach to monitoring SDN & virtual networks is usable in several use cases such as IoT networks and anomaly detection, and it increases visibility into the complex and dynamic networks. Additionally, it can help with creation of well-annotated datasets that are essential for any further research.

Nudging: a double-edged sword in the era of Big Data

Brian Franco Guilhelm Fabregue (University of Zurich & Retreeb Company, Switzerland); Andrea Bogoni (University of Bergamo, Italy)

This article aims to analyse the tool of nudging, in its most recent evolution of hypernudging, from a mainly practical perspective. The development of the big data world and the parallel phenomena of datafication have on the one hand reduced the costs of implementing nudging and on the other hand exponentially increased its pervasiveness. By penetrating the intimacy of one's private life, hypernudges risk compromising the renown individual's right to be left alone. The article therefore elaborates on these privacy risks and attempts to offer solutions both theoretically and practically.

Towards a Method for Evaluating Realism of Randomly Generated Models of IT Systems

Ivan Kovačević (University of Zagreb & Innovation Centre Nikola Tesla, Croatia); Stjepan Gros (University of Zagreb, Croatia)

Informally, an information technology system (ITS) consists of hardware and software infrastructure, such as workstations, servers, LANs, etc., along with their connections and interdependencies. Although most organizations operate an ITS, very few share detailed information about their ITS publicly. Because of this, models of arbitrary IT systems have to be generated either manually or automatically, following well known best practices and domain specific requirements. For applications in cyber security, the generated ITS models should be realistic in a sense that a relevant real-world organization could choose to organize its ITS according to them. Since most such models lack a corresponding real-world ITSs for comparison, their realism cannot be evaluated in the sense of conforming to a real-world ITS.

In this paper, we propose a method for evaluating arbitrary models of ITSs for which a corresponding real-world ITS is not available for comparison, relying on several visualizations and a questionnaire. We perform a small-scale survey to validate the method, and present its results. The results are encouraging and show that the basic idea of the proposed method can serve the intended purpose, but also indicate several problems that must be addressed before definite conclusions regarding realism can be made.

Obfuscated JavaScript Code Detection using Machine Learning with AST-based syntactic and lexical analysis

Eren Kilic (Istanbul Technical University & ASELSAN, Turkey); Mehmet Tahir Sandikkaya (Istanbul Technical University, Turkey)

Obfuscation is a technique used to obscure code in order to make it more difficult to understand or reverse engineer. In recent years, it has become a popular technique used by attackers to hide malicious code in JavaScript applications. The detection of obfuscated code in JavaScript is a challenging task due to the use of various techniques that can be employed by adversaries.

In this paper, we present a survey of existing techniques for obfuscation detection in JavaScript. We provide an overview of the different obfuscation techniques used by intruders and describe the challenges associated with their detection. We also review the existing detection techniques, including static and dynamic analysis, and discuss their advantages and limitations.

Furthermore, we propose a novel approach that combines both static and dynamic analysis to improve the accuracy of obfuscation detection in JavaScript. Our approach is based on the idea of detecting suspicious code patterns that are commonly used in obfuscated code using syntactic and lexical analysis.

Finally, we evaluate the effectiveness of our proposed approach using a data set of real-world JavaScript applications. The results show that our approach can achieve a high level of accuracy in detecting obfuscated code, outperforming existing techniques in terms of both detection rate and false positive rate.

Akats: A System for Resilient Deployments on Edge Computing Environments Using Federated Machine Learning Techniques

Josu Díaz-de-Arcaya and Ana Isabel Torre-Bastida (TECNALIA, Basque Research and Technology Alliance (BRTA), Spain); Lander Bonilla and Juan López-De-Armentia (Tecnalia, Basque Research and Technology Alliance (BRTA), Spain); Raúl Miñón (TECNALIA, Basque Research and Technology Alliance (BRTA), Spain); Gorka Zarate (TECNALIA, Basque Research & Technology Alliance (BRTA), Spain); Aitor Almeida (DeustoTech - Deusto Institute of Technology, Spain)

Edge computing is a game changer for IoT, as it allows IoT devices to independently process and analyze data instead of just sending it to the cloud. But managing this considerable number of devices and deploying workloads on them in a coordinated and intelligent manner remains a challenge nowadays. In this paper, we focus on introducing the resilience dimension into these deployments, and we provide two main contributions: the use of federated machine learning techniques to develop a collaborative tool between the different devices aimed at detecting the possibility of a device failure, and subsequently, the utilization of the inferred information to optimize deployment plans ensuring the resilience in the devices. These two advances are implemented in an intelligent system, Akats, whose architecture is described in detail in this article. Finally, an application scenario is presented, based on Industry 4.0 - Machine predictive maintenance, to exemplify the benefits of the proposed intelligent system.

BLE-based IoT Proximity Warning System for Guaranteeing the Operators' Safety in Outdoor Working Environments

Teodoro Montanaro, Ilaria Sergi, Angela-Tafadzwa Shumba and Marco Pizzolante (University of Salento, Italy); Marco Pirozzi (INAIL, Italy); Luigi Patrono (University of Salento, Italy)

One of the most difficult tasks for employers is to guarantee the safety conditions of every worker in every situation. Luckily, in the last decades various technologies have been introduced to address such a difficult task and the IoT paradigm is playing a key role in this direction. However, the task remains hard in specific working environments, like the agricultural one where, for instance, heavy vehicles (e.g., tractors or excavators) operate every day. In this framework, a localization system installed on remote-controlled farm machines (RCFM) can help in guaranteeing safety and preventing fatal accidents. This paper presents the preliminary results obtained by experimenting an IoT system that estimates the distance between the machinery and operators through the Bluetooth Low Energy technology and the combination of the Log-distance path loss model and the fingerprint technique. The performed experiments demonstrate the reliability of the approach and how the prompt estimation of the distance is important for the generation of warning notifications that could save operators from accidents. Finally, some open questions are discussed to promote future works on the topic.

RFID4: Future Trends of RFID Technology for Society and Industry Toward green IoT Devices

The MONITOR Robot with UHF-RFID Rotating Antennas enhancing Indoor Tag Localization

Glauco Cecchi, Andrea Motroni, Alice Buffi and Paolo Nepa (University of Pisa, Italy); Salvatore D'Avella (Sant'Anna School of Advanced Studies & Mechanical Intelligence Institute, Italy); Matteo Unetti and Paolo Tripicchio (Scuola Superiore Sant'Anna, Italy); Luca Del Col (Partitalia, Italy); Alfredo Salvatore (Sensor ID, Italy)

The MONITOR Project is born to respond to the increasing demand for highly accurate and quick inventorying operations. For this purpose, an automatic Ultra-High-Frequency (UHF) Radio Frequency IDentification (RFID) system consisting of a mobile robot is conceived. Particularly, the robot is equipped with rotating arms allowing an antenna motion able to improve tag localization when Synthetic Aperture Radar (SAR) methods are applied. In this paper, the proof-of-concept of the mobile robot with rotating arms is firstly presented. Localization performance is shown in a realistic warehouse/store environment where RFID tags are attached to clothes arranged on dress racks. Also stray tags are considered in the indoor scenario, to make the environment more challenging. The experimental analysis demonstrates the system capability in improving localization performance thanks to rotating antennas.

Wireless BMS Architecture for Secure Readout in Vehicle and Second life Applications

Fikret Basic, Claudia Laube, Patrick Stratznig and Christian Steger (Graz University of Technology, Austria); Robert Kofler (NXP Semiconductors Austria GmbH Co & KG, Austria)

Battery management systems (BMS) are becoming increasingly important in the modern age, where clean energy awareness is getting more prominent. They are responsible for controlling large battery packs in modern electric vehicles. However, conventional solutions rely only on a wired design, which adds manufacturing cost and complexity. Recent research has considered wireless solutions for the BMS. However, it is still challenging to develop a solution that considers both the active in-vehicle and the external second-life applications. The battery passport initiative aims to keep track of the batteries, both during active and inactive use cases. There is a need to provide a secure design while considering energy and cost-efficient solutions. We aim to fill this gap by proposing a wireless solution based on near-field communication (NFC) that extends previous work and provides a unified architecture for both use cases. To provide protection against common wireless threats, an advanced security analysis is performed, as well as a system design analysis for the wake-up process that reduces the daily power consumption of the stored battery packs from milli- to microwatts.

UHF RFID tags on paper based on capacitive coupling between bare die IC and antenna

Arnaud Vena (University of Montpellier & Institut d'Electronique Et Des Systèmes (IES), France); Benjamin Saggin (University of Montpellier, France); Brice Sorli (University of Montpellier & IES, France)

This work demonstrates the possibility to attach an RFID bare die IC on a paper based antenna using a non-conductive adhesive taking benefit of the capacitance effect between their respective pads. A parametric study on the thickness of the adhesive, and its permittivity is performed to evaluate its impact on the impedance seen by the antenna. Optimized antenna design is proposed to perform conjugate matching in this specific situation and validated by simulation and practical measurements.

A Machine Learning-Enabled mmID-Sensor for High-Accuracy Orientation and DoA Estimation

Marvin Joshi, Genaro Soto-Valle, Charles A Lynch III and Manos M. Tentzeris (Georgia Institute of Technology, USA)

In this work, the implementation of a machine learning algorithm in conjunction with a Frequency-Modulated Continuous Wave (FMCW) radar system and a miniaturized ultra-low-power 24 GHz-mmID for precise localization, orientation sensing, and direction of arrival (DoA) estimation is presented. The rotational sensing capability is exploited by the use of four antenna elements with different polarization offsets between each other. The Multiple Signal Classifier (MUSIC) algorithm is employed for accurate DoA estimation, utilizing a single input multiple output (SIMO) custom antenna configuration on the reader system. The supervised learning KNN-model enabled achieving a high accuracy < 1° orientation detection along the z-axis, whereas the MUSIC algorithm achieved a mean error of < 1° in DoA estimation over a wide azimuth range of ±45°, both at a range of 4m. The proposed system presents an important step for envisioning highly accurate virtual reality and motion-tracking systems in real time.

Enhancing Worker Safety in Unmanned Agricultural Environments through the Integration of RFID, RTK, UWB, and LIDAR: Insights from Research Projects

Luca Catarinucci (University of Salento, Italy); Glauco Cecchi (University of Pisa, Italy); Francesco P. Chietera (University of Salento, Italy); Massimo Cecchini (Università degli Studi della Tuscia di Viterbo, Italy); Riccardo Colella (University of Salento, Italy & National Research Council (CNR), Italy); Roberto Gabbrielli (University of Pisa, Italy); Luca Landi (University of Perugia, Italy); Leonardo Marrazzini (University of Pisa, Italy); Danilo Monarca (University of Tuscia, Italy); Teodoro Montanaro (University of Salento, Italy); Andrea Motroni and Paolo Nepa (University of Pisa, Italy); Luigi Patrono (University of Salento, Italy); Marco Pirozzi (INAIL, Italy); Daniele Puri (Italian Institute for Insurance Against Accidents at Work - INAIL, Italy); Pierluigi Rossi (University of Tuscia, Italy); Ilaria Sergi (University of Salento, Italy); Emanuele Tavanti (University of Pisa, Italy); Leonardo Vita (Italian Institute for Insurance Against Accidents at Work - INAIL, Italy)

Managing human-machine collisions and obstacle avoidance in agriculture is crucial to ensure a high level of safety for both tractors and workers. The "SMARTGRID" project, funded by the Italian National Institute for Insurance against Accidents at Work (INAIL), integrates passive Radio Frequency Identification (RFID) tags and Bluetooth Low Energy (BLE) devices to identify fixed obstacles and workers on foot within 10 meters from an unmanned tractor, providing alerts and automatic emergency stop procedures through a dedicated in-cloud IoT infrastructure. The project results demonstrate how an RFID-based localization system on board an unmanned vehicle, along with appropriately designed RFID tags, both passive and battery-assisted passive (BAP), can feed an IoT infrastructure to generate potential alerts through a BLE interface. BLE is also used to locate critical workers, such as the remote driver, ensuring redundancy. However, challenges such as remote driver visibility, obstacle detection at greater distances, and tractor blind spots may require further investigation. In the follow-up project "SIRTRACK", also funded by INAIL, an improved system for unmanned agricultural tractors is designed to detect and track obstacles by exploiting additional technologies such as ultra-wideband (UWB) localizers combined with LIDARs and real-time kinematics (RTK) navigation systems. A multi-criteria approach is adopted to develop an innovative infrastructure that identifies distances from fixed obstacles through RTK positioning in relation to layout information of the working area and LIDAR measurements onboard the tractor. The system also detects the presence of nearby workers on foot through the addition of a UWB-based system to the RFID/BLE one from the previous project. The infrastructure is designed to merge all the information into an alert system for the remote driver. This paper showcases the results obtained with the SMARTGRID infrastructure, as well as the conceptual idea of the sensing infrastructure and alerting system of SIRTRACK, drawing upon multidisciplinary expertise in Agricultural Engineering, Electromagnetics, Safety at work, Computer Engineering, and more.

SML2: Symposium Statistics and ML in Electronics II

Steganography App Based on Local Colour Statistics

Barbara Dzaja, Mirjana Bonkovic and Tonko Kovacevic (University of Split, Croatia); Ana Kuzmanić Skelin (Faculty of Electrical Engineering, Croatia)

In today's world the usage of smart phones goes way beyond the ability to make or receive phone calls. Users can instantly send and receive data, use it as a personal organizer or television. They can make, send or store photos and videos which can be easily transferred to a PC, a laptop computer or sent to a friend. Therefore, they can be used to send and receive secret messages. As mobile phones are everyday electronic devices used for communication they are also the easiest asset for using everyday image steganography. This paper presents Steganography Application applied on electronic device, a smart phone.

Application is made using Matlab platform and is based on statistical Gaussian Mixture Model of pixel representation by two colour model in the local neighborhood.

Learning Trajectory Tracking For An Autonomous Surface Vehicle In Urban Waterways

Toma Sikora (University of Zagreb, Croatia); Jonathan Klein Schiphorst (Roboat, The Netherlands); Riccardo Scattolini (Politecnico di Milano, Italy)

Roboat is an autonomous surface vessel (ASV) for urban waterways, developed as a research project by AMS Institute and MIT. The platform can provide numerous functions to a city, such as transport, dynamic infrastructure, and an autonomous waste management system. The goal of this project is to develop a learning-based controller for the Roboat platform with the goal of improving robustness and generalization. When subject to uncertainty in the model or external disturbances, the proposed controller should be able to track set trajectories with less tracking error than the current Nonlinear Model Predictive Controller (NMPC) used on the ASV. To achieve this, a simulation of the system dynamics was developed based on research done on the platform and previous literature. The simulation also includes the modelling of the necessary uncertainties and disturbances. In this simulation, a trajectory tracking agent was trained using the Proximal Policy Optimization (PPO) algorithm which was then validated and compared to the current control strategy both in simulation and in the real world

Digital Accessibility for People with Special Needs: Conceptual Models and Innovative Ecosystems

Maya Dimitrova (IR-BAS, Bulgaria); Galina Bogdanova (Institute of Mathematics and Informatics at the Bulgarian Academy of Science, Bulgaria); Nikolay Noev (Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences (IMI-BAS), Bulgaria); Negoslav Sabev (IMI-BAS, Bulgaria); Georgi Angelov and Yasen Paunski (IR-BAS, Bulgaria); Aleksandar Krastev (Institut of Robitics, Bulgarian Academy of Sciences, Bulgaria); Mirena Todorova-Ekmekci (Institute of Ethnology and Folklore Studies with Ethnographic Museum Bulgarian, Bulgaria)

The paper presents the developed framework for providing relevant digital accessibility to learners with various needs - sensor support, knowledge provision for better understanding of the texts in web sites and support to the motivation of the learner to acquire better knowledge from the web search, in the classroom, or in rehabilitation. Example cases are described as current and future case studies within the proposed technological ecosystem, called Accessibility Barometer.

Investigation of Different Hot Bar Soldering Modes for Obtaining Strong Solders by Statistical Metods

Valentin Petrov Tsenev and Nedyalko Peshev (Technical University of Sofia, Bulgaria)

The article examines and analyzes the results of the conducted research on the strength of solders with electronic assembly type LGA (Land Grid Array) in different modes of soldering with Hot bar technology. Experiments and results obtained to achieve the maximum breaking strength of soldered pads of a flexible printed circuit board (FPC) to a standard rigid printed circuit board (PCB) under various hot bar soldering process parameters are described. The solder used and the machine used are specified. The soldering system of a flexible and rigid circuit board is applied, the design of which is optimized for the specific use. The breaking force measurement system is presented, and the MSA (Measurement System Analysis) method is used for validation. By using the SPC (Statistical Process Control) statistical method, a reliable analysis was made and objective conclusions were generated. An optimum mode for Hot bar soldering has been determined, which results in a stable maximum breaking strength of the solders for a particular application.

Creating and storing 7D digital twins

Radoslav Markov and Galina Bogdanova (Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences); Malinka Ivanova (Technical University of Sofia, Bulgaria)

The possibility of creating digital twins of physical objects, particularly those from cultural heritage, is explored in this position paper. The proposed 7D digital twin model extends beyond the standard 3D voxel representation, incorporating full color representation via XYZ color coordinates, surface structure through optical coherence tomography, surface composition through spectral fingerprint and surface sound. Various technologies that can be used for this new type of 7D scanning are discussed, as well as a proposed file format for storing these digital twins. The benefits and current limitations of this process are also explored, with suggested strategies for overcoming these limitations. The creation of 7D digital twins presents new opportunities for preservation, study, and access to physical objects, and has the potential to revolutionize the way cultural heritage is experienced and shared.

BD4: Energy and buildings

Computational BIM method for automated insight into BREEAM credits achievement in the refurbishment evaluation process of an existing building

Sanja Dubljević, Bojan Tepavčević and Aleksandar Andjelkovic (University of Novi Sad, Serbia)

Refurbishment and fit-out of existing construction facilities in order to reduce the negative impact on the environment and maintenance costs has been one of the most current topics in Architecture, Engineering, Construction, and Operation (AECO) sector in recent years. The method described in this paper is intended for architects and engineers to provide real-time insight into the achievement of certain BREEAM credits during the entire design process in the Building information modeling (BIM) environment. BIM, visual programming language (VPL) and Microsoft Excel were combined to create this tool. In this way, the process of evaluating buildings through one of the Green Building Certification Systems (GBCS) was simplified. One of the categories from the technical manual BREEAM International Non-Domestic Refurbishment 2015 was handled in this work because of the challenges of parameterizing the criteria for achieving specific credits. Further research will be focused on increasing the number of BREEAM categories and applying this method to other GBCS

Indoor thermal environment and daylighting performance of a building containing PCM glazing curtain wall

Wanyu Hu, Yao Lu, Dong Li, Yuxin Ma, Xinpeng Yang and Chengjun Zhang (Northeast Petroleum University, China)

With the continuous development of energy-saving technologies for glazing envelope, enhance the thermal inertia of the glazing envelope by heat storage means is gradually springing up to reduce building energy consumption. In this paper, the heat transfer and daylighting models of a building with PCM glazing curtain wall (PGC) were developed to analyze its indoor thermal environment and daylighting performance, respectively. Building containing silica aerogel (SGC) and hollow glazing curtains (HGC) were selected as the reference models, and several indexes including inner surface temperature, liquid phase

rate of PCM, indoor temperature, indoor natural illumination and indoor daylighting coefficient were adopted as the evaluations. The results show that in comparison with SGC and HGC, building containing PGC can reduce the fluctuation of temperature, delay the time of peak temperature, reduce indoor temperature, and greatly improve indoor temperature uniformity and indoor thermal comfort. With the increase of PCM thickness, the liquid fraction rate of PCM decreases greatly, which directly affects the energy storage performance of PGC. Increasing the thickness of PCM from 10 mm to 20 mm has no obvious effect on improving the thermal insulation of glazing envelope and indoor thermal comfort. The PGC filled with 10 mm PCM can reduce the temperature fluctuation of the inner surface of the glass and interior midpoint temperature by 35% and delay the peak time of glass inner surface temperature by 0.89h, which can greatly improve the indoor temperature uniformity and meet the natural lighting requirements.

Energy efficiency, resilience and sustainability: A trilemma for hospital buildings?

Georgios Chantzis (Aristotle University of Thessaloniki, Greece); Sandro Nizetic (University of Split, FESB, Croatia); Muslum Arici (Kocaeli University, Turkey); Agis M. Papadopoulos (Aristotle University of Thessaloniki, Greece)

Hospitals are highly interesting buildings; considering their importance for public health and well-being and, it is only reasonable to apply state of the art technological solutions, so as to ensure that the buildings will perform in the expected way, namely, to serve as true health care facilities, with high levels of indoor air quality, thermal, optical and acoustic comfort. Ensuring these conditions comes at significant energy requirements, which made hospitals primary targets for improving their efficiency over the last decades in order to make them more sustainable and also financially viable. However, resilience is a vital quality for hospital buildings which has to be guaranteed and which sets demand both on the building itself and on the infrastructure of energy grids. There are a series of threats to a hospital's resilience, against which precautionary measures have to be taken, considering the likelihood of the threats and their possible impact on the hospital's operation. Achieving resilience and sustainability may seem a contradiction at a first glance, but in fact there are more common aspects than competing requirements as it will be discussed in this paper.

Efficient Facade Envelope Layout with Novel Waste-Based Thermal Insulation to Lower Air-Conditioning Costs and Carbon Emissions

Saboor Shaik, Abin Roy, Aabid Husssain Shaik and Mohammed Rehaan Chandan (Vellore Institute of Technology, India); Muslum Arici (Kocaeli University, Turkey); Tabish Alam (Central Building Research Institute, India)

Concerns about the consequences of climate change stimulate construction-related research. Throughout the last several decades, there has been a significant worldwide growth in building energy usage. HVAC systems in buildings mostly make use of this energy for thermal comfort. By reducing heat transmission, the interior temperature can be maintained and thermal comfort may be improved, this can be achieved by incorporating thermal insulation materials into the building envelopes. Without adequate treatment, discharging garbage directly into the environment increases environmental contamination. Integrating industrial waste into building insulation materials is essential for environmental preservation and energy efficiency improvements. The objective of this article is to evaluate the air-conditioning cost-saving potential of different patterns of fly ash brick containing novel insulation materials. In this context, the novel insulation materials were packed into the various hollow sections of fly ash brick. For the purposes of this study, thirteen different types of insulation materials were considered, and their thermo-physical properties were experimentally investigated.

CS1: Citizen Science sekcija I

BeeMate the Game: A hunting treasure serious game for raising awareness and audience engagement in air pollution monitoring

Marina Eirini Stamatiadou, Nikolaos Vryzas, Lazaros Vrysis and Charalampos Dimoulas (Aristotle University of Thessaloniki, Greece)

The current paper presents a serious game approach to engage citizens in monitoring pollution, mainly in urban areas, and raise awareness regarding its effects in modern human lifestyle. A prototype mobile application is proposed, urging users to capture images showing polluting sources (e.g., traffic jams, trucks) and their audio footprint (if applicable) to assist in the process of monitoring air pollution. A deep learning algorithm is running in the backend of the application and is responsible for image and audio pattern recognition. The results of this module feed the application which in turn, is asking contributors to validate and further annotate the pollution sources identified by the image and audio recognition algorithms. A repository containing datasets with audiovisual content related to polluting sources' footprints is gradually constructed and carefully annotated through crowd intelligence strategies. Spatiotemporal information that is extracted and related to the content itself also allows for indirect pollution monitoring. Gamification strategies are employed to reward players with scoring points according to the level of engagement and the quality of their contributions. Based on the achieved score, the application unlocks access to regional pollution monitoring maps, allowing users to check pollution levels in nearby areas, while also levels up different ranks (i.e., worker-bee, corporal-bee, sergeant-bee, lieutenant-bee, captain-bee, etc.). The ultimate goal of the proposed application is to identify those users who are willing to participate in dedicated pollution monitoring campaigns, using dedicated sensors and measurement protocols.

The BeeMate: Air quality monitoring through crowdsourced audiovisual data

Nikolaos Vryzas, Marina Eirini Stamatiadou, Lazaros Vrysis and Charalampos Dimoulas (Aristotle University of Thessaloniki, Greece)

The BeeMate module for collecting and analyzing audiovisual data related to air quality monitoring is presented. This module is implemented as part of a mobile citizen science application for user engagement and environmental behavioral change. The application allows volunteers to perform air quality measurements along with audiovisual data capturing in urban areas, using low-cost and built-in mobile device sensors. The BeeMate module implements a micro-service architecture, providing semantic analysis of the collected audiovisual data, and associating them with the detection of air-polluting sources. Several machine learning models are integrated into the backend of the application. An audio-driven model for the detection of air-polluting sources based on a 1D-CNN architecture is proposed and evaluated. Moreover, to address the problem of managing multi-source, multimodal, and heterogenous data, a lexicon of pollution-related terms is built.

A Micro-volunteering Engine to drive crowd-measuring of Air Quality in Citizen Science

Maite Puerta-Beldarrain (Universidad de Deusto, Spain); Oihane Gómez-Carmona (University of Deusto, Spain); Diego López-de-Ipiña (Deusto Institute of Technology - DeustoTech, University of Deusto, Spain); Diego Casado-Mansilla (University of

Deusto, Spain); Alexandre Barco (Universidad de Deusto, Spain); Unai Hernández-Jayo and Javier Garcia-Zubia (University of Deusto, Spain)

Citizen Science is a great instrument to drive societal challenges. The Micro-Volunteering Engine (MVE) is responsible to provide the best-fitting spatial cells that need to be measured given a user's location. MVE is used in SOCIO-BEE, a project where members with different profiles organize, manage, and execute Citizen Science campaigns. This paper demonstrates, through CS campaign simulations, how this engine may be usable to mobilize and drive citizens to carry out crowd-sourcing campaigns which help understanding better the effects of air pollution and, hence, aid decision-making, i.e. co-design of pro-environmental mitigation actions.

IoT5: Special Session on AI and Deep Learning applied to Smart environment

Gulf Dialect Speech Recognition Using Neural Network

Manar Alkhatib (The British University in Dubai, United Arab Emirates); Ashwaq Faisal (The United Arab Emirates University, United Arab Emirates); Maen Almubarek (The British University in Dubai, United Arab Emirates); Mariam Alsuwaidi (Alsuwaidi, United Arab Emirates); Abdulrahman AlQaderi (The British University in Dubai, United Arab Emirates)

Communication has been an important aspect of human life, civilization, and globalization for thousands of years. Automatic Speech Recognition has found its application on various aspects of our daily lives such as biometric analysis, education, security, healthcare in smart cities. Most studies have mainly concentrated on English, Spanish, Japanese, or Chinese, disregarding other low-resource languages, such as Arabic, leaving their analysis open. This paper implements Automatic Speech Recognition Mechanism along with Neural Network where the system converts the Arabic and Gulf dialect speech into Arabic text that is written in flask framework. A comprehensive research of utilizing a Convolutional Neural Network, Recurrent Neural Network and transforms in speech recognition besides introducing methods for training of the neural network so that a convenient neural output can be acquired to the desired output. Python simulation has been executed to validate the results. The results depict the efficiency and the robustness of the presented process.

Multi-Position Human Activity Recognition using a Multi-Modal Deep Convolutional Neural Network

Aime Cedric Muhoza, Emmanuel Bergeret, Corinne Brdys and Francis Gary (Université Clermont Auvergne, France)

Human Activity Recognition (HAR) is a challenging task due to the complexity of human motions and the variability of datasets. The wide adoption of wearable devices and the incorporation of high-grade motion sensors and biosensors in these devices increased the number of available data that could be employed in sensor-based HAR. In this paper, we propose a multimodal deep convolutional neural network capable of recognizing different activities using accelerometer data from several body positions. We compare the performance of our proposed system with existing DCNN model architectures. Our experiments on two public datasets for HAR demonstrated that our approach surpassed the performance of both single-position and simple multi-position DCNN models. This study provides valuable insights for the development of efficient edge-AI systems for activity recognition on resource-constrained embedded devices.

Sentiment Analysis Using Bi-CARU with Recurrent CNN Models

Ka-Hou Chan (Macao Polytechnic University, China)

For many natural language processing tasks, sentiment analysis has become increasingly important for extracting meaningful information from social media data. With the outperformance of neural network technology, the task of sentiment analysis can be addressed by advanced deep learning models. In this work, a combination model of Bidirectional-CARU (Bi-CARU) and Recurrent CNN is introduced to the sentiment analysis tasks. The proposed Bi-CAUR consists of three layers designed to obtain the main features of the input sequence, which can alleviate the long-term dependency problem and perform kernel information filtering from concrete to abstract, effectively improving the performance of the intermediate network on this problem. Next, the recursive structure of the CNN is connected to Bi-CARU to determine the sentiment analysis. The proposed Recurrent CNN implementation accepts features produced by its own previous convolution and pooling, which incorporates the performance of a CNN and requires only fewer parameters. Experimental results show that we are slightly more accurate, achieve faster convergence, and require fewer training parameters.

SpO2 Estimation Using Deep Neural Networks: A Comparative Study

Maria Carla Gammariello, Ilaria Sergi, Teodoro Montanaro and Angela-Tafadzwa Shumba (University of Salento, Italy); Pier Luigi Mazzeo and Cosimo Distante (CNR, Italy); Luigi Patrono (University of Salento, Italy)

In recent years, there has been a growing interest in using smartphones as non-invasive medical devices for estimating vital signs. One of the most important parameters for assessing the respiratory and circulatory function of a patient is the level of blood oxygen saturation, commonly known as SpO2. In this paper, we present a novel approach for SpO2 estimation using smartphone cameras and neural networks. Our proposed method uses the RGB camera of the smartphone to capture images of the fingertip and extract the photoplethysmography (PPG) signal. The PPG signal is then analysed using a convolutional neural network to estimate the SpO2 value. Specifically, a machine learning algorithm was developed for estimating blood oxygenation levels by analysing and implementing models from the literature and comparing their performance to select the best model. To validate the model, a smartphone application was developed to capture fingertip images, extract the PPG signal, and use the selected machine learning model for estimating blood oxygenation levels.

Exploring the influence of motion estimation algorithm selection and its parameters on the quality of HEVC-encoded 4K drone footage

Jakov Benjak (University of Zagreb, Croatia); Daniel Hofman (University of Zagreb & Faculty of Electrical Engineering and Computing, Croatia)

Real-time video coding on UAV devices presents a challenge where all components of the system must be optimised to get the lowest latency in the video transmission. We focus on the coding and decoding part of the pipeline where the coding side is located on the UAV and needs to also be energy efficient. Choosing the right number of reference frames which are looked at when searching for a reference block in the motion compensation in High Efficiency Video Coding (HEVC) is crucial for getting the requested video quality and maintaining the latency and power consumption in the requested range. By increasing the number of searched reference frames the quality increases but as a drawback, the power consumption and latency also increase.

We investigated the impact of Group of Pictures (GOP) structure and Motion Estimation (ME) algorithm selection on the quality of 4K drone footage encoded using the Kvazaar implementation of HEVC standard. We vary different encoding parameters such as ME algorithm, ME search step, number of referent frames

used in ME, target bitrate, etc. After encoding, three objective quality measures were calculated for all the videos. Since there were over 4000 examined videos, everything was done remotely on a supercomputer BURA.

Analysis of Sensor Data and Machine Learning Models for Gesture Recognition in Smart Toy Design

Lea Dujić Rodić (FESB, University of Split, Croatia); Ivo Stancic (University of Split, Croatia); Duje Čoko (University of Split, FESB, Croatia); Petar Solic (University of Split & FESB, Croatia)

This study focuses on the analysis of sensor data and machine learning models for gesture recognition in Smart toy design. By examining different sensor technologies and evaluating various machine learning algorithms, the research aims to determine the most effective approaches for enhancing gesture recognition. The findings obtained from analyzing the sensor data and machine learning models will provide valuable insights for developing interactive Smart toys with improved gesture recognition capabilities.

RFID5: Artificial intelligence (AI)-enhanced edge sensing and decision-making for electromagnetic devices

Dataset distillation as an enabling technique for on-device training in TinyML for IoT: an RFID use case

Andrea Accettola (Università Mediterranea di Reggio Calabria, Italy); Massimo Merenda (University Mediterranea of Reggio Calabria, Italy)

Enabling decision making at the far edge involves the capillarity distribution of Machine Learning models on resource-constrained devices with limited memory and computational capabilities. In this context, implementing the training phase on the device itself is challenging for the aforementioned limitations. The utilization of knowledge distillation as enabling techniques for single- or few-shot on-device training on resource-constrained devices is presented in this work. With the combination of histogram analysis and subsequent dimensionality reduction techniques, we show in this work an effective technique of dataset distillation that leads to condensate the information in very few observations. The use of these techniques on a dataset built of measurements from Radio Frequency Identification (RFID) devices is the subject of a case study that we provide. Our findings demonstrate that the suggested approach performance is comparable with state-of-the-art models while utilizing a sizable reduction in processing power and memory. The contributions of this work are twofold. Firstly, we provide a novel approach for on-device training which is particularly relevant for resource-constrained devices. Secondly, we present an application of the proposed method to a challenging dataset of RFID data, demonstrating its effectiveness in a real-world scenario.

An Embedded EOG-based Brain Computer Interface System for Robotic Control

Arcangelo Bruna (ST Microelectronics, Italy); Valeria Tomaselli and Oleksiy Chepyk (STMicroelectronics, Italy); Nadia Mammone (Mediterranean University of Reggio Calabria, Italy); Giuseppe Ruggeri (University of Reggio Calabria, Italy); Maurizio Campolo and Francesco Morabito (University Mediterranea of Reggio Calabria, Italy)

In this paper we present a BCI systems for robotic control to rapidly and accurately produce control commands. To this end we use four kinds of electrooculography (EOG) signals which are left winks, right winks, voluntary and involuntary eye blinks which can be easily produced and detected by using electro-stimuli grabbed with electrodes in Fronto-Polar position (Fp1, Fp2). We describe a custom hardware board based on very low noise analog front end, a tiny microcontroller (STM32F475) and wireless connectivity (Bluetooth Low Energy) and a firmware to grab digital data. Moreover a deep learning algorithm has been developed to detect and classify eye blinks and winks events. The classification can be used to control smart devices: from robotic platforms to IoT devices. In order to increase the classification reliability, we distinguish voluntary and involuntary eye blinks to prevent unwanted commands from being executed by the system. The algorithm has been designed for real time execution in tiny device, taking care both memory and complexity. The proposed asynchronous system consists of an event detection algorithm that selects segments of the signal and a 1D CNN to classify the selected portions. This system is capable of three degrees of freedom (DoF) control with an average classification accuracy of 99.3 % for the four classes of EOG signals. It has been tested by different users.

Efficient and Reconfigurable Directional Beam Steering in Phased Arrays using AI and Edge Computing

Riccardo Colella (University of Salento, Italy & National Research Council (CNR), Italy); Massimo Merenda (University Mediterranea of Reggio Calabria, Italy); Luigi Spedicato (IISS "E. Mattei" Maglie, Italy); Riccardo Carotenuto (University "Mediterranea" of Reggio Calabria, Italy); Luca Catarinucci (University of Salento, Italy)

This paper presents an Artificial Intelligence (AI) based-on method for controlling the radiation pattern of phased arrays. The method employs a feed-forward Artificial Neural Network (ANN) that is trained to steer the beam towards a desired direction by changing the radiation pattern. The ANN acts as a function that takes the pointing direction as input and returns the corresponding phase shift matrix as output for each radiating element. To ensure efficiency in terms of computational complexity and time response, specific layers are extracted from the level curve of the array factor at -3dB before training the neural network by assigning the connection weights. This approach achieves a balanced trade-off between the number of phase-shifting processes and the spatial resolution, which is crucial in contexts such as IoT and 5G. The proposed AI-based method has been successfully tested and verified using an AI-oriented Microcontroller for Edge Computing applications, where a specific neural network is implemented and used to compute phase matrices of a 4x4 phased array for a number of pointing directions obtained through data fusion of IMU data.

A Synchronous Digital Phase Detector Architecture based on a Coarse Time-to-Digital Approach

Antonello Florio (Politecnico di Bari, Italy); Claudio Talarico (Gonzaga University, USA); Gianfranco Avitabile and Giuseppe Coviello (Politecnico di Bari, Italy)

Phase detection plays a key role in many scientific and industrial applications. Furthermore, nowadays interest is put also in using the phase difference as a way to deploy localization and positioning systems. In this work, we describe and experimentally validate a novel and lightweight digital approach to phase difference estimation based on time delay measurement. The architecture is fully synchronous and employs a coarse simple Time-to-Digital converter fed by delay measurement stages to transform the phase difference information into a digital word. The experimental campaign proves what is described through the formulas that can be employed to dimension the architecture based on the desired accuracy.

Wearable Electromagnetic Sensor for Potassium Monitoring

Domenico Caggiano and Claudio Maria Lamacchia (IAMAtek Srl, Italy); Gaetano Chimenti and Angela Ferraris (IAMAtek srl, Italy); Luciano Mescia (Polytechnic University of Bari, Italy)

This paper presents a wearable potassium sensors based on a flexible electromagnetic filter. The filter design includes four supershaped double split ring resonators optimized for operating at 3.5 GHz. The RT/duroid®6202 dielectric substrates was selected for its flexibility and durability against wear and abrasion. The resonators were embedded to reduce their footprint and increase sensitivity, especially near the operating frequency. A parametric analysis was conducted to identify the optimal shape and geometrical parameters for the resonators improving sensing capabilities. The sensor performance was investigated under normal and critical conditions achieved through a curved profile on a sphere.

Capacitive Coupling for RFID-based Wireless Transcranial Link for Patient-Centric Medicine

Federica Naccarata, Addolorata Grieco and Gaetano Marrocco (University of Rome Tor Vergata, Italy)

The estimated incidence of brain tumors has increased significantly in the last 20 years for all ages. The periodic follow-up, after medical treatments, comprises expensive and invasive methods to monitor and detect the tumor recurrence. In this scenario, a telemedicine paradigm based on remote and non-invasive monitoring could improve the safety and comfort of the patient. Hence, this paper proposes a wireless transcranial link to monitor brain biophysics parameters by means of capacitive coupling between coaxial curvilinear plates in the RFID-UHF band. The compact layout of the implanted antenna permits to host in the central region additional sensors without increasing the overall footprint. Numerical simulations and a preliminary experiment demonstrate that a reliable battery-free communication link can be achieved with just 2.7 mW.

WF1: Wildfires Track I

Dead Fuel Moisture Content in Wildfire Propagation Potential Estimation for Split-Dalmatia County

Darko Stipaničev (University of Split - Faculty of Electr. Eng., Mech. Eng. and Naval Arch., Croatia); Marin Bugarić (FESB University of Split, Croatia)

Wildfire risk is quite important measure in wildfire prevention. In this paper, after a review and comparison of dead fuel moisture content models, particularly those used in practice, we present statistical analysis of dead fuel moisture content calculated using various models for our case study territory (Split-Dalmatia County in Croatia). Weather data of past fires from 2008 - 2022 were collected and used as input for dead fuel moisture calculation. In conclusions, the recommendations about the most suitable models for dead fuel moisture calculation for propagation potential estimation is given.

Advancement of an Integrated Technological Platform for Wildfire Management through Edge Computing

Lovorko Marić (Micro Digital, Croatia); Krishna Chandramouli (Venaka Treleaf, Germany); Maria I. Maslioukova and Georgia Christodoulou (Catalink Limited, Cyprus); Konstantinos Avgerinakis (Catalink Limited, Greece); Jose-Ramon Martinez-Salio (ATOS, Spain); Pavlos Kosmides (Catalink Limited, Cyprus & National Technical University of Athens, Greece)

The wildfire phenomenon is becoming an increasing threat in the climate crisis era, as estimates from the Copernicus Atmosphere Monitoring Service show that global wildfire and vegetation fires in 2022 had generated around 1,455 megatonnes of carbon emissions, while European countries such as France and Spain had emissions at their highest level since at least 2003. New conceptual, technological and computational innovations are therefore crucial for more efficient wildfire prevention and suppression, in order to mitigate the problem of extreme wildfire and its impact on climate change. An environmentally sustainable and climate resilient forest management platform to prevent and combat forest fire, which integrates a technological solution based on the incorporation of fire detection data from IoT devices and fire alarms, can provide an outlook on the potential and future of edge computing. Edge computing is therefore a crucial tool in the advancement of wildfire prevention technology, facilitating quicker response time, higher reliability of data, and more efficient data interpretation. This paper provides an overview of the use of modern technologies in wildfire prevention and subsequent data interpretation through edge computing, and proposes possible solutions for its efficient future implementation in wildfire prevention.

Predicting catastrophic wildfires is crucial for confronting the European wildfire crisis

Fermín Alcasena Urdíroz (University of Lleida, Spain); Cristina Vega (Universitat de Lleida, Spain)

Contemporary fires threaten human assets in southern European regions, and aggressive suppression efforts are ineffective during extreme wildfire episodes. In this paper, we present the wildfire risk definition, advance a proof-of-concept risk assessment example conducted in various Mediterranean areas, discuss the main misconceptions, and summarize the future research needs for developing a long-term fire-wise strategy in the European Union. Anticipating surprise catastrophic wildfires is essential to prevent losses under a changing-climate scenario, and stochastic simulation modeling allows the generation of a plausible set of candidate fire footprints likely occurring in the coming years. Developing and implementing a probabilistic fire modeling system is a crucial preliminary step to help develop a long-term adaptation strategy and confront the wildfire crisis in Europe.

Wildland fuel type mapping in Attica using Sentinel-2 time-series

Michail Sismanis, Alexandra Stefanidou, Dimitris Stavrakoudis and Ioannis Gitas (Aristotle University of Thessaloniki, Greece)

Wildfire prevention and wildfire danger modelling are becoming more critical on account of increased pressure emanating from human activities and the effects of climate change. Recently, a new fuel type classification system has been developed specifically for the conditions of the European territory, facilitating an accurate and adaptable mapping of fuels across the European landscape. The work presented in this manuscript aims at mapping fuels at a regional scale, employing machine learning algorithms on a timeseries of multispectral data, along with information derived from official thematic maps. The region of Attica in Greece was selected as the study site with an area of approximately 2,900 km^2. Two fuel type maps were generated for the years 2020 and 2022, each based on a timeseries of six Sentinel-2 images with minimum cloud cover, selected in two-month intervals. Agricultural and urban areas' extents were identified using the Land Parcel Identification System (LPIS 2018). Agricultural areas are further split into herbaceous and woody croplands, via a Support Vector Machine (SMV) classification. Urban areas are distinguished into the continuous urban fabric, discontinuous urban fabric, and non-urban classes with the use of the 2018 Copernicus Imperviousness Density product. The non-urban areas were combined with the remaining study site areas and are discriminated into broadleaved deciduous, needleleaved evergreen, shrublands, grasslands, water, and not vegetated areas using an SVM classifier. The Copernicus Tree Cover Density and the ETH Global Canopy Height official products provided the required information regarding tree height and canopy cover. To assess the accuracy of the produced map for the year 2020 Land Use and Coverage Area frame Survey (LUCAS 2018) dataset was employed. The results display a promising accuracy of 72%, considering the first level of the hierarchical classification scheme. Updated fuel type maps will be generated in the

future, with enhanced information regarding height information in grasslands and shrublands and understory structure by means of expert knowledge or field observations.

Do fire danger classes in Croatia need calibration?

Tomislava Hojsak (Meteorological and Hydrological Service, Croatia)

The Canadian Fire Weather Index (FWI) System was calibrated for Croatian Adriatic some 40 years ago. Five fire danger classes were introduced, which since then have been in use for fire danger assessment during the fire season. In the presence of the climate change the fire danger is continuously growing, which indicates the need for a review of the Fire Weather Index System and eventually a new calibration. In this paper, a simple analysis of the highest danger class was performed to determine whether there are reasons for revision of fire danger classes and possible introduction of the extreme danger class. The results show rather high occurrence of the very high danger class, 20% of cases in the fire season and 25% during the peak of fire season (July and August). The percentile values of FWI and BUI obtained by the large fire (burned area > 400 ha) analysis, especially the 50th percentile, with a 3% occurrence rate in average, can be used as an indicator of the specific fire weather conditions that can be described with an extreme fire danger class.

Preliminary Coupled Fire-Atmosphere Model Simulations over Croatia

Ivana Čavlina Tomašević (Croatian Meteorological and Hydrological Service, Croatia); Barbara Malečić (University of Zagreb, Croatia); Višnjica Vučetić (Croatia); Maja Telišman Prtenjak (University of Zagreb, Croatia)

The main focus of this study was to implement a coupled fire-atmosphere model for the first time in Croatia and to investigate possible effects of a wildfire on the surrounding atmosphere. A physically-based coupled fire-atmosphere modelling system applied in this research is the WRF SFIRE model. WRF SFIRE model has been applied for multiple wildfire cases worldwide, but never to a wildfire event from Croatia. Therefore, this study provided an opportunity to present the preliminary WRF SFIRE simulations over Croatia with the Split wildfire in July 2017 selected as the first case study. The Split wildfire is the most severe wildfire in Croatian history given the size and unexpected fire behavior, which produced the downslope fire runs into the densely populated area. In order to provide a verification of the model data, the wildfire beforehand needed to be reconstructed in detail. While the reconstruction of the wildfire gave a valuable and rare opportunity for detailed verification of the fire progression in coupled simulations, the model's option to include and exclude energy fluxes that are exchanged between the fire and the atmosphere provided an opportunity to determine whether and how a simulated fire might affect the local atmosphere. This method of running simulations in two modes - feedback 'on' and feedback 'off' mode, provided the first numerical evidence of fire-atmosphere interactions occurring in a fire event along the Adriatic coast. This research contributes to Croatian fire weather research and knowledge and although coupled simulations over Croatia should be improved with input vegetation and topography data of higher resolution, the present study lays the groundwork for future improvement and research.

WSP: RES HEAT WORKSHOP

Energy simulation scenario to social hosuing building: combining heat pump and renewable energy system

Andrea Vallati, Francesco Muzi, Costanza Vittoria Fiorini and Miriam di Matteo (Sapienza University of Rome, Italy)

The control and improvement of both energy and environmental quality of buildings are responsible for almost 40% of the emissions caused by energy processes, and are essential to achieving the United Nations climate change targets. In Italy, 84% of the buildings are residential, which makes it necessary to study redevelopment approaches in order to optimize consumption and greenhouse emissions. The aim of this proposal is to help engineers identify the most influential factors affecting energy consumption and develop the best energy-saving procedure for old social housing buildings. Indeed, research is focused on social housing and in detail, study the energy consumption of a building from the 80s, type of construction extremely common in Rome and in the city suburbs. The building in question has three floors over ground and consists of flats of different sizes. Existing literature lacks a multiple interacting factors analysis, and it has not already solved the high energy consumption problem in the existing buildings. Multiple factors that influence energy consumption have been analyzed, such as climate, architecture of the building, equipment and occupants behavior. Analysis of which factors influence the energy consumption of buildings is highly important to evaluate energy saving strategies and to plan consumption reduction in social housing residential buildings. In order to meet this requirements, an optimization proposal was studied to comparing with the current situation, so as to have two different scenarios: A: Actual Heating; B: Replacing the boiler with a heat pump and installing a photovoltaic system. The retrofit scenario is able to provide through the RESHeat system, an efficient heating system and the inclusion of summer air conditioning; these implementations also significantly reduce overall consumption and CO2 emissions.

Optimization of a thermal storage tank for a water source heat pump solar assisted

Andrea Vallati, Gianluigi Lo Basso, Francesco Muzi, Costanza Vittoria Fiorini and Miriam di Matteo (Sapienza University of Rome, Italy); Pawel Oclon (Cracow University of Technology, Poland)

This paper analyzes the performance of a hybrid photovoltaic-thermal (PVT) system with a solar-assisted heat pump to cover the electricity and air conditioning needs for a social housing building of 15 apartments with a total of about 50 occupants. This system combines a water-to-water heat pump with PVT panels to provide electricity and hot water for heating in the winter period and domestic hot water in the summer period. The PVT array provides a low-temperature heat source for the water-to-water heat pump, while cooling the PVT array and thus preventing the degradation of electrical efficiency that occurs at higher operating temperatures. The results show that in order to optimize the use of renewable energy to serve the system, the energy storage system and associated regulation plays a crucial role. This system has the potential to produce (2.4 MWh of electricity (gross) and 2.0 MWh of hot water per year, which is equivalent to just over 30 percent of the electricity and 80 percent of the hot water needs of the building under study, with the PVT field acting to reduce the heat pump electricity consumption in the heating system by just over 60 percent. The system has lower annual recurring costs than current domestic energy systems that use electricity from the grid and natural gas, despite having higher investment costs. It is also found that the system can reduce the annual CO2 emissions of the household examined by 910 kg per year (about 18 tons over a 20-year life cycle).

The mathematical model for the design of the RESHeat system

Piotr Cisek (Cracow University of Technology, Poland); Paweł Ocłoń (Al Jana Pawła II 37, Cracow & Cracow University of Technolog, Poland); Marzena Nowak-Ocłoń, Karol Kaczmarski and Monika Rerak (Cracow University of Technology, Poland); Andrea Vallati (Sapienza University of Rome, Italy); Adam Pawłowski (Cracow University of Technology, Poland)

This paper presents new computer software for the analysis and selection of components for Resheat systems. The system uses renewable energy sources (RES) to produce heat and electricity. The developed software aims at the optimal selection of the Resheat system elements and their parameters based on the

specific constraints of the investor. The Resheat system software takes into account statistical weather data for different project locations with different climates. In addition, the programme can perform a user-defined economic analysis of the system. The calculated results of the system performance in a given year may vary from the actual values by ± 20% for annual values and ± 40% for monthly values due to changing weather conditions in a given year. The results obtained from part of the resheat system (e.g. estimated energy gains from PV) were compared with the results obtained from calculations using commercial software to verify the accuracy of the calculations. The comparison shows that the results obtained from the Resheat software are at an acceptable level.

Simulation software for design improvement

Filip Bartyzel (Cracow University of Technology, Poland); Paweł Ocłoń (Al Jana Pawła II 37, Cracow & Cracow University of Technolog, Poland)

This article describes the advantages of using the simulation software for the development of the designed novel renewable energy system and for design improvements achieved from the insights of the simulation results.

BD5: Advanced energy systems and technologies in buildings

Optimization of a Hybrid Renewable Enery System for power generation on Greek Non-Interconnected Islands: The case of Amorgos

Georgios Chantzis and Anastasia Zafeiriou (Aristotle University of Thessaloniki, Greece); Amalia Chavari (Upstream S.A. Gerakas, Greece); Effrosyni Giama (Aristotle University of Thessaloniki, Greece); Paris Fokaides (Frederick University, Cyprus); Agis M. Papadopoulos (Aristotle University of Thessaloniki, Greece)

Areas isolated from the central grid, where power generation relies on fossil fuels, will have to deal with keeping their energy autonomy while increasing the RES penetration to high levels. In such areas this can only be achieved by the development of hybrid electricity production systems along with appropriate energy storage. Representative examples of such areas are undoubtedly the Greek islands. Specifically, the Greek island of Amorgos can become a model of an autonomous island with the installation of a hybrid renewable energy system at an affordable investment cost which makes it feasible. The study proposes a hybrid system that consists of renewable energy sources (wind turbines, photovoltaic panels) and storage technologies (batteries). The optimal dimensioning of each subsystem came from solving a linear programing problem that has the objective of cost minimization for the proposed system, while managing to maintain lost load at the lower possible level. The optimization took place in GAMS environment and Matlab was utilized to simulate the case study.

Analytical examination of the performance of a novel heat recovery unit consisting of a thermal wheel and a building-integrated photovoltaic/thermal system with PCM

Amin Shahsavar (Kermanshah University of Technology, Iran)

Introducing a heat recovery system that includes a thermal wheel and a building-integrated photovoltaic/thermal system with PCM and checking its monthly and annual performance are among the goals of this research. This system is able to transfer/absorb heat to/from the ambient air in order to bring its temperature to the design indoor temperature. Also, the electric power produced by the photovoltaic panels can also supply the required electrical load of the building. It was revealed that this system is able to supply 445.54 kWh of thermal load, 1214.43 kWh of electrical load of the building every year, which is equivalent to about 70% of the energy load of the building.

Investigation of Electricity Consumption and CO2 Emissions from Cooling System Operation Strategies in Mosques

Ahmet Yuksel (Yalova University, Turkey); Muslum Arici (Kocaeli University, Turkey); Michal Krajčík (Slovak University of Technology, Slovakia); Mihriban Civan and Hasan Karabay (Kocaeli University, Turkey)

Air conditioners used to provide thermal comfort conditions in indoor environments in hot summer months cause high energy consumption. In this study, three different operation strategies were proposed to diminish the electricity consumption and CO2 emissions caused by air conditioners for cooling in mosques that were regularly and intermittently used for five times a day. The findings obtained by simulating a typical neighborhood mosque in Turkey were compared with the electricity consumption invoices arising from the use of air conditioners. Furthermore, monthly average thermal comfort conditions were evaluated in the study. In Case-1, the non-operation and continuous operations of air conditioners were examined. In Case-2, air conditioners were operated at prayer times, 20 and 60 minutes before the daily prayers, until the end of the prayers. In Case-3, the cases of operating the air conditioners from the morning to the night prayer and from the noon to the night prayer were evaluated. Higher electricity consumption and CO2 emissions in cases where the air conditioners in cooling mode were operated continuously (2138 kWh, 1303 kg) and operated from the morning to the night prayer (1926 kWh, 1174 kg) than the invoices were ensured. Although the electricity consumption and CO2 emissions were lower in the operation the air conditioners during prayer times in Case-2 than invoices, monthly average thermal comfort conditions were not suitable. Therefore, it was suggested to determine the most appropriate operation strategies for air conditioners by examining the thermal comfort conditions at prayer times.

PCM-Based Glazing Systems: Solar-Optical Properties, Energy Savings, and Carbon Emission Abatement

Saboor Shaik (Vellore Institute of Technology, India); Vishnu Priya, Maduru Venkata Ramana and SK Ariful Rahaman (Vellore Institute of Technology Vellore, India); Muslum Arici (Kocaeli University, Turkey); Karolos J. Kontoleon (Aristotle University of Thessaloniki, Greece); Dong Li (Northeast Petroleum University, China)

This article demonstrates the glazing materials with improved thermal performance and solar-optical properties to suppress solar radiation transmission and achieve energy savings in buildings. The double-glazing with organic phase change materials (PCMs) in the interspace has adequate control in solar irradiance, which causes a significant reduction in heat gain/loss. PCM-filled double-glazing units will effectively reduce energy requirements for cooling and heating needs in buildings. The article presents the luminous, solar properties, and thermal properties of double-glazing units filled with various organic PCMs in the interspace experimentally. Organic PCMs with different melting points (OM 21, OM 30, and OM 35) were used in the double-glazing unit for solar-optical properties, thermal indices, and daylight inflow. A mathematical model that describes the solar and thermal properties of PCM-filled glazing systems was developed to perform thermo-economic analysis to compute the potential energy savings with various PCMs glazing systems. Low solar heat gains during summer days and minimal heat loss during winter days have been demonstrated by PCM glazing systems, resulting in low energy requirements for cooling and heating. Energy savings and carbon emission abatement potential of PCM-filled double-glazing units for a multistorey office building (G+13)

were investigated in two distinct Indian climates (Temperate& Hot). The year-round cost savings of glazing systems for various levels of latent heat utilization (25, 50, 75, and 100%) were computed; the highest cost savings of 69817 and 66344 $/year for temperate (New Delhi) and hot (Madras) climates were found for the complete utilization of latent heat. For solar heat gains through PCM-glazing systems, there was a good agreement between mathematical model results and experimental data. The glazing systems with OM 30 PCMs have concluded the carbon emission abatements of 855 and 812 tCO2/year for temperate and hot climates, respectively. The results demonstrate that PCM-based glazing systems have remarkable outcomes and can help to achieve better thermal conditions.

Current trends of district heating and cooling in Europe - A review

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District heating and cooling systems (DHCS) have been widely recognized as key energy systems for the ongoing and future decarbonization process, as well as for improving energy efficiency in the building sector across Europe. The purpose of this article is to provide a comprehensive overview of the current state of DHCS in European countries, with a specific focus on their technical characteristics, market structure, legal frameworks, and policies. Additionally, future trends in DHCS development is presented.

CS2: Citizen Science sekcija II

Calibration strategies for low-cost compact field sensors in Citizen Science Air Quality measurements: Insights from SOCIO-BEE project

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This paper delves into the calibration approaches for low-cost, compact air quality sensors (LCSs) in Citizen Science (CS) experiments. LCSs are recognized for their potential to revolutionise environmental monitoring by supplementing traditional air quality monitoring from regulatory agencies, thereby marking a paradigm shift in data acquisition. LCSs are an appealing option for creating dense observation networks, providing high spatial and temporal resolutions at affordable cost, leveraging the public participation and engagement, in order to support scientific research and regulatory decision making. However, despite the great advantages from fostering community engagement in scientific research, calibration of LCSs is of utmost importance in order to ensure data quality and their consolidation in scientific research and regulatory activities. Their accuracy, drift (due to time, temperature and/or humidity) and cross-sensitivity to non-target analytes challenge their use in official air quality databases, creating concerns regarding data quality and performance stability, which have greatly restricted its large-scale uptake. Up to now, for the calibration of LCSs, it is common practice to co-locate one or more sensors with reference monitoring air quality stations for short or long periods of time. A calibration model is then developed to establish the correlation between the raw output of the LCSs and the measurements from the reference stations, which is then transferred to the other sensors in the network. Nevertheless, it is of immense significance to outpace the limitations of LCSs under real-world conditions during citizen science experimental campaigns performed exclusively by citizen scientists. Hence, this paper discusses the challenges and the level of effectiveness of in-field calibration campaigns conducted solely by citizen scientists, which so far have received little attention by the scientific community and constitute a barrier to effective decision making. This paper discusses the requirements for accurate sensor calibration and validation, by: i) employing various citizen- and expert-operated calibration strategies, ii) including pre-deployment and post-deployment validation and iii) evaluating the impact of the duration of collocation (short-term and long-term) on the acquired results. Thus, in order to shed light to these questions, we employ data from two small networks of LCSs one in Municipality of Ancona, Italy and one in Municipality of Amaroussion, Greece, deployed through the European-funded project "Socio-Bee". We present a preliminary assessment of the feasibility of CS-based calibration measurement campaigns and finally we conclude this study with future scope to improve sensor calibration strategies in CS experiments for air quality measurements to be employed in similar citizen science projects.

Framing Citizen Science for Climate Assemblies

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Citizen engagement in Citizen Science (CS) means an active involvement of individual citizens in scientific research, policy and program development. However, it should be noted that including stakeholders in CS organisation, planning, decision-making, implementation of activities and evaluation requires adequate technological capacity, the understanding of roles and clear communication. The possibility to engage users in data science together with the power of AI algorithms presents no doubt opportunities for crowd sourced data science and collective intelligence to be brought to bear on fundamental challenges facing humanity like poverty, diseases, famines and developmental challenges. The focus of the interdisciplinary multinational consortium CLIMAS is research on empowerment of citizen scientist, researchers, civil organizations, SMEs, innovators, and policy makers by offering practical insights for co-creation of collective intelligence, aligning values and build trust between stakeholders. The project is based on idea that Climate Assemblies can be a perfect domain for participating in citizen science projects, with an active contribution of citizens by tackling environmental issues. In this sense, citizens participate in the collection of evidence, but also in the co-creation of new knowledge to increase awareness of climate change and ultimately to drive changes in climate policy.

Tackling co-delivery in co-production processes

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Co-production is a collaborative process involving two main phases, namely co-design and co-delivery. INTERLINK provides technological support to tackle co-production of public services. This work demonstrates how INTERLINK's Collaborative Environment supports effectively and efficiently co-designing public services, after having assessed it in 3 pan-European pilots, and outlines its approach to tackle co-delivery, which will deliver sustainable and replicable public services.

WF2: Wildfires Track II

Assessing human-caused wildfire ignition likelihood across Europe

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Fire ignition probability is an essential component of most fire risk assessment frameworks. This study, framed within the H2020 project FirEUrisk, features a cohesive modelling approach in a set of representative regions (pilot sites; PS) in terms of fire activity across the European territory. These PS encompass different wildfire regimes in contrasting environmental settings: PS1- Kalmar län (South-East Sweden), PS2- Southern Brandenburg and Eastern Saxony (Germany), North Bohemia (Czechia), and Lower Silesia (Poland), PS3- Central region of Portugal, PS4 - Barcelona province (Spain) and PS-5 Attica region (Greece). Our main goal was to develop a common approach to model human-caused ignitions at a fine-grained spatial resolution (100 meters). For each pilot site we (i) ascertain which factors influence ignition, hence addressing potential differences in driving forces and (ii) provide a spatial-explicit depiction of the patterns of ignition probability. For that propose, we fitted a Random Forest (RF) model in each PS from historical fire records (compiled by local fire agencies) and geospatial layers for land cover, accessibility, and population related factors. All models attained a high predictive accuracy (with AUCs that ranging from 0.69 to 0.89). In turn, the most relevant explanatory variable was the population density (ranked most influential in four out of the five PS), followed by fuel type, distance to roads, distance to the WUI, and percent cover of forest and wildlands. These findings are a valuable product to upscale future solutions at regional level (beyond NUTS3-type areas), and to enrich the science-based decisions which come from the forest and fire management agents at national and European level.

Community Involvement in Fire reporting: Time Series Examination of Official Reports and Social Media Posts in Split and Dalmatia County

Selena Knežić Buhovac (University of Mostar & University of Split, Bosnia and Herzegovina); Ljiljana Šerić (University of Split - Faculty of El. Eng., Mech. Eng. and Naval Arch., Croatia); Antonia Ivanda (University of Split - Faculty of El. Eng., Mech. Eng. and Naval Arch. Croatia, Croatia)

In this paper, we examine the value of social media posts in comparison with official records on a case study of wildfires that occured on the teritory of Split and Dalmatia County in 2021 and 2022. Three sources of data were used. Unofficial data from the Facebook social network fun page, official daily media reports posted by Croatian Fire Association and official data from the firefighting interventions database. Appropriate measures for event description based on word counts and number of intervention participants was utilized to create timeseries of data from three sources. To obtain insights into data correlation, time series analysis metrics and Pearson's and R^2, coefficient of determination were employed. While the plots reveal similarity among the data, the metrics did show evident correlation with traditional measures. However, this paper high-lights the significance and value of unofficial crowdsourced data when compared to official data and the significance of community involvement in crisis management.

Visual-SEVEIF: a tool for economic planning on wildfire decision-making

Macarena Ortega Pardo, Juan Ramon Molina and Antonio López Sancho (University of Cordoba, Spain)

The quantification of wildfire impacts on natural resources or ecosystem services is an increasingly important demand of forest and land managers as well as of fire managers, due to it is a meaningful component of the vulnerability section of the risk assessment process. Ecosystem services are part of complex and integral systems in which everything is correlated. Therefore, the economic assessment of wildfire impacts requires an integrated approach, combining ecological, economic, and social considerations. The aim of this paper is to describe and detailed explain a methodological framework for assessing economic fire impacts on both tangible and intangible ecosystem services and the exposition of some implementation examples in Andalusia Region (Spain). SEVEIF model (System for the Economic Evaluation of Forest Fires) is proposed as the methodology to calculate potential losses on ecosystem services affected by wildfires. It incorporates the concept of net-value change, considering the pre-fire value of each resource and depreciation ratio based on fire behavior. Furthermore, SEVEIF model extends the economic assessment theory to economic vulnerability using time restoration or vegetation resilience (years needed for restoring the original resources values). Visual-SEVEIF is a tool to assist in the implementation of the SEVEIF model. It is downloaded for free (www.labif.es). This ecosystem service assessment support tool is useful in different decision-making approaches as prevention, suppression and post-fire, predominantly regarding fuel treatment prioritization, cost-efficient management, and budget allocation.

Multichannel data from temporal and contextual information for early wildfire detection

Damir Krstinic (University of Split, Croatia); Ljiljana Šerić (University of Split - Faculty of El. Eng., Mech. Eng. and Naval Arch., Croatia); Antonia Ivanda (University of Split - Faculty of El. Eng., Mech. Eng. and Naval Arch. Croatia, Croatia); Marin Bugarić (University of Split, Croatia)

Modern forest fire surveillance systems offer automatic observers as an assistance to human monitoring. Intelligent algorithms analyze video stream, trying to find early visual signs of fire, which are smoke during the day and flames during the night, with large expected detection distance. In the early stage of fire, smoke occupies a very small part of the image. Degradations like mist, dust, camera shake, pronounced sunlight effects and dirt on camera lenses lowers the quality of images. In this phase smoke is often hardly distinguishable even for a human operator responsible for confirming an alarm. All of the abovementioned make detecting early visible signs of a forest fire a complex task. Deep learning algorithms applied to emerging smoke footage typically perform poorly compared to other problems, with a high false alarm rate. In this paper, we study the possibility of using other available pieces of information that define the context and dynamic characteristics of an image. This information is merged into a multi-channel image. The information content of the

resulting data set is evaluated by applying the same neural network architecture to original RGB images collected from surveillance cameras and compiled multichannel images. The obtained results encourage further research in this direction

WSP: FSES: Flexible and smart energy systems to decarbonise buildings

H1: Health I

Respiratory Disease Detection through Spectogram Analysis with Explainable Deep Learning

Francesco Mercaldo and Antonella Santone (University of Molise, Italy); Fabio Martinelli (CNR-IIT, Italy); Mario Cesarelli (University of Napoli, Italy); Luca Brunese (University of Molise, Italy)

One of the death leading cause is represented by respiratory disease. In this context the screening is really crucial in order to early diagnose respiratory disorders. In this paper we propose an approach to automatically analyse respiratory audio recordings for disease detection, by converting respiratory audio recordings into spectrograms. We design a convolutional neural network aimed to classify respiratory audio recording into one of the following classes: Bronchiectasis, Bronchiolitis, Chronic obstructive pulmonary disease, Upper respiratory tract infection, Pneumonia or Healthy. Moreover the proposed method provides a kind of explainability about the model decision by highlighting the areas on the spectograms related to a certain respiratory diagnosis, to increase confidence and trustworthiness from doctors and patients, in this way we aim to boost the development of machine learning techniques in the real-world medical context. We present an experimental analysis including 2751 different annotated respiratory audio recordings of length varying from 10s to 90s related to 126 different patients obtaining an accuracy equal to 0.849, thus showing the effectiveness of the proposed method for explainable respiratory disease detection.

Interdependency and cross-dependencies of COVID-19 time-series parameters using autocorrelation and cross-correlation

Mohammed Anwer (Independent University, Bangladesh); Ferdous Jahan (Bangabandhu Sheikh Mujib Medical University, Bangladesh)

Tools of correlation studies have been applied to open-source COVID-19 data of different countries. Considering all the restrictions and availability of data, study could be conducted on 35 countries for infection-ratio and deathrate. During this time, hospital admission and ICU admission data were available for 8 countries. Extended studies were conducted for these 8 countries. Autocorrelation has been computed till a delay of 360 days. It has been able to detect a second wave as well as a third wave for some groups of countries. Cross-correlation was computed till a delay of 60 days. Cross correlation results have found a delay of approximately 19 days between infection-ratio and death-rate.

A Novel Human Metabolism Measurement Approach and Wearable Sensor Realization for Thermal Comfort Evaluation

Pei Zhang (The Hong Kong University of Science and Technology, Hong Kong); Huihe Qiu (The Hong Kong University of Science & Technology, Hong Kong)

The metabolic rate has attracted widespread interest because it is the most important parameter in thermal comfort assessment. Nevertheless, it is often determined inaccurately. This paper establishes a novel metabolic rate model, which we believe is the first of its kind to achieve straightforward metabolism evaluation via wearable technology. The theory starts from the root of the metabolic rate, combining a new heat-loss calculation approach, which, together with heart rate, skin resistance, and body muscle rate, finally results in a linear model. Besides, a novel metabolic rate sensor is designed and invented based on the proposed theory to achieve a miniature, real-time, user-friendly, comfortable measuring device. Three environmental temperature conditions (22, 25 & 28 °C) under four physical activity stages are involved in our experiments. The remarkable results demonstrate that a linear relationship is established and verified between the metabolic rate (0 ~ 3.5 Mets) tested by the instrument and our proposed model. There is a high coefficient of determination at all temperature conditions, showing at least 95% accuracy and less than 2% uncertainty. The most notable finding is that the proposed model is deterministic for fixed objects, regardless of the experimental temperature conditions. This research focuses on wearable metabolic rate sensor measurement. Further still, our innovative approach and the designed sensor can play a constructive role in thermal comfort evaluation.

Heart Sound Classification using Deep Learning

Marija Habijan (FERIT Osijek & FEA, Croatia); Irena Galić (Faculty of Electrical Engineering, Computer Science and Inf. Technology Osijek, Croatia); Aleksandra Pižurica (Ghent University, Belgium)

Cardiac auscultation is the process of listening to the sounds of the heart with a stethoscope, which can provide important diagnostic information about a patient's heart function. It is a key component of a physical examination and can help doctors identify potential heart problems such as murmurs, arrhythmias, and valve disorders. Deep learning-based cardiac auscultation is of great interest to medical professionals as it can reduce the burden of manual auscultation by automatically detecting abnormal heartbeats. However, automatic cardiac auscultation is a challenging task due to the need for dependable and precise results, as well as the interference of background noise in heart sounds. In this work, we propose a heart sound classification method that could potentially accelerate automated cardiac auscultation. The method is based on Long Short-Term Memory (LSTM) Recurrent Neural Networks (RNN). We use heart sounds from the dataset Classifying Heart Sounds Challenge and extract input features using Mel Frequency Cepstral Coefficients (MFCCs). Further, we examine the use of a simple data augmentation technique and show that adding noise, stretching, and shifting of heart sound signals significantly improves the classification accuracy of the normal, murmur, and artifact heart sounds.

P1: Professional papers session I

Remote expert system for diagnostics of propulsion engine

Ozren Bukovac (University of Rijeka, Croatia); Vladimir Pelić and Tomislav Mrakovcic (University of Rijeka, Faculty of Engineering, Croatia); Maro Jelić (University of Dubrovnik, Croatia); Tino Vidović and Gojmir Radica (University of Split, FESB, Croatia); Nikola Račić and Branko Lalić (University of Split, Faculty of Maritime Studies, Croatia); Karlo Bratić (University of Split Maritime Studies, Croatia)

The implementation of an expert system for diagnostics of the propulsion engine with the possibility of failure prediction is the basis for condition-based maintenance. Engine failures can occur even before major repairs, so it is necessary to detect and eliminate them in time to avoid potential problems. Early

failure indication can reduce damage, allowing more time to plan appropriate maintenance which results in reduced maintenance activities and maintenance frequency. The purchase of spare parts can be reduced by timely replacement instead of mandatory replacement, and the accumulation of unnecessary parts in warehouses can also be reduced. In this paper, the data collected from the propulsion engine are analyzed using the expert's knowledge to detect irregularities and faults at an early stage. The system monitors the trends of relevant engine parameters. An innovative algorithm for detecting possible failures based on a remote monitoring system is proposed. The results obtained by applying the proposed expert diagnostic system on a ship in operation are presented.

Thermal Performance Comparison of Insulation and Phase Change Material for Building Wall Applications

Ekrem Tunçbilek and Muslum Arici (Kocaeli University, Turkey); Michal Krajčík (Slovak University of Technology, Slovakia); Dong Li (Northeast Petroleum University, China); Sandro Nizetic (University of Split, FESB, Croatia); Agis M. Papadopoulos (Aristotle University of Thessaloniki, Greece)

The paper investigates the thermal performance of PCM and Insulation comparatively by considering a building external wall. A hypothetical solar air temperature profile is assumed to increase latent heat activation of PCM. In the analyses, different layer thicknesses (2 mm - 40 mm) are tested to reveal energy saving performance of PCM and insulation for each thickness. Besides, two different locations are considered for PCM or Insulation positioning. Furthermore, different melting temperatures for PCM is studied to find optimum melting temperature, i.e., the temperature which gives highest energy saving for each thickness. According to the findings, 22 °C is found as optimum melting temperature for the inside location while it fluctuates radically for the outside location. In the case of PCM utilization, 8 mm (for the inside location) and 24 mm (for the outside location) are determined as optimum thickness values meaning that selection of any thickness other than these values reduce the energy saving performance of PCM. Comparison of PCM and Insulation energy saving performances shows that PCM outperforms Insulation for certain layer thicknesses. Consequently, it is observed that the thermal performance of PCM is strongly dependent on the latent heat exploitation and can even be better than Insulation despite its relatively high thermal conductivity value under the considered circumstances.

Optimization of auxiliary channel dimensions for improved water removal from PEM fuel cells

Jure Penga (University of Split, FESB, Croatia); Željko Penga and Klara Bonković (University of Split, Croatia); Gojmir Radica (University of Split, FESB, Croatia); Lei Xing (University of Surrey, United Kingdom (Great Britain)); Qian Xu (Jiangsu University, China)

One of the main problems that occur during the operation of proton exchange membrane fuel cells at higher workloads is the accumulation of water in porous layers that reduces the flow of gases to the catalytic layers. During the previous research, a complex flow field has been developed, which, in addition to the channels for reactants in the form of serpentines, also contains additional channels that are located near the end of the cathode flow field whose role is to enhance the removal of liquid water from the diffusion layers. Such configuration should achieve high operating efficiency, decreased pressure drop and water accumulation in cathode channels. Disadvantage of this configuration regarding the conventional serpentine geometry is manifested by increased contact resistance and complexity of geometry, which cannot be made by conventional methods such as machining processing. Therefore, during previous research the flow field with additional channels was developed using 3D metal printing technology and was experimentally tested on a unit fuel cell with an active area of 8 cm2. Experimental and numerical analyses in previous studies have shown that 6 channels result in optimal performance characteristics for channel depth of 1.25 mm. In this paper, further improvements to the newly developed concept were made using computational fluid dynamics, where the dimensions and depth of the channel corresponded to those for a smaller active area. Simulations are carried out on a larger active area of 25 cm2. The parameters of the membrane-electrode assembly for numerical simulation correspond to those obtained by experimental tests and previous validation. They were also used during the previous simulations. The aim of this study is to determine how the change in channel depth for reactants affects the performance of the fuel cell when working on increased workloads. By analyzing the obtained results, it can be concluded that the depth of the channel has significant impact on the performances of fuel cell with auxiliary channels, and it is shown at polarization curve that the configuration with channel depth of 1.25 mm has about 4% of power and electric potential increase for observed current density compared to other configurations. Also, it has very significant impact on the distribution of reactants and the accumulation of liquid water in the fuel cell.

PS: Professional short papers

Estimation of the composite ply transverse elasticity modulus distribution using semi-empirical and numerical micromechanics

Frane Vlak, Petra Bagavac, Stipe Perisic, Marko Vukasović and Branka Bužančić Primorac (University of Split, Croatia)

Transverse elasticity modulus, as effective composite ply property, can be predicted using analytical, semi-empirical or numerical micromechanics. In this paper, the simplest inverse rule-of-mixture model, as analytical representative, and Halpin-Tsai model as commonly used semi-empirical model, are applied to glass-epoxy composite ply. Parametric finite element analysis, using 3D solid elements, performed by executing finite element software ADINA within MATLAB environment for different fiber volume fractions, is applied to square, rectangular, hexagonal and diamond fiber arrangements to determine its influence on elasticity modulus distribution. All the results are compared to experimental data for unidirectional glass-epoxy composite by calculating residual sums of squares. The least square method is implemented to Halpin-Tsai and numerical rectangular fiber arrangement to find best curve fit to experimental data.

The influence of the use of waste from olive oil production on the structural and technological properties of the produced bio-coke

Michał Rejdak (Institute of Energy and Fuel Processing Technology, Poland); Michał Książek (Sintef AS, Norway); Małgorzata Wojtaszek-Kalaitzidi (Institute of Energy and Fuel Processing Technology, Poland); Bartosz Mertas (Institute of Energy end Fuel Processing Technology, Poland); Sten Yngve Larsen (Eramet AS, Norway); Robert Baron (Koksownia Częstochowa Nowa sp. z o. o., Poland)

In addition to iron ore, an important raw material in the steel production process is coke. In addition to steel production, coke is also used in a number of other important industrial processes, including the foundry industry, production of ferroalloys, insulating wool, burnt lime, carbide or as fuel for heating purposes. Depending on the process in which it is used, coke can perform various technological functions, i.e. energy (fuel - source of thermal energy), chemical (source of elemental carbon for ore reduction and carburizing) and physical (grid function - a framework for feedstock materials, providing gas permeability of the bed, drainage of liquid metal to the lower parts of the furnace). Norwegian ferroalloy industry produces more than 1 million of tonnes of ferroalloys per year (i.e. FeSi/Si, FeMn/SiMn). The Polish coke-making industry is the largest European exporter of high-quality coke. Polish coke is mainly used in blast furnaces for the production of pig iron and as a reducing agent in ferroalloy smelting processes in Norwegian smelters. Ferroalloys are enrichment

additives for the production of the highest quality steel, including special purpose steel. Because raw materials of fossil origin (coal and coke) are used as raw materials for ore reduction, the ferroalloy industry is a significant CO2 emitter, and accounts for approximately 5 % of the total industrial CO2 emissions in Norway. Eramet AS Norwegian producer of ferroalloys aims to reduce CO2 emissions by 43% by 2030. To achieve the goal - reduction of CO2 emission - it is necessary to replace fossil-based reducers with low- or zero-emission reducers of renewable - biomass origin. The idea of the implemented project is based on the production of a hybrid reductant with use of coal-biomass blends (replacement of non-renewable elemental carbon forming the coke structure with carbon from renewable sources) and verifying its suitability on a pilot scale. One of the potential biomass raw materials for this purpose may be waste from olive oil production. The presented content shows the study of the impact of the addition of waste olive pits, both in raw and thermally processed form (biocarbon) on the quality parameters of the obtained bio-coke. Bio-coke was produced on the basis of a mixture of coal and olive pits (kernels) in the amount of up to 20%. The effect of the additive on the structural properties related to pore morphology, optical texture and technological properties such as reactivity towards CO2 (CRI), post-reaction strength (CSR) and drum mechanical strength will be presented. Moreover, the parameters important from the point of view of the use of bio-coke in submerged arc furnaces (SAF) for the smelting of ferroalloys, including electrical resistivity and slag reactivity will also be shown.

Fourteen months operation of a 200 kWh latent heat storage pilot

Olav Galteland and Margaux Gouis (SINTEF & SINTEF Energy Research AS, Norway); Jorge Salgado-Beceiro (SINTEF & SINTEF Energy Research, Norway); Alexis Sevault (SINTEF & SINTEF Energy Research AS, Norway)

A latent heat storage was in 2021 installed in an office building in Trondheim, Norway. The unit contains 3 tons of CrodaTherm 37, which is a bio-based wax phase-change material with a melting temperature of 37 degrees Celsius. The thermal energy storage can be charged from heat pumps or district heating and can be discharged to domestic hot water, radiators, ventilation, or heat pumps. This unit has been collecting data on operations for over 14 months. The total thermal energy capacity was measured to be 226 kWh, and the average discharge rate over 12.2 hours of 10.51 kW and average charge rate over 11 hours of 13.7 kW was measured. An average temperature reduction of 47.3 to 38 Celsius over 234 hours during storage was measured. The average heat loss was measured to be 64 W, or 0.68% of the total capacity per day.

Thermochemical Energy Storage: an approach to integration pathways

Jorge Salgado-Beceiro (SINTEF & SINTEF Energy Research, Norway); Ragnhild Sæterli and Magnus Rotan (SINTEF Energy Research AS, Norway); Jan Hendrik Cloete (SINTEF, Norway); Margaux Gouis and Alexis Sevault (SINTEF & SINTEF Energy Research AS, Norway)

In this work we test the potential of thermochemical energy storage (TCES) for waste-heat recovery in industry processes. Different TCES technologies were considered, finding sorption TCES the most promising. The temperature range of TCES absorption technologies is extensively wide, so it was decided to focus on the most unexplored range, 100-300 °C, as it fits the heat generated in several industry processes. With the analysis of the background of TCES as solution in the mentioned temperature range and given the scarce research on it, a project idea was proposed related to water-sorption TCES. The results from this work will facilitate the industrial uptake of water-sorption thermochemical energy storage materials and technologies by analyzing the performance of compounds in a lab-scale reactor.

Energy consumption analysis according to green remodeling of public buildings

Hansol Lee (University of Science and Technology, Korea (South)); Kyeong-seok Choi (Korea Institute of Civil Engineering and Building Technology(KICT), Korea (South))

The Korean government is promoting efficient remodeling by minimizing energy consumption and improving the performance of passive and active technologies for energy efficiency in existing public buildings. This study analyzed the effect of improving energy performance before and after green remodeling through simulation results of existing public buildings, essentially demonstration sites, and actual energy consumption. The airtightness of the target building was measured after remodeling; it was observed to have improved by approximately 16%. Furthermore, primary and secondary heating energy consumption were reduced by 25.3% and 9.4%, respectively, as noted from the ECO2 simulation analysis reflecting field measurement values of airtightness performance through remodeling. On average, actual energy consumption after remodeling decreased by 34.2% compared to that before remodeling. The difference in actual energy use is the most prominent in the summer season (August); the energy usage in 2022 was observed to have decreased by 43.0% compared to that in 2019. The energy performance improvement effect through green remodeling with applied technology can considerably reduce the cooling costs during the summer season. Furthermore, it is necessary to compare the actual energy consumption before and after remodeling for many buildings in the future. In addition, a study on the economic feasibility analysis of green remodeling as well as a charge analysis on the actual usage must be conducted in the future

TPS IOT: Technical short papers IoT

Rock masses crack monitoring using a LoRa-based Wireless Sensor Network

Mattia Ragnoli (University of L'Aquila, Italy); Paolo Esposito (University of L Aquila, Italy); Vincenzo Stornelli, Giuseppe Ferri and Alfiero Leoni (University of L'Aquila, Italy); Nicola Sciarra (University of Chieti-Pescara, Italy)

Several technologies are recently evolving and allowing new possible structures and implementations for rockfall monitoring sensor networks. Wireless Sensor Networks (WSNs) are a particularly well-suited solution for geologic monitoring thanks to the flexibility that these structures offer. In this paper, an urban monitoring system for rockfall, based on crack metering, is presented. The WSN is based on Long Range (LoRa) physical layer and LoRaWAN Media Access Layer (MAC) layer. The aim is to monitor the structural health of a rock formation located in the city of Civitella del Tronto, Italy, where rock cracking is in progress. The cracks in act must be monitored for safety purposes in order to enable preventive maintenance and to ensure the management of viability. The physical part of the network is composed of sensor nodes, a central solar powered, and a gateway. The system is based on an Internet Of Things (IoT) scheme, where the data and reports are sent to an online platform. The paper reports a complete system description featuring the hardware and functionality insight of all the elements, a power analysis, details of the remote monitoring web section, and data obtained from the real scenario.

Automatic Sensor Detection System for Automotive Industry Applications

Massimo Scarsella and Mattia Ragnoli (University of L'Aquila, Italy); Beniamino Tambelli (TCM Group Srl, Italy); Germano Longo (RO. GER. PRO Srl, Italy); Giuseppe Ferri and Vincenzo Stornelli (University of L'Aquila, Italy)

In this paper, a system for the automatic detection of the state of automotive sensors is presented. In particular, we consider ultrasonic parking sensors, cameras, and radar units, mounted in cable bundles and assembled into front and rear bumpers. The apparatus operation relies on the DC electrical properties of the sensors, to recognize whether a sensor is correctly connected within the system and working properly. A microcontroller board is used to communicate the sensor state to a Programmable Logic Controller (PLC). Once performed the validation check, the results are displayed on a Graphical User Interface (GUI) to immediately recognize errors in connections or failed sensors. The system is implemented in a real industrial scenario, allowing the manufacturer to reduce work effort and time, hence the costs, for the assembly and validation of automotive components. The system is described at hardware level as well as for its functionality.

Agency and responsibility in smart air pollution monitoring

Karin Ekman and Marisa Ponti (University of Gothenburg, Sweden); Marc Peñalver Grau (Norwegian Institute for Air Research, Sweden); Nuria Castell (NILU, Norway); Rasmus Nedergård Steffansen and Enza Lissandrello (Aalborg University, Sweden)

In this paper, we use two cases to illustrate the role of citizens, researchers, and low-cost sensors for air quality monitoring in communal smart environments. In these settings, human-sensor collaborations might reconfigure relations between actors of Citizen Science and the political processes in the terms of roles, agency, and responsibilities. By looking at two cases run in Denmark and Norway, we strive to understand the roles played by citizens, researchers, and sensors in air quality monitoring, the responsibilities assigned to citizens and sensors in producing data about air pollution, and how the quality of the collected data was judged. The two cases project show that low-cost sensors constitute an important driver for participation. By collecting data that can be used by local governments to derive relevant insights and inform action, citizens can be more actively involved in improving and maintaining the quality of their living environment. In both cases, we see the sensors as holding the potential to change the way citizens look at their living environments and facilitate data creation as a purposeful and meaningful social activity

A multi-standard Universal Datalogger for industrial applications

Petar Solic (University of Split & FESB, Croatia); Mattia Ragnoli and Alfiero Leoni (University of L'Aquila, Italy); Toni Perkovic and Duje Čoko (University of Split, FESB, Croatia); Josip Sabic (University of Split, Croatia); Paolo Esposito (University of L Aquila, Italy)

Industrial applications rely on the remote data acquisition for their control systems. The possibility to implement devices that allow multi-protocol communication represents a relevant opportunity to enable more simple data exchange. This paper presents a multi-standard wired/wireless Universal Datalogger (UD) for data acquisition and control of industrial processes. In order to allow direct device deployment, the device implements data exchange mediums in the form of analog and digital inputs and outputs. First results in respect to its power consumption are presented.

Modeling and Implementation of an Adaptive Wireless Sensor Network for Low Power IoT Applications

Kardelen Olcay, Baykal Sarioglu, Ertugrul Taparci, Melike Akmandor, Banu Kabakulak and Yigit Gokdel (İstanbul Bilgi University, Turkey)

Wireless Sensor Networks (WSNs) consist of low cost and energy small electronic devices such as sensors, actuators, routers and gateways. A WSN can sense various type of data, such as temperature, humidity, pH.. etc, with the sensors scattered on an agricultural region and collect the data at a cloud database via multi-hop data transmission routes. The number of periods that a WSN operates is the network lifetime which strongly depends on the limited battery energy of the devices. Hence, in order to prolong the lifetime, we propose a centralized mathematical model which deploys minimum number of devices within limited budget, efficiently utilizes the device battery by planning their active/sleep schedules and determining the minimum energy consuming data flow paths towards the cloud. We also realized the proposed model on hardware level using low power embedded system architectures.

H2: Health II

Initial User Evaluation for a Neck Gaiter for Tracing Swallowing Movements

Tiina Vuohijoki, Tiina Ihalainen, Saara Törmä, Erja Sipilä, Karri Palovuori and Johanna Virkki (Tampere University, Finland)

This paper presents a design process, of a non-invasive neck gaiter for detecting swallowing movements. Previous studies have presented different solutions to detect swallowing movements, but according to our knowledge, none have integrated sensors into textiles. Moreover, the sensitive neck, and the thyroid area in particular, cannot be pressured with any kind of device, as it interferes with swallowing. Thus, devices used in the neck area must be comfortable. The gaiter was designed with an exploratory prototype, tested with a technical validation study, and finally, a feedback questionnaire was offered to participants. 17 participants submitted the questionnaire. The questionnaire results indicate the neck gaiter was relatively comfortable and soft; although the used Velcros were uncomfortable, and the gaiter disturbed turning the head. With the questionnaire, we identified the factors influencing user comfort during short-term usage and thus gained extremely important information for further development.

Fuzzy Inference System for Predicting Type of Delivery: A Valuable Smart Tool for Obstetrics and Gynecology

Ayman Mansour (TTU, Jordan)

In obstetrics and gynecology, a fuzzy inference system has emerged as a valuable tool for predicting delivery type in advance by considering various factors, such as the mother's age, baby head measurement, pelvis size, body mass index, blood pressure, general health risk, and gestational diabetes. The system calculates a risk score based on these factors, aiding healthcare providers in making informed decisions about the delivery process and improving outcomes for both mother and baby. By utilizing membership functions and defuzzification techniques, the system ensures that predictions are based on a comprehensive analysis of all relevant factors. In conclusion, this fuzzy inference system is an essential tool for enhancing the quality of maternal and neonatal care, offering recommendations to expecting families while providing physicians with an advisory system. Developed using MATLAB, the system was tested with real data and exhibited high accuracy of 95%, with physician validation confirming a perfect match with their decision-making.

Smartphone app based psychological interventions for patients with eating disorders

Filip Mustac (University Hospital Centre Zagreb, Croatia); Tin Galijašević (School of Medicine University of Zagreb, Croatia); Martina Matovinović and Darko Marčinko (University Hospital Centre Zagreb, Croatia)

Smartphone applications that purport to address mental health issues have become popular in the last few years. Eating disorders are characterized by a noticeable impairment in social functioning and may be highly debilitating to patients mental and physical health. Many people suffering from eating

disorders often have issues getting psychological support so smartphone apps may be a novel avenue to help these patients. The safety and efficacy of these apps has not been the topic of many studies. In this narrative review, we seek to provide practical considerations around the use and research of these applications. We conducted a PubMed search identify relevant publications on the topic of smartphone apps for eating disorders. Evidence-based content is often incorporated in apps for eating disorders but the market is currently relatively small, the most popular apps account for almost all active users. Clinicians should familiarize themselves with how those apps work so they can better explain and recommend these apps to their patients. The current marketplace should focus on promoting more evidence based apps as current research on the efficacy on the majority of smartphone apps is lacking. Clinicians should keep in mind the research gaps when choosing to recommend a particular app to a patient. While some studies have shown that online self-help interventions may produce moderately sized reductions in cognitive a behavioral symptoms of eating disorders it should be highlighted that many studies in this field have some methodological limitations like poor user adherence and high dropout rates. Despite promising new approaches for the treatment of eating disorders there are few publicly available, evidence based apps for eating disorders.

P2: Professional papers session II

Modelling a Big Data-based Analytical Process: an Aerospace Case Study

Angelo Corallo (Italy); Francesco Otello Buccoliero, Anna Maria Crespino, Vito Del Vecchio and Marianna Lezzi (University of Salento, Italy); Alessandra Spennato (Università del Salento, Italy)

Industry 4.0 experienced a wide range of cutting-edge technologies, including Big Data Analytics (BDA). BDA plays a key role in extracting value from industrial Big Data to uncover hidden patterns, correlations and market trends. In smart manufacturing, it also supports the improvement of operations and production, the reduction of machine downtime, the enhancement of product quality and a more efficient supply chain. When approaching with BDA project, it is important to accurately model and design the entire process for achieving a specific analytical goal. This paper aims to understand how to model a big data-based analytical process within manufacturing environments. To achieve this goal, starting from a theoretical background on standards for modelling analytical processes, the paper proposes the BigDAM (Big Data Analytics Modelling) framework, as an integrated conceptual representation of the key steps to consider in modelling a BDA path. Also, the framework is contextualized within an aerospace case study.

Development of ML algorithm to improve in situ measurement of the thermal properties of a building

Serena Serroni (Università Politecnica delle Marche, Italy); Marco Arnesano (Università eCampus, Italy); Gian Marco Revel (Università Politecnica delle Marche, Italy); Morh Mamoun (Università Politecnica Delle Marche, Italy)

This study presents a method to enhance the accuracy of the procedure for in-situ measurement of the wall thermal transmittance and the overall performance of the building envelope based on IoT infrared sensors. This will be achieved by applying a Machine Learning (ML) algorithm to detect and identify the various elements present within the wall, including windows, which exhibit different emissivities that are required for thermal transmittance measurement. Accounting for these differences is crucial to improve measurement accuracy and simplify the calculation of thermal transmittance. In particular, the thermographic images are processed with a detection algorithm, You Only Look Once (YOLO-v5) trained with a personalized dataset and accuracy for detecting elements (such as windows). Results show that the metric values of precision, recall, F1 for the implemented algorithm to detect windows are 0.79, 0.84, 0.81 respectively. Moreover, the identification of the different elements of the wall, having a thermographic map and therefore a punctual measurement of the transmittance value of the entire wall, allows the presence of thermal bridges to be correctly identified.

A contribution toward the definition of criteria and indicators for climate change resilient buildings

Laura Cirrincione, Giorgia Peri and Gianluca Scaccianoce (University of Palermo, Italy); Domenico Mazzeo (Politecnico di Milano, Italy); Nicoletta Matera (Independent Researcher, Italy)

Decarbonized built environments are crucial item for a future that is climate change resilient, not only in terms of environmental sustainability but also taking into account energy efficiency and economic viability, within current and future climate change and socio-economic scenarios [1].

Detection of Tomato Leaf Disease in Farmland using Deep Learning

Sarvesh Vishwakarma, Aanchal Sharma, Riya Dobhal, Naman Vijay and Prakriti Gupta (Graphic Era Deemed to Be University Dehradun, India)

This research paper proposes a model for detecting various diseases that commonly affect tomato plants using a Convolutional Neural Network (CNN). The proposed prototype was honed on a dataset that accommodates 4000 images of tomato leaves, with 400 images for each of the 10 diseases, including bacterial spot, leaf mold, late blight, early blight, Septoria leaf spot, spider mites, target spot, tomato mosaic virus, tomato yellow leaf curl virus, and healthy leaf. The proposed model uses CNN, which is a popular deep-learning technique for image recognition, to accurately classify the images into their respective categories. The model's accuracy was evaluated, and it was found that the model could detect tomato leaf diseases with a precision of 98%. Following a high level of accuracy is because of deep learning approaches that can effectively learn and extract features from the images, allowing the model to distinguish between healthy and diseased leaves accurately. Additionally, the model can help farmers identify the diseases that need to be treated in a timely and efficient manner by the cure provided by the model for every disease it detects. The proposed model takes only 20 minutes to run, which is a significant improvement in terms of speed compared to traditional methods of disease detection. The model's efficiency makes it a practical tool for farmers to use, as they can effectively identify illness in their tomato leaves, allowing them to take necessary steps to prevent plant losses and increase crop yields.

PV: Photovoltatronic

A tool providing I-V curve and IS analysis of a PV module embedded in a string

Monica De Riso, Pierluigi Guerriero and Ilaria Matacena (University of Naples Federico II, Italy); Santolo Daliento (University of Napoli Federico II, Italy)

To sustain the green transition, the Photovoltaics (PV) source is called to play a relevant role. To this aim the PV plants must operate in the better condition, thanks to smart monitoring and diagnostics tools based on single module characterization devices declined as IoT sensors. In this paper, the authors discuss

the applicability of a I-V tracer conceived to perform online characterization, to be adopted also for impedance spectroscopy analysis. Numerical simulation performed in SPICE environment prove the applicability of the proposed approach. Nevertheless, challenging design aspects are also highlighted.

Reconfigured PV array performance of BIPV system in urban area under Partial Shading Conditions

Chuanyong Shao (Universite Paris-Saclay, France); Anne Migan-Dubois (University Paris Saclay, France); Demba Diallo (Université paris Sud, France)

Partial shading Condition (PSC) is responsible for most of the power losses in a PV system, especially in urban areas with high building density. Conventional configurations, Series-Parallel (SP), Bridge-Link (BL), Honey-Comb (HC) and Total-Crossed-Tied (TCT) can mitigate these losses. Besides, physical network reconfiguration (PAR) or electrical network reconfiguration (EAR) can achieve better performance. This paper compares the performance of the four conventional configurations and two reconfiguration techniques for a homogeneous building district. Nine buildings are arranged uniformly in three rows and three columns, with the central building being the focus of the study. The areas studied correspond to the roof and a vertical (south) facade with a 5x5 PV array. The performance is evaluated by analyzing the daily energy losses on typical days in August (summer) and February (winter). With the data extracted from a database in Geneva, the results show that reconfiguration techniques can reduce the energy losses by 5% in August and 20% in February.

Bandwidth Characterization of c-Si Solar Cells as VLC Receiver under Colored LEDs

Yilong Zhou, Aya Ibrahim and Mirco Muttillo (Delft University of Technology, The Netherlands); Patrizio Manganiello (TU Delft, The Netherlands); Hesan Ziar (Delft University of Technology, The Netherlands); Olindo Isabella (Delft University Of Technology, The Netherlands)

This paper presents the fundamental study on the relationship between LED light sources and the performance of solar cell as receivers in visible light communication (VLC) links. Here, different colors of LEDs are modulated with a sinusoidal signal, and the bandwidth of various c-Si PV architectures is characterized at different bias voltages. The preliminary results show that the bandwidth of solar cells is highly influenced by the bias voltage where higher bias voltage leads to lower bandwidth. This means that there is a trade-off between energy harvesting and communication performance when solar cells are used as VLC receiver. Meanwhile, we also observed that the bandwidth decreases as the LED irradiance level increases, and the color of LED (currently red and blue LEDs are characterized) does not pose a significant impact on the bandwidth.

Novel Asynchronous Algorithms for the Detection of Shading in Fully Reconfigurable Series-Parallel PV Modules

Mirco Muttillo, Malte Ruben Vogt, Devyani Salokhe and Andres Calcabrini (Delft University of Technology, The Netherlands); Olindo Isabella (Delft University Of Technology, The Netherlands); Rudi Santbergen (Delft University of Technology, The Netherlands); Patrizio Manganiello (TU Delft, The Netherlands)

Photovoltaic (PV) systems get frequently shaded by nearby objects in urban environments, which greatly reduces their power production. A potential solution to reduce losses due to mismatch is to embed power electronics directly on PV modules, so to have a more granular control of the PV system's operation. One such embedded solution is the so-called Reconfigurable PV module, which dynamically changes the interconnection between different groups of cells within the PV module itself - the so-called cell blocks - according to its actual illumination conditions. Reconfigurable PV modules rely on reconfiguration algorithms to operate. One simple and effective reconfiguration algorithm uses cell blocks' short circuit current sensing (SCCS) to identify the actual best configuration of fully reconfigurable series-parallel PV modules. However, like many other reconfiguration strategies, SCCS operates synchronously, that is it runs periodically, independently of the actual illumination conditions and the presence of any partial shading. This article proposes a set of asynchronous shade detection algorithms, which identify suboptimal configurations during regular operation. Eight different asynchronous shade detection algorithms, consisting of combinations of four different reconfiguration mechanisms and three different shade detection mechanisms, are proposed and assessed through simulation. Afterwards, the best performing shade detection algorithm is further validated using outdoor experimental data from a fully reconfigurable PV module made of six cell blocks of sixteen series-connected cells each. The results show a significant reduction of the reconfiguration count - more than one order of magnitude - accompanied by a 0.2% increase in energy yield compared to SCCS under the same conditions.

Determining series resistance of the photovoltaic module

Mario Ratković (FESB, Croatia); Tihomir Betti (University of Split, Croatia); Ivan Marasović (University, Croatia); Ivan Škalic (University of Split, FESB, Croatia)

Procedures for determining the series resistance value of a photovoltaic module, are explained theoretically and mathematically. Applying a simulation of the mathematical model of a solar cell with two diodes in the Simulink program package, the U-I characteristics were confirmed to be in line with realistic work performance. Besides of external effects, the effect of PID on the parameters of the photovoltaic module is shown by simulation, which, in the end, effect on the normalized series resistance. Based on the effect of degradation, the conclusion is made on whether the normalized series resistance can be used as a parameter in predicting the quality of a photovoltaic module

SDN: Smart Distributed Electrical Network

Detection of Smart Grids Instability with Convolutional Neural Networks and Global Explainability

Francesco Mercaldo (University of Molise, Italy); Fabio Martinelli (CNR-IIT, Italy); Antonella Santone (University of Molise, Italy)

Smart grid is an advanced concept of power systems devoted to harmonize electricity and communication in system networks. It is able to provide real-time information to producers, operators and consumers. There is an urgent demand to efficiently route supplied energy to consumer domains such as, for instance, households, organisations, industries and also smart cities. In this context, a smart grid with a stable system is required to supply the dynamic energy demand. In this paper we propose a method aimed to detect, in real time, whether a smart grid is in an unstable state. We exploit deep learning, by considering a neural network developed by authors and global explainability, with the aim to determine the features useful in the model prediction. We evaluate a dataset composed by 60000 smart grid observations we obtain interesting results, by demonstrating the effectiveness of the proposed method.

Maximum Power Point Tracking Algorithms

Tea Erceg (University of Split & FESB, Croatia); Ivan Marasović (University, Croatia); Tihomir Betti (University of Split, Croatia); Ivan Škalic (University of Split, FESB, Croatia)

This paper covers the equivalent circuit and the principle of operation of the solar cell, as well as the influence of the current-voltage characteristic on temperature and irradiance changes. There are described maximum power point tracking techniques. The goal of algorithms is to determine the maximum current and voltage product under various irradiances. The operation of a solar cell will be demonstrated by comparing different MPPT techniques using efficiency calculation. Power loss on two parallel-connected solar panels. The power loss of two identical modules with different orientations under the same irradiation conditions is calculated to demonstrate the impact of shade on modules.

Comparison of Genetic and Reinforcement Learning Algorithms for Energy Cogeneration Optimization

Giorgia Ghione, Vincenzo Randazzo, Alessandra Recchia, Eros G Pasero and Marco Badami (Politecnico di Torino, Italy)

Large process plants generally require energy in different forms: mechanical, electrical, or thermal (in the form of steam or hot water). A commonly used source of energy is cogeneration, also defined as Combined Heat and Power (CHP). Cogeneration can offer substantial economic as well as energy savings; however, its real-time operation scheduling is still a challenge today. Multiple algorithms have been proposed for the CHP control problem in the literature, such as genetic algorithms (GAs), particle swarm optimization algorithms, artificial neural networks, fuzzy decision making systems and, most recently, reinforcement learning (RL) algorithms.

This paper presents the comparison of a RL approach and a GA for the control of a cogenerator, using as a case study a thermal power plant serving a factory during the year 2021. The two methods were compared based on an earnings before interest, taxes, depreciation, and amortization (EBITDA) metric. The EBITDA that could be obtained using the RL algorithm, exceeds both the EBITDA that could be generated using a per-week genetic algorithm and the one from the manual scheduling of the CHP. Thus, the RL algorithm proves to be the most cost-effective strategy for the control of a CHP.

TPS EM: Technical short papers engineering modelling

X-FEM Calculation of Stress Intensity Factors in a Butt-Welded structure caused by Residual Stresses

Mato Perić (University North Varaždin, Croatia); Ivica Galić and Krešimir Vučković (University of Zagreb, Croatia); Zdenko Tonković (Faculty of Mechanical Engineering and Naval Architecture, Zagreb, Croatia); Dragan Žeželj and Ivan Čular (University of Zagreb, Croatia)

In this paper the authors conducted a numerical investigation of the residual stress distribution on two butt-welded plates. After that, the obtained residual stresses were introduced to the welded model with a hypothetical semielliptic crack to calculate the stress intensity factors (SIFs) using the eXtended Finite Element Method (X-FEM). The obtained SIFs results match very well with the analytical results of the API 579-1 standard as well as with the results obtained by the conventional Finite Element Method (FEM).

Analysis of geometrical parameters for modification of Goldak heat source model in MCAW using Ar-CO2-O2 mixtures

Mato Perić (University North Varaždin, Croatia); Ivica Garašić (Faculty of Mechanical Engineering and Naval Architecture, Croatia); Zdenko Tonković (Faculty of Mechanical Engineering and Naval Architecture, Zagreb, Croatia); Maja Jurica (Faculty of Mechanical Engineering and Naval Architecture, Croatia); Mislav Štefok (University of Zagreb, Croatia); Tomasz Kik (Silesian University of Technology & Faculty of Mechanical Engineering, Poland)

In this article, the issue of Goldak heat source model modification was analysed for Metal-Cored Arc Welding (MCAW) process utilizing gas mixtures based on different argon, carbon dioxide and oxygen ratios. In order to define specific dimensions of Goldak heat flux model, bead on plate welding was performed at three heat level inputs. Consequently 3D scanning of samples was performed as well as macrograph analysis for each experiment condition. Acquired results show that both heat input and shielding gas composition influence the weld geometry and shape of fusion.

Magnetotherapy Device Induced Fields in Simplified Human Body Model

Mario Cvetković and Bruno Sučić (University of Split, Croatia)

The paper deals with the analysis of induced current density and the induced electric field in the body of a human exposed to magnetic field of a magnetotherapy device. As the displacement currents at extremely low frequencies can be neglected, the biological tissues can be considered as a weakly conducting medium, facilitating the use of a quasi-static eddy current approximation. The formulation is based on the surface integral equation for the unknown surface charges, whose numerical solution is obtained using the method of moments technique. The numerical results are presented for various configurations of magnetotherapy coil device.

Development of Nanomaterials for Sustainable Food Packaging Applications

Sanja Rackov, Milan Vraneš and Branka Pilić (University of Novi Sad, Serbia)

The actual price fluctuation of petroleum combined with ecological and environmental issues led the industrial attention to develop and design more sustainable alternatives. The use of biodegradable polymers from renewable resources in polymer manufacturing, food packaging and for medical application is becoming a favorable option over petroleum-based plastics. Among all biopolymers, biopolyesters poly(lactic acid) (PLA) and polyhidroxyalkanoates (PHAs) are considered as the most commercially promising bioplastics. PLA is a biopolyester produced by polymerization of D-, L- lactic acids originated through fermentation of simple sugars from agricultural sources (corn, potato, sugar cane, sugar beet, etc.). PHA is a generic designation for biopolyesters produced by controlled microbial fermentation in the presence of an abundant source of sugars or lipids. The main objective of this work is to develop flexible PLA/PHB thin nanomaterials for sustainable food packaging applications by means of electrospinning technique. Since PHAs possess low resistance to thermal degradation with melting temperatures close to degradation narrowing the processing window thus electrospinning technique reduce energy consumption and avoid thermal degradation during processing. A complete morphological, structural and thermal characterization of the developed materials was conducted at the same time.

Filter implementation as a means to enhance electromagnetic compatibility in chargers

Domagoj Veštić (University of Split, FESB, Croatia); Ivan Marasović (University, Croatia); Tihomir Betti (University of Split, Croatia); Ivan Škalic (University of Split, FESB, Croatia)

EMC stands for "electromagnetic compatibility," and it refers to the ability of electronic devices and systems to function properly in their electromagnetic environment without causing interference to other devices or systems. EMI stands for "electromagnetic interference", and it refers to the unwanted electromagnetic energy that can interfere with the normal operation of electronic devices and systems. Both EMC and EMI are important considerations in the design and operation of electronic devices and systems, as well as in the management of the electromagnetic environment. This is particularly true in the fields of telecommunications, aerospace, automotive, where electronic systems are often required to function in challenging electromagnetic environments. The concept of EMC has become increasingly important as electronic systems have become more prevalent and more integrated into all aspects of our daily lives. As a result, many national and international standards have been developed to help ensure that electronic systems meet minimum requirements for EMC and do not cause harmful interference. The goal of this paper is to find a way of improving conducted EMC regarding the CISPR 16 standard of a specific charger using different filters and to see how the spectrum behaves in regard to the real-life counterpart of a car charger.

Numerical and experimental analysis of residual stresses in a metal-cored arc welded I-profile

Mato Perić (University North Varaždin, Croatia); Ivica Garašić (Faculty of Mechanical Engineering and Naval Architecture, Croatia); Mislav Štefok (University of Zagreb, Croatia); Maja Jurica (Faculty of Mechanical Engineering and Naval Architecture, Croatia); Krešimir Osman (Zagreb University of Applied Sciences, Croatia); Ante Čikić and Zoran Busija (University North Varaždin, Croatia)

In this paper, the distribution of residual stresses on a structure welded by metal-cored arc welding was investigated numerically and experimentally. The residual stresses were measured by the X-ray method and correlate well with the results obtained by numerical welding simulation.

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