1st International Winter School on

Energy Efficient Sensor Interfaces and Networked Sensors

Organised by:

University of Zagreb Faculty of Electrical Engineering and Computing, and ETH Zürich

Sponsored by:

Swiss National Science Foundation SCOPES Programme

Partners:

Hrvatski Telekom d.d.,

BEST – Board of European Students of Technology,

EESTEC – Electrical Eng. Students' European Assoc.,

ACROSS – Centre of Excellence for Advanced Cooperative Systems

11th-12th December 2017, Zagreb, FER, Gray Hall

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Organisation Commitee:

General Chairs:	Vedran Bilas, University of Zagreb Michele Magno, ETH Zürich
Program Chair:	Dinko Oletić, University of Zagreb
Registration Chair:	Marko Gazivoda, University of Zagreb

Time: from Monday 11th to Tuesday 12th of December, 2017

Place: FER, Unska 3, 10000 Zagreb – Gray Hall, Gallery of FER

Workshop is intended for registered student participants.

Monday, 11th December 2017

Tuesday, 12th December 2017

09:00… …09:30	**Registration** (Gallery of FER)	
09:30… …11:00	**Session #4: Communications in sensor networks** (Gray Hall)	page
09:30… …10:15	**The Internet of Things: from Vietnam to radios & lights** Marco A. Zúñiga, TU Delft (Netherlands)	13
10:15… …11:00	**MAC Protocol leveraging Wake-Up Radio for Energy Harvesting Wireless Sensor Networks** Alain Pegatoquet, University of Nice (France)	14
11:00… …11:30	**Coffee break** (Gallery of FER)	
11:30… …13:00	**Session #5: IoT Applications: Industrial perspective** (Gray Hall)	page
11:30… …12:15	**Human sensing in smart connected lighting systems** Vana Jeličić, Zumtobel (Austria)	15
12:15… … 13:00	**IoT application in Smart City solutions – from business plan to technical implementation** Rebeka Belavić, HT (Croatia)	16
13:00… …14:00	**Farewell reception** (Gallery of FER)	

Capacitive and Eddy Current Nano-displacement Sensors: Advantages and Limitations

Dr. Stoyan Nihtianov,
Microelectronics department, Delft University of Technology

This lecture provides an overview of capacitive and eddy-current sensors for measuring very small displacements in the sub-nanometer range, in view of the latest advances in the field. The need for an accurate displacement/position measurement in such an extremely small scale as nanometers and picometers, has increased significantly over the last few years. Application examples can be found in the high-tech industry, metrology, and space equipment. A better understanding of the commonalities between these two types of sensors, as well as the main performance differences and limitations, will help to make the best choice for a specific application. The comparison is based on both theoretical analysis and experimental results. The main performance criteria used are: sensitivity, resolution, compactness, long-term stability, thermal drift, power efficiency.

Stoyan Nihtianov (M'93-SM'98) received his M.Sc. and Ph.D. degrees in electronics from the Technical University in Sofia, Bulgaria in 1980 and 1987, respectively. From 1987 till 1995 he was an Associate professor at the Technical University in Sofia, teaching and researching in the field of smart sensors and sensor systems. Since 1995 till 2000 he was with the Laboratory of Electronics, University of Technology - Delft, The Netherlands, where he was a senior research fellow engaged in the research and development of methods and electronic equipment for non-destructive testing. Since 2000 he is with the high-tech company ASML, The Netherlands, in the position of a senior research fellow. Since 2003 he is also a part-time professor in the Electronics Instrumentation lab of TU Delft, The Netherlands, leading a research group working on industrial electronic instrumentation. Stoyan Nihtianov has authored or co-authored three books and four book chapters, more than 150 peer-reviewed journal and conference scientific papers in the field of sensors and sensor interface electronics. He holds 24 patents.

Multi environmental sensor chip sensing gas, temperature and humidity

Gregor Schatzberger,
Principal Analog Design Engineer, Austrian Micro Systems

Three different types of sensors are integrated into a single environmental sensor chip. The device has the possibility to measure 3 different MOX gases by using a hot plate and special chemical compounds to identify the different MOX gases. A high resolution on chip temperature sensor featuring +-0.1% from -40 to 85°C is part of the product and a relative humidity senor. Markets like HABA, industrial IoT and smartphones fits perfect for such multi sensor solutions.

Gregor Schatzberger (born 1971) is principal analog designer at ams AG. Gregor began his 19-year semiconductor industry career in 1998 where he joined ams AG. Since then Gregor has held various roles within the BaseIP group of ams AG. Start-ing with base IP block, ADC, clock generator, PLL design and is now responsible for development, design and characterization of ams AG eeprom/flash memories. Gregor hold several patents and has written several papers. Gregor holds a degree in Electronic Engineering from the Technical University of Graz, Austria. Gregor is a citizen of the Austria.

Energy efficient smart sensors for IoT scenarios

Dr. Elisabetta Farella,
Fondazione Bruno Kessler, Italy

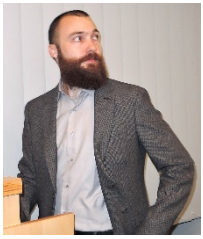
The Internet of Things, including smart objects, wearables and wireless sensor networks, is becoming a key technology in several application domains such as Smart Cities and Communities, Personal Health, HCI, Smart Retail and Industry 4.0. Key scenarios require connecting people and their environments through smart services supported by intelligent devices that observe and provide enriched contextual information. As such devices increasingly pervade physical spaces, challenges of sustainability arise in terms of scalability, device lifetime, and management of the massive amounts of generated data. The talk will approach these challenges starting at the "smart thing" level, targeting cognitive devices, i.e. exploiting local and near-sensor processing to limit communication, considering both collective and personal scenarios.

Elisabetta Farella is head of the explorative unit E3DA - Energy Efficient Embedded Digital Architecture at ICT – FBK from 2014. She received a Ph.D degree in electrical engineering and computer science from University of Ferrara in March 2005. Her research activity is in the field of microelectronics, with particular reference to components (sensors, transceivers, microcontrollers, actuators), systems (particularly "embedded" systems consisting of advanced microcontrollers interfaced with sensors and communication components) and their application, mainly in the following fields: Wireless Sensor Networks, Ambient Intelligence, Wearable Electronics (for health and rehabilitation), Internet-of-Things for natural and 3D human-computer interaction. She worked since 2014 as coordinator of the research activities on body sensor and actuators networks, smart objects and tangible interfaces at the Department of Electrical, Electronic and Information Engineering (DEI) at University of Bologna (www.dei.unibo.it) within the group of Prof. Luca Benini. She participates as team leader in many EU projects (FP6 SENSACTIONAAL, FP7 SMILING, FP7 CuPiD, Eureka Eurostar NIIT4CAD, ARTEMIS CAMMI, ARTEMIS SOFIA) and national cooperation with industries (STMicroelectronics) and research centers (INAIL, IMEC, ETH). From 2006 to 2010 she was research supervisor at T3lab (www.t3lab.it) of 3 groups of researcher working on embedded systems (wireless sensor networks, ambient assisted living, RFID).

Low-power wake-up sensor interfaces for always-on acoustic event detection

Dr. Dinko Oletić,
FER, University of Zagreb

Many acoustic event detection sensor netorks applications require on-sensor processing with a significant energy footprint, which hinders autonomous operation and battery lifetime of the sensor nodes. In this talk, we explore the sensor-node level power savings gained by splitting the processing architecture for continuous event detection into two stages: 1) an always-on ultra-low-power mixed-signal wake-up sensor (WUS) interface, performing rudimentary event recognition, and 2) main energy-hungry digital signal processor (DSP). We demonstrate architecture, implementational specifics and power budget required for design of the WUS interface for wake-up the main DSP unit upon recognition of potential acoustic events discriminated by their specific time-frequency pattern (signature). This enables for activation of the DSP only at the rate of event occurrence without penalising responsiveness and monitoring continuity.



Since April 2017 Dinko Oletić is a postdoctoral fellow at the Department of Electronic systems and Information Processing of the Faculty of Electrical Engineering and Computing, University of Zagreb. He received his Ph.D. in electronics in 2016 from University of Zagreb. Since 2010 He worked on 8 research projects and international collaborations, including one EU FP7 project and 3 project in collaboration with industry. In 2015 and 2016 he was a visiting researcher at Integrated Systems Institute (IIS) at ETH Zürich, Switzerland. His research interests include sensors and sensor networks applied to biomedical, environmental sciences, and agriculture, including hardware and software design of low-power sensing interfaces, novel signal acquisition paradigms, and energy efficient pattern recognition on energy-constrained hardware. He published 2 journal articles and more than 16 conference papers. He is member of IEEE.

Is Energy Wearable?
Wearable Energy Harvesting for smart sensing

Dr. Michele Magno,
Institut für Integrierte Systeme, ETH Zürich

Wearable technology will provide personal objects with computational, sensing and communication functions to improve our life. Power consumption is the limiting factor of such systems and energy harvesting seems a possible solution. The main challenge with wearables is how to provide enough energy for the sensors and electronics to run over a usable amount of time without increase the size of the device. This talk focuses on all aspects of energy harvesting for wearable devices addressing production technologies and architectures, energy conversion and management, system design and integration. Special focus is given to solar, thermoelectric and kinetic energy harvesting systems and the will introduce the trend of emerging flexible technology allowing wearable body applications. The presentation will provide insight into the basic principles, potential and current applications of energy harvesting systems and it will be shown two practical example and prototypes of self-sustaining intelligent wearable devices with sensors.

Dr. Magno is researcher at ETH Zurich in the Information technology and Electrical Eng, department. He received his Ph.D. degree in computer science, electronics telecommunication engineering at University of Bologna, where he joined the group of Ambient Intelligence and wireless sensor networks of the Department of Electronics, Information, Systems (DEIS). The most important themes of his research are: sensor systems, wearable devices, embedded devices and wireless sensor networks (WSN), biomedical sensors, power management techniques, signal processing of embedded devices and sensors, sensor network in different application scenarios. His research has led to interest in the design of intelligent devices, tracking systems, multi sensors, video surveillance, multimodal and ultra-low power radio triggers and wake ups, machine learning and classification algorithms, low power sensor data processing, low power radio communication and special emphasis on energy efficiency of the nodes and the network, using harvesters, such as solar panels, wind turbine, kinetic and thermal harvesters, and using the fuel cells to hydrogen to feed the nodes and recharging of batteries.

A new generation of sensing systems at the intersection of unmanned aerial vehicles and sensor networks

Dr. David Boyle,
Faculty of Engineering, Imperial College, London

This talk explores an emergent, almost symbiotic relationship between unmanned aerial vehicles and static sensing devices. In synergy, these technologies are particularly suitable for long-term monitoring applications in extreme and remote environments. Sensor data collection by mobile sink nodes has long been known to alleviate many of the problems associated with low-power and lossy wireless sensor networks, particularly in terms of energy efficiency and reliability. Autonomous aerial robots are a potentially convenient way to collect sensor data from, and deliver power wirelessly to static devices in the field. Recent results in developing data collection capabilities and wirelessly powering devices will be discussed together with a range of exciting new research problems.

David Boyle is a Research Fellow in the Department of Electrical and Electronic Engineering at Imperial College London. He is a member of the Optical and Semiconductor Devices Group, with research interests at the intersection of wireless sensing, actuation and control systems, data analytics, and the digital economy. David received his PhD in Electronic and Computer Engineering from the University of Limerick, Ireland, in 2009, for his work in the area of security for wireless sensor networks, having graduated with a B. Eng. (Hons) in Computer Engineering in 2005. Before joining Imperial, David worked with Wireless Sensor Network and Microelectronics Applications Integration Groups in the Microsystems Centre at Tyndall National Institute, and the Embedded Systems Research Group, University College Cork, Ireland. Previously, he was with Orange Labs, France, and a Visiting Postdoctoral Scholar at the Technical University of Madrid.

The Internet of Things: from Vietnam to radios & lights

Assist. Prof. Marco A. Zúñiga Zamalloa,
Computer Science Department, Delft University of Technology

Not long ago, access to the Internet was limited to ‘proper' computers: PCs, laptops, tablets and phones. Now everyday objects such as TVs, watches and cars are connected to the Internet too. And increasingly, we are embedding tiny computers into other things --such as furniture, plants and animals-- to make them part of a new ecosystem: the Internet of Things (IoT). In the future, these 'things' will form networks of their own that could, for example, lead to self-herding cattle and street lights agreeing amongst themselves about the level of illumination in our cities. The sheer number of devices expected to be part of the IoT poses two important scientific challenges. The first challenge is energy consumption. These (billions of) ‘things’ will require vast amounts of energy to operate. To flourish, the IoT needs to minimize its energy footprint. The second challenge is bandwidth. The IoT will need to communicate vast amounts of information. We need to investigate new means of wireless communication to accommodate this demand. In this talk, I will present our recent work on IoT systems based on radio and optical links, and describe how we enhance their communication and energy-efficiency performance. The talk will be divided into two parts. First, I will focus on IoT networks that communicate with low-power radios. I will describe methods to increase the lifetime and reliability of radio networks aimed at gathering sensor data. Second, I will discuss the integration of light sources into the IoT. This part will introduce two systems: one describing a novel method built upon visible light communication to monitor the energy consumption of individual lights in our homes and buildings; and the other will present a new passive communication channel that leverages any ambient light source, including the sun, to monitor mobile elements in our cities and buildings.

Marco A. Zúñiga Zamalloa is Assistant Professor at the Computer Science Department of Delft University of Technology. He's author of 40+ publications in peer reviewed journals and conferences, including: 5 ACM/IEEE IPSN, 4 ACM SenSys, 2 IEEE Percom, 1 IEEE Infocom, 1 ACM CoNEXT and 1 IEEE RTSS. He was awarded with Best Paper Awards at IEEE MASS 2015 and ExtremeComm 2013. Also his papers ended as Best Paper Runner Ups at ACM CoNEXT 2016, IEEE SenseApp 2015, ACM/IEEE IPSN 2014, ACM/IEEE IPSN 2011, and Best Poster Runner Up at EWSN 2014.

MAC Protocol leveraging Wake-Up Radio for Energy Harvesting Wireless Sensor Networks

Assoc. Prof. Alain Pegatoquet,
LEAT, University of Nice

Wireless Sensor Networks (WSNs) with energy harvesting capabilities have drawn increasing attention in the last few years, as they enable long-term monitoring applications. However, the level of power harvested is usually limited to few mW. To improve the energy efficiency of WSNs, many power management techniques have been proposed to adjust the quality of service (QoS) according to the harvested energy fluctuations. As wireless communications consume a major fraction of the available energy, numerous MAC protocols have been proposed to minimize energy consumption, latency and data collisions. In this talk, we present MAC protocol for energy-harvesting based WSNs (EH-WSNs) leveraging ultra-low power wake-up radios. To overcome the limited range typical of wake-up radios, a multi-hop wake-up scheme based on a dual radio system is proposed, enabling asynchronous communications between a base station and any node of the network, while maintaining a low latency and a high energy efficiency. This approach is applied to monitoring applications composed of autonomous sensor nodes powered by indoor light energy. OMNeT++ simulation results as well as experiments performed with real WSN platforms show the benefits of this approach in terms of energy, latency and collisions when compared to state-of-the art duty-cycled MAC protocols.

Alain Pegatoquet received the M.Sc. and Ph.D degrees in Electrical and Computer Engineering from the University of Nice Sophia Antipolis (France), in 1995 and 1999 respectively. After 9 years of experience in the industry as a system DSP engineer (VLSI Technology, Stepmind SA and Texas Instruments), he joined the Electrical and Computer Engineering department of the University Institute of Technology (IUT) of Nice as an Associate Professor in 2008. He teaches digital electronics, microprocessors, computer science, networks, Linux… Alain Pegatoquet is currently member of the “System level modeling and design of communicating objects” team of the LEAT laboratory from University of Nice Sophia Antipolis and CNRS. His research interests include power and mobility management for wireless autonomous communicating objects (energy harvesting systems), high level approaches for performance and power consumption modeling and estimation, as well as ESL approach for the design and verification of low-power System-on-Chip.

Human sensing in smart connected lighting systems

Dr. Vana Jeličić,
Technology Expert, Zumtobel Lighting GmbH

Lighting systems are recognized as a promising candidate for the Internet of Things backbone, integrating the sensors and communication modules. Collecting data from a dense network of smart sensors will enable providing information and services beyond lighting, such as about building utilization, or about people comfort and wellbeing. This talk will give an overview of sensing technologies for enhanced human detection, with their benefits and downsides, as well as respective challenges for satisfying requirements in different applications.

Vana Jeličić received her Master (Dipl.-Ing.) and PhD degree in Electrical Engineering from Faculty of Electrical Engineering and Computing (FER), University of Zagreb, in 2009 and 2014, respectively. From 2009 to 2015 she was a researcher in the Laboratory for Intelligent Sensor Systems (LISS), at the Department of Electronic Systems and Signal Processing, FER. From 2010 to 2012 she was a visiting researcher at the University of Bologna, Italy. Her main research activities have been focused on power management in wireless sensor networks with high-consuming sensors. Vana Jeličić co-authored 7 papers in peer-reviewed international journals and 15 papers at international conferences and workshops. Dr. Jeličić has been working for Zumtobel Group in Austria as a Technology Expert since November 2015. Her main tasks are scouting and assessing smart sensor technologies for connected lighting systems and ambient intelligence in general.

IoT application in Smart City solutions – from business plan to technical implementation

Rebeka Belavić,
ICT Business Development Department Director, Hrvatski Telekom

Smart City concept is one of the strategic initiatives in Deutsche Telekom, leading telecom in Europe. Hrvatski Telekom, as part of DT group, is making significant investments in their own network infrastructure, and by the smart pilot projects directly participate in transformation changes that contribute to the development of local communities. The smart solutions, like eMobility, smart waste management and air quality, are applied in local communities and generate savings in the budgets, preserve the environment, raise the citizens' quality of life, and contribute to the establishment of an entrepreneurial climate attracting new investment. Lecture will provide short overview of the Smart City solutions in Croatia and focus on technnical implementation of such a solution in one example.

Rebeka Belavić is Director of ICT Business Development in Hrvatski Telekom d.d where she is responsible for driving strategic initiatives and developing new businesses. Previously she has been working as Technical Program Manager in Deutsche Telekom where she was responsible for development and execution of aggregation networks strategy across all EU countries in DT footprint. She received Masters degree in information and communication and communication technology from Faculty of electrical engineering and computing in 2010. Her research activity was in the fieald of agent-based social networks and she co-authored 2 publications in international journals. In 2014 she received Masters degree in Business administration from ZSEM and Nagoya University of Commerce and Business, Japan with focus on strategic management, marketing and finance.




December, 2017