SENSORNETS 2020
Final Program and Book of Abstracts

9th International Conference on Sensor Networks

Valletta - Malta
February 28 - 29, 2020

Sponsored by
INSTICC - Institute for Systems and Technologies of Information, Control and Communication

ACM In Cooperation
ACM SIGMETRICS - ACM Special Interest Group on Performance Evaluation

In Cooperation with
IFSA - International Frequency Sensor Association
IET - The Institution of Engineering and Technology

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Foreword

This book contains the final program and paper abstracts of the 9th International Conference on Sensor Networks (SENSORNETS 2020), which was sponsored and organized by the Institute for Systems and Technologies of Information, Control and Communication (INSTICC) and held in cooperation with the ACM Special Interest Group on Performance Evaluation (ACM SIGMETRICS), the International Frequency Sensor Association (IFSA) and the Institution of Engineering and Technology (IET).

The Conference Program includes oral presentations (full papers and short papers) organized in eight tracks: “Energy and Environment”, “Intelligent Data Analysis and Processing”, “Security and Privacy in Sensor Networks”, “Wireless Sensor Networks” and “Wireless Sensor Networks and Architectures”, “Sensors Networks Hardware”, “Sensor Networks Software”, “Sensor Networks Applications”. Furthermore, the plenary program also includes 2 plenary keynote lectures, given by Prof. Steffen Lochmann (Hochschule Wismar, University of Applied Sciences: Technology, Business and Design, Germany) and by Prof. Stephan Olariu (Old Dominion University, United States).

SENSORNETS 2020 received 34 paper submissions from more than 20 countries. To evaluate each submission, a double-blind paper review was performed by the Program Committee, whose members were carefully selected and are highly qualified researchers in SENSORNETS topic areas. Based on the classifications provided, 6 papers were selected as full papers which led to a full paper acceptance ratio of 17,6%. This strict acceptance ratio shows the intention to preserve a high-quality forum which we expect to develop further next year. All papers presented at this conference will be available at the SCITEPRESS Digital Library.

The SENSORNETS conference series intends to be a meeting place where information exchange occurs and where collaboration projects emerge from social contacts amongst the participants.

We would like to express our thanks to all participants, and particularly to the authors, whose quality works provide the essence of this conference. Secondly, we owe gratitude to all members of the Program Committee and auxiliary reviewers, who helped us with their expertise and valuable time. We would also like to deeply thank the invited speakers for the excellent contribution in sharing their knowledge and vision. Finally, a word of appreciation for the hard work of the secretariat: organizing a sizable and reputable conference is a task that can only be achieved by the collaborative effort of a dedicated and highly capable team.

We wish you all an inspiring conference and an unforgettable stay in the lovely city of Valleta, Malta. We hope to meet you again next year for SENSORNETS 2021, details of which will soon be available at http://www.sensornets.org.

Nirwan Ansari, New Jersey Institute of Technology, United States
Andreas Ahrens, Hochschule Wismar, University of Technology, Business and Design, Germany
César Benavente-Peces, Universidad Politécnica de Madrid, Spain

Social Event and Banquet

Venue: Bacchus Restaurant, Mdina
Friday, 28th of February - 19:00 – 23:30

The walled-city of Mdina, also known as the 'Silent City', is believed to be one of Malta's iconic symbols and is especially interesting to lovers of history and architecture. Walking through Mdina's gates will allow you to travel through time to a place that has not changed much throughout the ages.


Right at the gates of Mdina, you will be met by knights, led by the Master of Ceremonies, who will escort you to the Bacchus Restaurant. There, you will be invited to watch a Knighting Ceremony, which will make you feel like you were transported to medieval times.
The restaurant, which has been preparing and serving quality food for the last forty years, is housed inside two chambers from the XVII century and, similarly to Mdina, they have also not changed much throughout the years. The chambers, built by the Grand Master Fra Martino De Redin back in 1657, have preserved their original characteristics, which turns this restaurant into the perfect place to introduce you to the Maltese cuisine.


Besides the Knighting Ceremony at the beginning of the event, there will also be more entertainment during the dinner: tarot reading, sword fighting, and even sword swallowing.
We invite you to take part in this wondrous experience, which will hopefully allow you to escape these modern times, into a different and curious scenario. We look forward to sharing this dinner and show with you during your stay in Malta!

Important Information

Internet Access
Please check at the welcome desk the information to connect to the wireless network.

Event App
Download the Event App from the Play Store and App Store now, to have mobile access to the technical program and also to get notifications and reminders concerning your favorite sessions.

Create Your Own Schedule *
The option “My Program” gives you the possibility of creating a selection of the sessions that you plan to attend. This service also allows you to print-to-pdf all papers featured in your selection thus creating a pdf file per conference day.

Online Access to the Proceedings *
In the option “Proceedings and Final Program” you cannot only download the proceedings but also access the digital version of the book of abstracts with the final program.

Digital Access to the Receipt *
By clicking on the option “Delegate Home” and then “Registration Documents” it will enable you to access the final receipt which confirmes the registration payment.

Photos Availability
The photos taken at the venue will be shared with you shortly after the event is finished. There will be an option entitled “Photo Gallery” in PRIMORIS. There, besides having access to the photos, you can also create your own personal albums by selecting “My Albums – Create New Album” and also be able to tag yourself in those photos, using the option “Tag Me”.

Keynotes Videos
The keynote lectures will also be available on video on the website after the event, as long as the appropriate authorization from the keynote is received, so you will be able to see them again or watch them should you have missed one.

Survey
Every year we conduct a survey to access the participants’ satisfaction with the conference and gather the suggestions. You will receive an e-mail after the event with the detailed information. Your contribution will be carefully analysed and a serious effort to react appropriately will be made.

* Please login to PRIMORIS (www.insticc.org/Primoris), select the role “Delegate” and the correct event.

If you have any doubt, we will be happy to help you at the Welcome Desk.

General Information

Welcome Desk/On-site Registration
Thursday, February 27 – Open from 16:15 to 18:15
Friday, February 28 – Open from 08:30 to 17:30
Saturday, February 29 – Open from 09:30 to 13:00

Opening Session
Friday, February 28, at 09:00 in the Grand Ballroom room.

Closing Session
Saturday, February 29, at 12:45 in the Grand Ballroom room.

Meals
Coffee-breaks will be served in the Foyer to all registered participants.
Lunches will be served in the Restaurant to all registered participants. Please check the hours in the Program Layout.

Communications
Wireless access will be provided free of charge to all registered participants.

Secretariat Contacts
SENSORNETS Secretariat
Address: Avenida de S. Francisco Xavier, Lote 7 Cv. C
2900-616 Setúbal, Portugal
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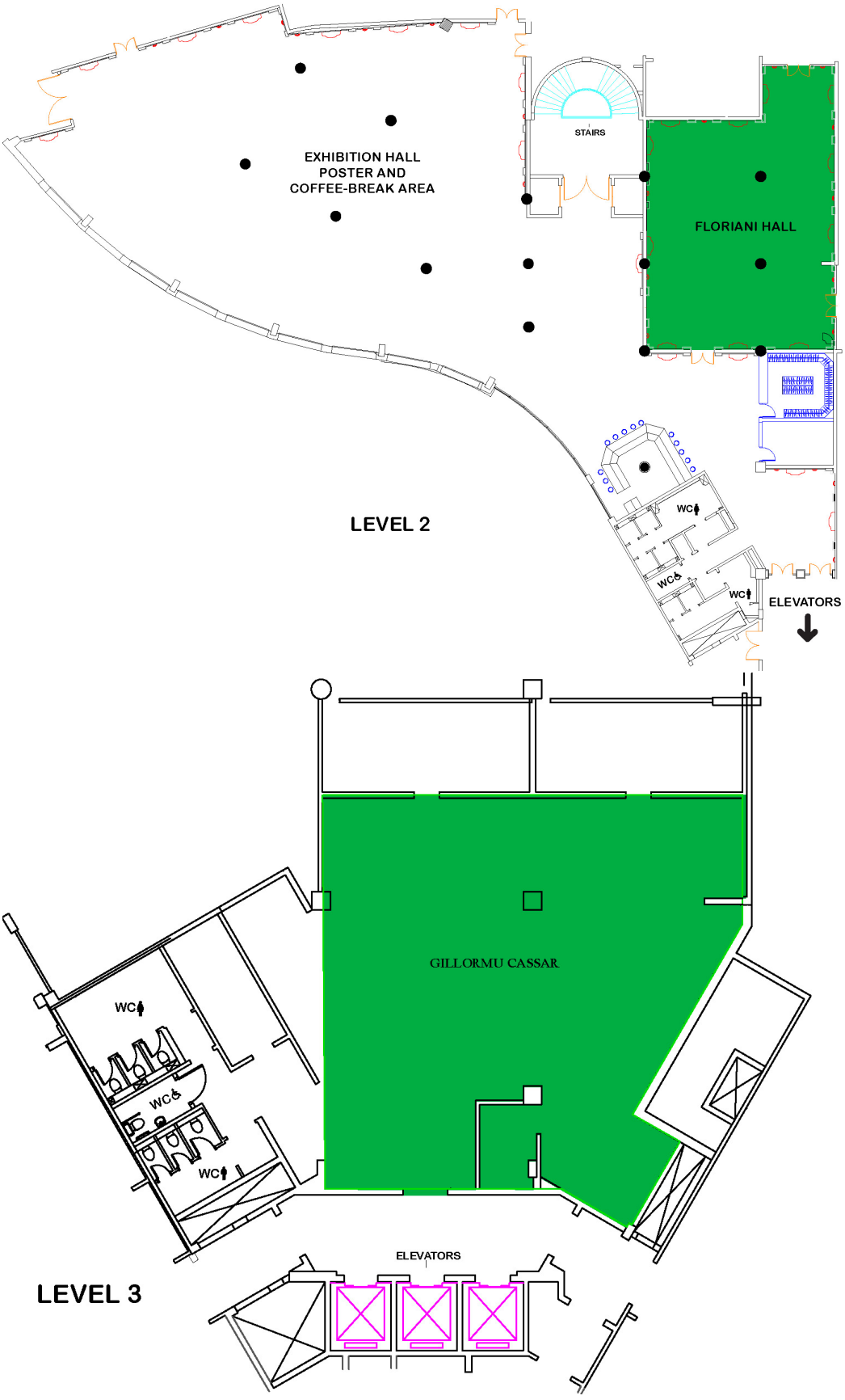
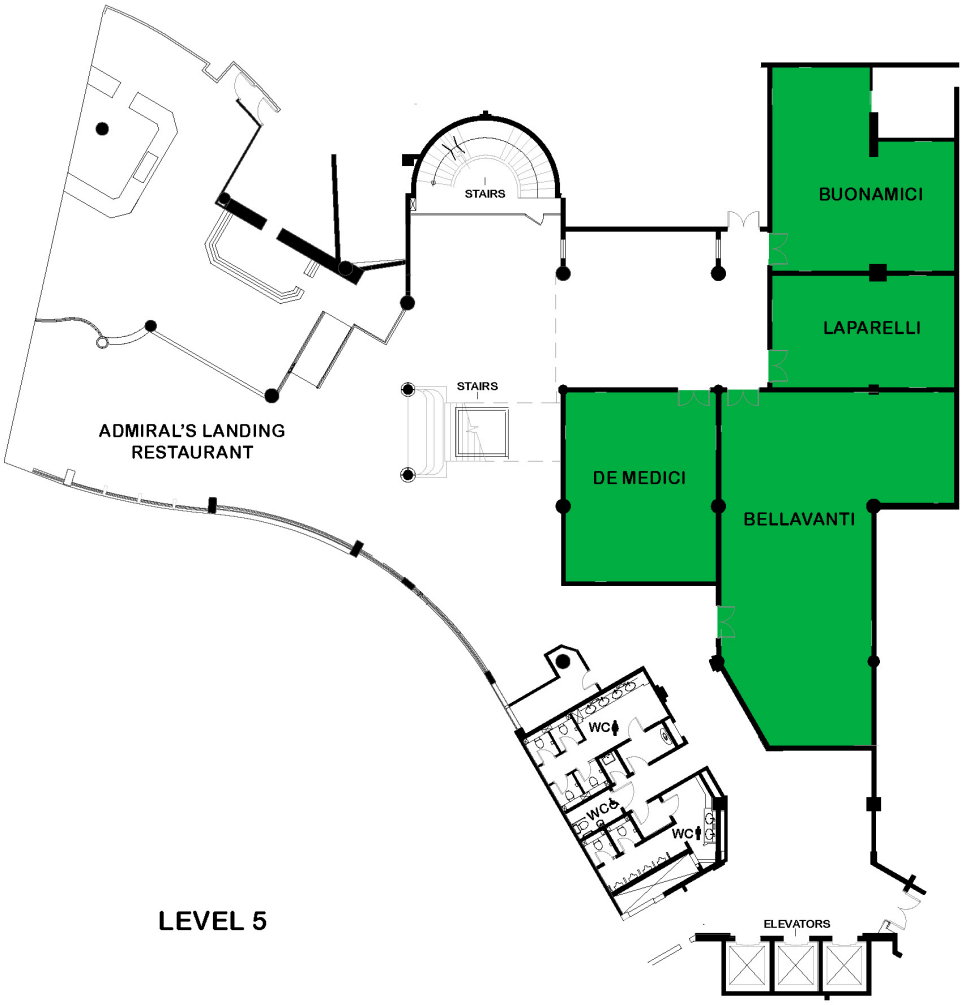
Fax: +351 265 520 186
e-mail: sensornets.secretariat@insticc.org
website: http://www.sensornets.org

Rooms Layout





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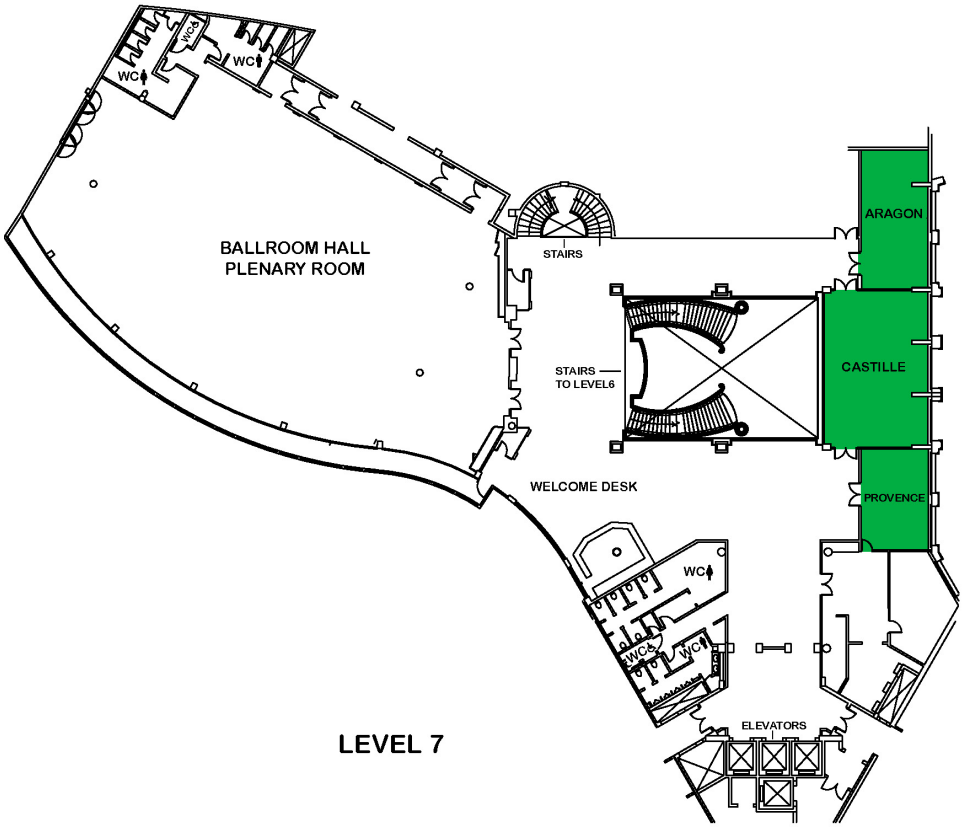

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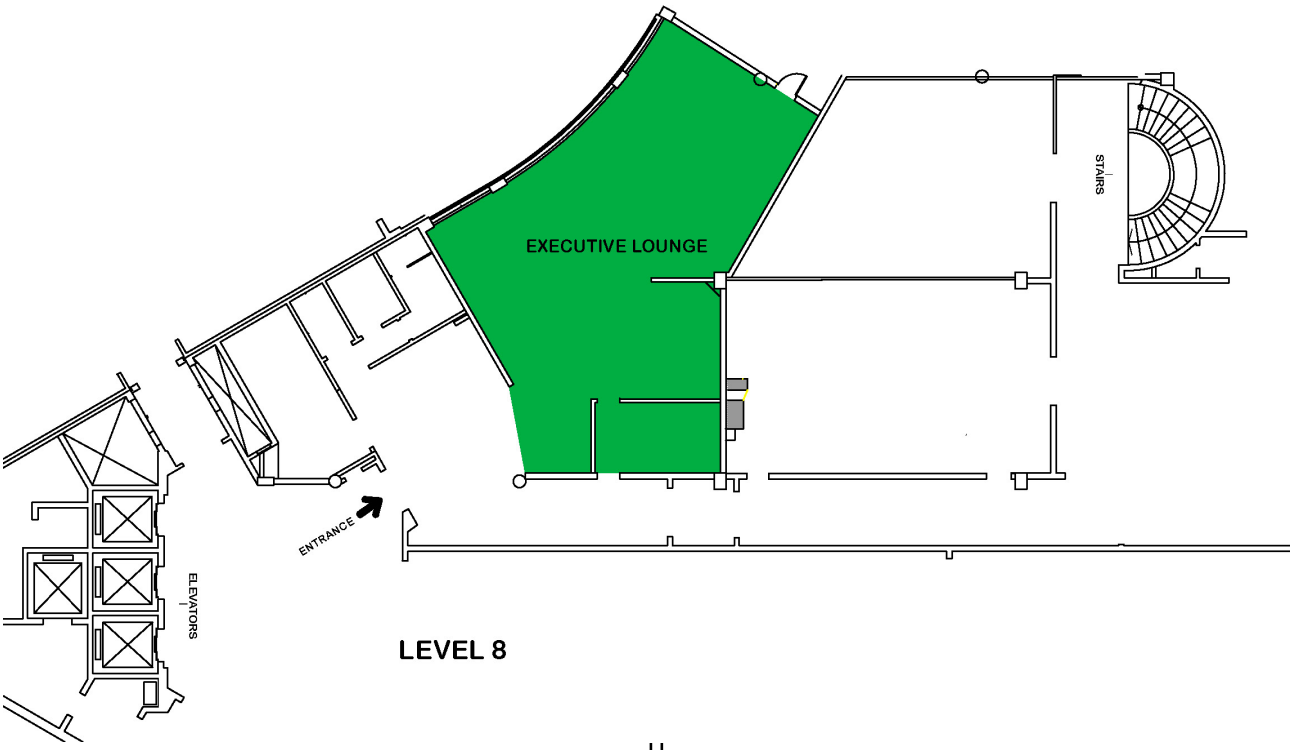

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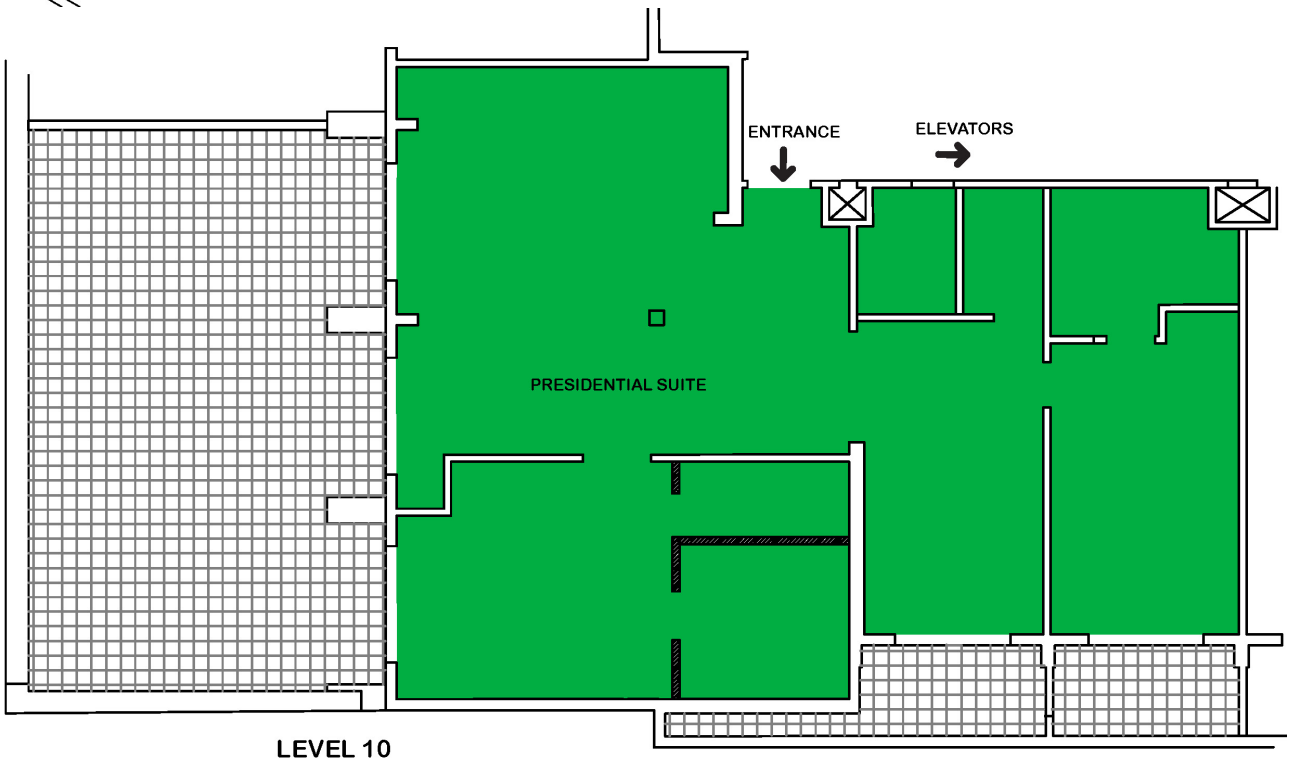

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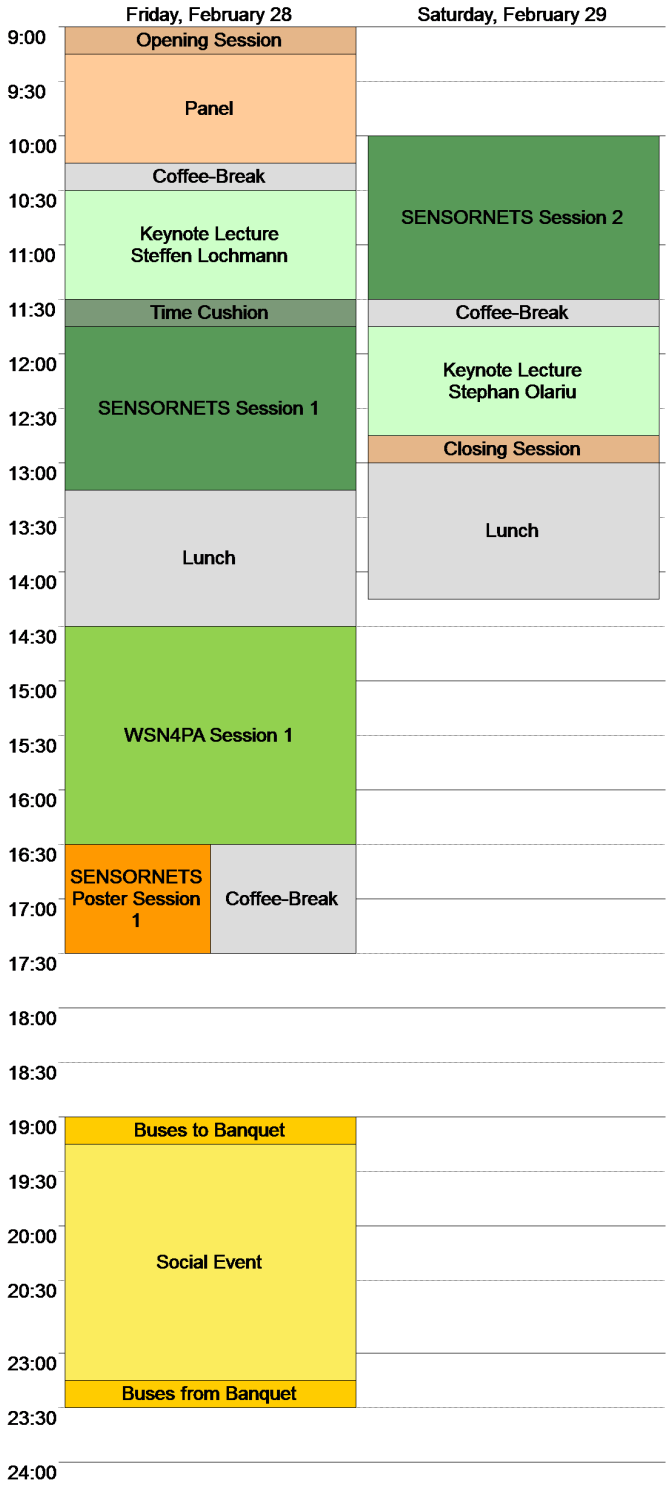

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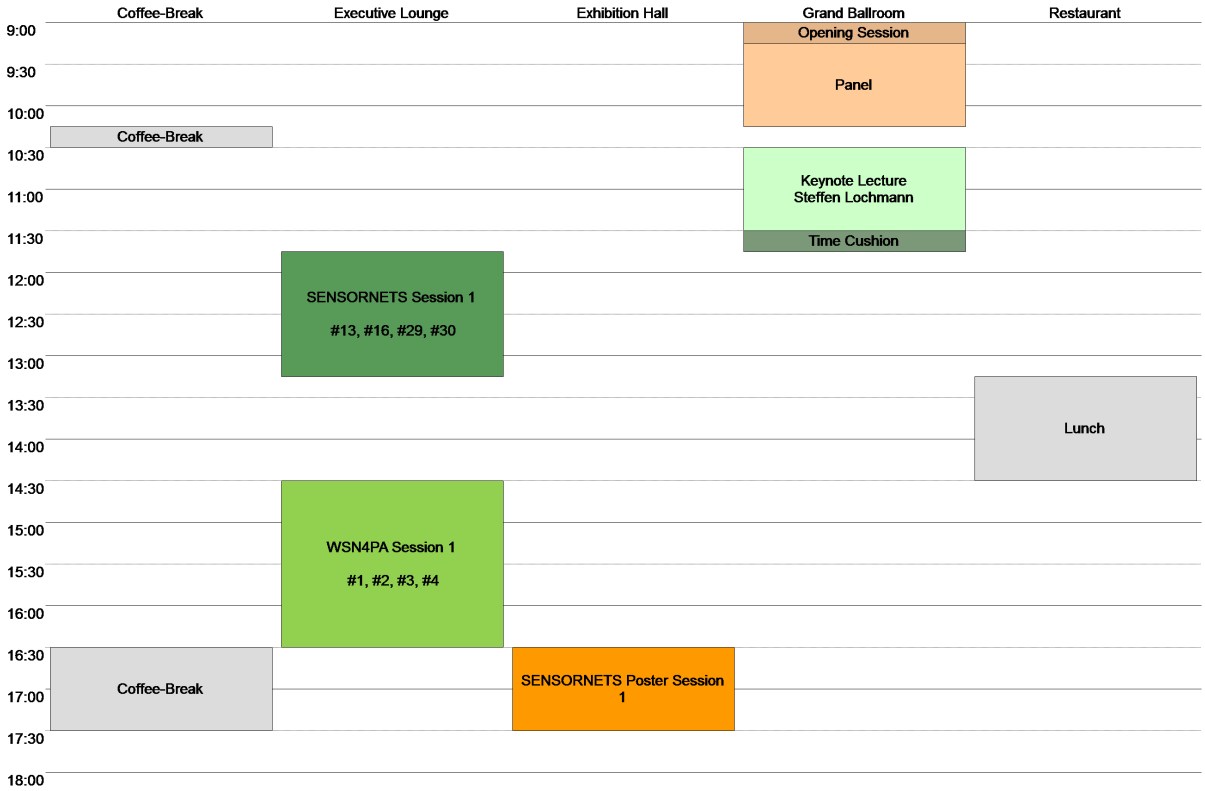

Opening Session	SENSORNETS
09:00 - 09:15	Room Grand Ballroom

Panel	SENSORNETS
09:15 - 10:15	Room Grand Ballroom

The Sensors Ecosystem: Monitoring Real Life

César Benavente-Peces[1], Andreas Ahrens[2], Nirwan Ansari[3], Stephan Olariu[4] and Steffen Lochmann[2]

[1] *Universidad Politécnica de Madrid, Spain*

[2] *Hochschule Wismar, University of Technology, Business and Design, Germany*

[3] *New Jersey Institute of Technology, United States*

[4] *Old Dominion University, United States*

Keynote Lecture	SENSORNETS
10:30 - 11:30	Room Grand Ballroom

Optical Fiber Sensors and Networks - Will They Further Brighten Our Future?

Steffen Lochmann

Hochschule Wismar, University of Applied Sciences: Technology, Business and Design, Wismar, Germany

Abstract: The optical fiber sensor sector, which started as a spin-off branch of the telecom industry decades ago, has been transformed into an independent stand-alone research area and profitable market. This market with its wide diversity has been amazingly robust over the years. Although the physical principles like intensity, phase, polarization, scattering or spectral sensing were studied in depth long ago and it seemed just a matter of a little bit of engineering to match a sensing principle to an application, we still experience constant and high annual growing rates in this market. The drivers behind it are mainly new sensor developments in terms of dimension, sensing sensitivity and dynamic range, extending fields of industry applications but also applications addressing harsh environments or EMI particularly. Moreover, the need for deploying more and more sensors, sometimes even in a massive way, asks for new developments in sensor networks, too. Here the different fields of application may set demanding boundary conditions. E.g. smart structures may demand high sensing resolution and low or even no impact on its mechanical parameters. On the other hand, pipeline intrusion detection has to deal with very long monitoring distances. Thus, new sensors, sensing concepts and related sensor networks continue to emerge and will do so in the future. Several advanced and latest examples, the author's laboratory was involved with, will be addressed in the presentation to provide evidence of an further growing and diversifying optical fiber sensor market.

Time Cushion	SENSORNETS
11:30 - 11:45	Room Grand Ballroom

Session 1A	SENSORNETS
11:45 - 13:15	Room Executive Lounge
Multi-sensor Processing and Machine Learning	

Paper #16

Deviation Prediction and Correction on Low-Cost Atmospheric Pressure Sensors using a Machine-Learning Algorithm

Tiago de Araújo[1], Lígia Silva[2] and Adriano Moreira[1]

[1] *Algoritmi Research Centre, Universidade do Minho, Guimarães, Portugal*

[2] *CTAC Research Centre, Universidade do Minho, Guimarães, Portugal*

Keywords: Low-Cost Sensors, Data Quality, Machine Learning, Environmental Monitoring, Collaborative Sensing.

Abstract: Atmospheric pressure sensors are important devices for several applications, including environment monitoring and indoor positioning tracking systems. This paper proposes a method to enhance the quality of data obtained from low-cost atmospheric pressure sensors using a machine learning algorithm to predict the error behaviour. By using the extremely Randomized Trees algorithm, a model was trained with a reference sensor data for temperature and humidity and with all low-cost sensor datasets that were co-located into an artificial climatic chamber that simulated different climatic situations. Fifteen low-cost environmental sensor units, composed by five different models, were considered. They measure – together – temperature, relative humidity and atmospheric pressure. In the evaluation, three categories of output metrics were considered: raw; trained by the independent sensor data; and trained by the low-cost sensor data. The model trained by the reference sensor was able to reduce the Mean Absolute Error (MAE) between atmospheric pressure sensor pairs by up to 67%, while the same ensemble trained with all low-cost data was able to reduce the MAE by up to 98%. These results suggest that low-cost environmental sensors can be a good asset if their data are properly processed.

Paper #29

Anomaly Detection in Beehives using Deep Recurrent Autoencoders

Padraig Davidson, Michael Steininger, Florian Lautenschlager, Konstantin Kobs, Anna Krause and Andreas Hotho

Institute of Computer Science, Chair of Computer Science X, University of Würzburg, Am Hubland, Würzburg, Germany

Keywords: Precision Beekeeping, Anomaly Detection, Deep Learning, Autoencoder, Swarming.

Abstract: Precision beekeeping allows to monitor bees' living conditions by equipping beehives with sensors. The data recorded by these hives can be analyzed by machine learning models to learn behavioral patterns of or search for unusual events in bee colonies. One typical target is the early detection of bee swarming as apiarists want to avoid this due to economical reasons. Advanced methods should be able to detect any other unusual or abnormal behavior arising from illness of bees or from technical reasons, e.g. sensor failure. In this position paper we present an autoencoder, a deep learning model, which detects any type of anomaly in data independent of its origin. Our model is able to reveal the same swarms as a simple rule-based swarm detection algorithm but is also triggered by any other anomaly. We evaluated our model on real world data sets that were collected on different hives and with different sensor setups.

Paper #30

Classification of Honeybee Infestation by *Varroa Destructor* using Gas Sensor Array

Andrzej Szczurek[1], Monika Maciejewska[1], Beata Bąk[2], Jakub Wilk[2], Jerzy Wilde[2] and Maciej Siuda[2]

[1] *Faculty of Environmental Engineering, Wroclaw University of Science and Technology, Wyb. Wyspiańskiego 27, 50-370 Wrocław,Poland*

[2] *Apiculture Department, Warmia and Mazury University in Olsztyn, Sloneczna 48, 10-957 Olsztyn, Poland*

Keywords: Semiconductor Gas Sensor, Beehive, Indoor Air, Varroosis, Measurement.

Abstract: Infestation of bee colony with *Varroa destructor* proceeds exponentially. It is important to detect the disease at its very early stage. However, the distinction of later infestation stages is also practical. We proposed to apply gas sensor array measurements of beehive air as the source of information which may be useful for this kind of assessment. Honeybee infestation was classified into three categories: 'low', 'medium' and 'high', two categories: 'low' and 'medium to high', and another two categories: 'high' and 'medium to low'. Responses of gas sensor array to beehive air were used as the input data of the classifier, which was trained to distinguish the categories. The results of the analysis demonstrated that category 'low' was determined most effectively, with an error rate of about 10%. Category 'high' was most difficult to determine. In this case the lowest error rate was about 20%. Based on our analysis, the approach based on binary classification was favoured and SVM outperformed ensemble of classification trees. It was found, that first several minutes of gas sensors exposure to beehive air were sufficient to attain effective classification. The presented method of varroosis determination, based on beehive air sensing with gas sensors is innovative and has high potential of application in beekeeping.

Paper #13

A Robust Serial FBG Sensor Network with CDM Interrogation Allowing Overlapping Spectra

Marek Götten[1,2], Steffen Lochmann[1], Andreas Ahrens[1] and César Benavente-Peces[2]

[1] *Bereich Elektrotechnik und Informatik, Hochschule Wismar, Phillip-Müller-Straße 14, Wismar, Germany*

[2] *Escuela Técnica Superior de Ingeniería y Sistemas de Telecomunicación, Universidad Politécnica de Madrid, Crtra de Valenica, km 7, Madrid, Spain*

Keywords: Code-Division Multiplex, Fiber-Bragg-Gratings, Smart Structures, Serial Optical Sensor Networks, Optical Autocorrelation.

Abstract: Massive optical sensor networks gained a lot of attention in recent years. They offer new advances in the fields of smart structures and health monitoring. All serial optical sensor networks rely on multiplexing techniques that provide huge amounts of sensors in a single optical fiber. Wavelength-division multiplex (WDM) which has been established in many applications, is restricted to the spectral width of the used light source that needs to be shared by several non-overlapping fiber-Bragg-grating (FBG) spectra. Time-division multiplex (TDM) uses short impulses and relies on different sensor round trip delays to distinguish each single FBG. These short impulses and long round trip times lead to a low signal-to-noise ratio (SNR). Optical frequency-domain reflectometry (OFDR) offers a high spatial resolution of FBGs but only within a short fiber length. This contribution deals with a code-division multiplex (CDM) interrogation technique that provides numerous sensors in a single optical fiber, a better SNR, and a long range of distributed sensing points. It requires codes with good autocorrelation behavior which is characterized by certain criteria. The detectable criteria are limited which narrows significantly a search for best possible codes for the interrogation system. In this contribution, practical implementation limits such as the trigger timing and the achievable SNR are studied. Based on the introduced SNR definitions for CDM and WDM systems, a direct comparison is possible and it shows the superiority of the proposed CDM scheme. A network with 25 sensors operating at the same wavelength can provide a 2.67 dB improvement compared to WDM

Special Session **WSN4PA**
14:30 - 16:30 **Room Executive Lounge**
Wireless Sensor Networks for Precise Agriculture

Paper #4

Digital Villages: A Data-Driven Approach to Precision Agriculture in Small Farms

Ram Fishman[1], Moushumi Ghosh[2], Amit Mishra[2], Shmuel Shomrat[3], Meshi Laks[1], Roy Mayer[1], Aakash Jog[4], Eyal Ben Dor[3] and Yosi Shacham-Diamand[1,4]

[1] *School of Public Policy, Faculty of Social Sciences, Tel Aviv University, Tel Aviv, Israel*

[2] *TAU/TIET Food Security CoE, Thapar Institute of Engineering and Technology, Patiala, Punjab, India*

[3] *Remote Sensing Lab, Faculty of Exact Sciences, Tel Aviv University, Tel Aviv, Israel*

[4] *School of EE, Faculty of Engineering, Tel Aviv University, Tel Aviv, Israel*

Keywords: Precision Agriculture, Sensor Network, Field-deployable Sensors, Satellite Multispectral Imaging.

Abstract: An approach for system monitoring of smallholder farms. The system will be based on low-cost mobile units (i.e. IoTs, phones) collecting and transmitting data directly from the farms. The IoT information will be merged with available and free access satellite data to form near real-time thematic images to the end-users. It will serve people with low technical literacy who are working with smallholders in developing countries. The novelty of using an integrated interdisciplinary behavioral-technological approach that builds on our respective disciplinary expertise, and the ability to pilot and implement at scale through partnerships, on the ground, allowing gaining new insights into smallholder cultivation and revolutionizing agricultural extension in the developing world. To achieve that goal of Holistic Integrated Precision Agriculture Network (HIPAN) three networks have been established in experimental farms in India: wireless network for "on-the-ground" sensing, virtual network with satellite multispectral imaging-based data and social network collecting the farmers' inputs. The three networks are fused together and the data is processed using a cloud supported data analysis; the results are visually transferred to the farmers as well as to organizations and companies for their benefit.

Paper #1

Reliability Comparison of Routing Protocols for WSNs in Wide Agriculture Scenarios by Means of η_L Index

Marco Cagnetti, Mariagrazia Leccisi and Fabio Leccese

Dipartimento di Scienze, Università degli Studi "Roma Tre", via della Vasca Navale n.84, Rome, Italy

Keywords: WSN, Routing Protocols, AODV, LEACH, PEGASIS, MPRR.

Abstract: A comparison between the most suitable routing protocols for WSNs applied in wide agriculture scenarios is shown. The protocols, already present in literature, have been conceived to better manage the power budget of the nodes and are particularly suitable to cover the energy issues that wide agriculture scenario can request. This study aims to indicate which of the protocols eligible for this scenario is the most suitable. Comparative simulation test will be shown.

Paper #2

A Wireless Sensor Network based on Laser-annealed ZnO Nanostructures for Advance Monitoring in Precise Agriculture

Davide Polese[1], Francesco Maita[1], Ivano Lucarini[1], Antonio Ferraro[2,3], Antonio De Luca[2,3], Domenico Cannatà[1] and Luca Maiolo[1]

[1] *IMM - Istituto per la Microelettronica e Microsistemi, CNR- Consiglio Nazionale delle Ricerche, Via del Fosso del Cavaliere n.100, 00133 Roma, Italy*

[2] *Department of Physics, University of Calabria, 87036 Rende, Italy*

[3] *CNR-Licryl Lab., NANOTEC Institute, 87036 Rende, Italy*

Keywords: Wireless Sensor Network, ZnO Nanorods, Laser-annealed Gas Sensors, Precise Agriculture.

Abstract: Plants own a complex way to communicate with each other based on the exchange of chemical and electrical signals. Indeed, plants are capable of creating extensive communication networks thus warning each other of the presence of pests. In response, plants trigger natural strategy against the infestation. The main tool used by plants for exchanging information is the emission and detection of specific volatile organic compounds in air. To this end, monitoring these compounds can be crucial to reveal the state of health of a cultivation far before visual symptoms arise. In this work, we present a wireless sensor network where each node is based on highly sensitive zinc oxide nanostructures enabling the detection and the discrimination of several chemical gases such as CO, CO_2, NO, NO_2, CH_4, etc. The response of each sensor is tuned by using excimer laser annealing procedure, a technique that changes the electrical and morphological properties of the sensing material. This wireless sensor network can be an appealing solution to capture signals coming from the plants without the usage of bulky and expensive equipment.

Paper #3

Internet of Trees: A Vision for Advanced Monitoring of Crops

Alessandro Checco[1] and Davide Polese[2]

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[2] *Istituto per la Microelettronica e Microsistemi, Consiglio Nazionale delle Ricerche, Roma, Italy*

Keywords: Precision Agriculture, WSN, OpenThread, Chemical Gas Sensors.

Abstract: Ecosystem preservation and production maximisation are competing objectives in agriculture. Reducing the need of undifferentiated or late interventions on the crops would reduce the number of disease treatments needed, as well as the consumption of water and fertiliser. This objective is only attainable through crop monitoring systems able to reach a single plant. Precision agriculture employ continuous and pervasive monitoring of crops, that in turn allows fast and targeted interventions. The aim of this paper is to highlight the problems that can be found in designing a wireless sensor network (WSN) able to measure environmental parameters such as relative humidity, irradiance and volatile pollutant concentration and introduces a possible solution that we named the Internet of Trees.

Poster Session 1 **SENSORNETS**
16:30 - 17:30 **Room Exhibition Hall**

Paper #1

Gallium Nitride based Hall-effect Sensors for Automotive, Aerospace, and Embedded Power Systems

Hannah Alpert[1], Caitlin Chapin[1], Karen Dowling[2], Savannah Benbrook[2], Helmut Köck[3], Udo Ausserlechner[3] and Debbie Senesky[1]

[1] *Department of Aeronautics and Astronautics, Stanford University, Stanford, CA, U.S.A.*

[2] *Department of Electrical Engineering, Stanford University, Stanford, CA, U.S.A.*

[3] *Infineon Technologies Austria AG, Villach, Austria*

Keywords: Magnetic Sensor, Hall-effect, Gallium Nitride, Wide Bandgap, Semiconductor, High Temperature, Extreme Environment.

Abstract: Hall-effect sensors are widely used in the automotive industry, in power electronics, and within inertial measurement units (IMUs) for navigation and position sensing. There is a growing need for Hall-effect sensors that can operate under extreme conditions, specifically in high temperature environments such as deep underground (e.g., well-logging) and in outer space. Electronic components, including Hall-effect sensors, are typically made of silicon, but these components begin to breakdown at temperatures beyond 200℃, and thus external cooling is often required. However, implementing external cooling processes necessitates additional power and contributes further bulk and complexity to the system, leading to increased size, weight, and overall costs of the system. Thus, components that can operate at extreme temperatures without additional cooling are necessary for achieving higher efficiency, higher reliability, and lower cost. Wide bandgap semiconductors such as gallium nitride (GaN) and aluminum nitride (AlN) have been shown to operate up to 1000℃ in vacuum and thus are a prime candidate for electronics in harsh environmental conditions. We have developed GaN-based

Hall-effect sensors with high sensitivity (similar to commercial silicon devices) and extremely low offsets. We characterized their voltage- and current-scaled magnetic sensitivities between room temperature and 600℃. Both devices showed decreasing voltage-scaled sensitivity at high temperature, corresponding to the decreasing electron mobility due to scattering effects at elevated temperatures. Alternatively, current-scaled sensitivities remained stable over the temperature range, only varying by 10% from their mean, due to a minimal dependence of sheet carrier concentration on temperature. Both devices showed consistency in their voltage- and current-scaled sensitivity over multiple temperature cycles as well as nearly full recovery when returned to room temperature after thermal cycling. Additionally, a sample held at 576℃ for 12 hours also showed nearly full recovery at room temperature, further suggesting that GaN-based Hall-effect sensors are a good candidate for use in high temperature applications.

Paper #2

Analysing Usage of Harvested Energy in Wireless Sensor Networks: A Geo/Geo/1/K Approach

O. Angwech[1], A. Alfa[2,3] and B. Maharaj[1]

[1] *Department of Electrical, Electronic and Computer Engineering, University of Pretoria, Pretoria 0002, South Africa*

[2] *Department of Electrical and Computer Engineering, University of Manitoba, Winnipeg, Manitoba, Canada*

[3] *Department of Electrical, Electronic and Computer Engineering, (CSIR/UP SARChI ASN Chair), University of Pretoria, Pretoria 0002, South Africa*

Keywords: Wirless Sensor Networks, Energy Harvesting, Markov Chain.

Abstract: A model that considers energy storage and usage in data transmission in Wireless Sensor Network applications is proposed. The system is modelled as a Geo/Geo/1/k system and analysed using standard finite Markov chain model tools. The stationary distribution of the queue length is obtained. In the model, the harvested energy is stored in a buffer and used as required by the packets. In addition to energy usage by the packets, leakage of energy is captured at each state. A situation that involves high and low priority data transmission is also captured in the model. For evaluation, the effects of the system parameters on the performance measures are analysed. The results show that the model accurately captures the energy usage and it can be used for the management of harvested energy in Wireless Sensor Networks.

Paper #3

Detecting Tunnels for Border Security based on Fiber Optical Distributed Acoustic Sensor Data using DBSCAN

Suleyman Aslangul

ASELSAN Homeland Security Programs Department, UGES Division ASELSAN Mehmet Akif Ersoy Mah. 296. Cad. No: 16 06370 Yenimahalle Ankara/ Turkey aaslangul@aselsan.com.tr

Keywords: Smart Border Security, Homeland Security, Intrusion Detection, DAS Fiber Optic Sensors, Data Mining, DBSCAN, Standard Deviation, Software, Situational Awareness, Machine Learning.

Abstract: The Border Situational Awareness may consist of many different features. Mainly, these features focus on detecting intrusion activities. New generation security systems are collecting important amount of data obtained from sensors. In general, the alarm confirmation mechanism is visual identification using cameras and Video Management Systems. On the other hand, this approach may not be enough to identify an invisible tunnel digging activity underground for trespassing the border. This paper is suggesting a new method to detect tunnels by using statically filtered alarm data and DBSCAN algorithm. In this particular case MIDAS® Fiber Optic based Distributed Acoustic Sensor (DAS) system is used, which is designed by ASELSAN Inc. The proposed approach is evaluated and positive results are seen on diverse areas of the Turkish borders.

Paper #9

Building an Open Source Access Control System for Fablabs based on odoo and openHAB

Fabian Meyer and Michael Schäfer

Institute of Computer Science, Hochschule Ruhr West, University of Applied Sciences, Lützowstraße 5 Bottrop, Germany

Keywords: Makerspaces, Fablab, Access Control.

Abstract: Controlling machine access in Fablabs and makerspaces is a crucial task. Different types of machines require different types of briefings. This is especially important to avoid damage and injury. Controlling access automatically is thereby desirable, as it is otherwise labor-intensive. Currently available software to organize Fablabs and makerspaces have either a rather high price tag or lacking the functionality for automated access control. Self-developed hardware is also quite common but often, due to regulatory constraints, not allowed to operate on mains. Also, there is a wide range of home automation devices that are certified for switching mains voltage. We have developed a prototypical system that makes these devices available for use in the access control of Fablabs and Makerspaces. We have identified openHAB as a useful solution for the abstraction of devices from various manufacturers.

Paper #10

Response of a SAW Sensor Array based on Nanoparticles for Measuring Ammonia in the Environment

D. Matatagui[1], I. Gràcia[2] and M. Horrillo[1]

[1] *SENSAVAN, Instituto de Tecnologías Físicas y de la Información (ITEFI), CSIC, Serrano 144, 28006 Madrid, Spain*

[2] *Instituto de Microelectrónica de Barcelona (IMB), CSIC, Campus UAB, 08193 Bellaterra, Spain*

Keywords: Sensor Array, Surface Acoustic Wave, Ammonia, Nanoparticles, Gas Sensors, Environment.

Abstract: Four surface acoustic waves (SAW) sensors based on sensitive layers of Fe_2O_3 nanoparticles, pure and combined with noble metals nanoparticles, composed an array sensor to measure ammonia in the environment. The sensor array was tested with nanostructured sensitive layers, which detected the changes of the elastic properties induced by ammonia interaction. The sensor with pure Fe_2O_3 nanoparticles exposed to 50 ppm of ammonia showed no significant effect, however the sensors with Fe_2O_3 nanoparticles combined with Au, Pt and Pd nanoparticles responded to these concentrations of this gas, which is so dangerous for the environment and the health, with a high sensitivity.

Paper #23

SALATA: A Web Application for Visualizing Sensor Information in Farm Fields

Nao Akayama[1], Daisaku Arita[2], Atsushi Shimada[1] and Rin-Ichiro Taniguchi[1]

[1] *Faculty of Information Science and Electrical Engineering, Kyushu University, 744 Motooka, Nishi-ku, Fukuoka 819-0395, Japan*

[2] *Faculty of Information Systems, University of Nagasaki, 1-1-1 Manabino, Nagayo, Nishisonogi, Nagasaki, 851-2195 Japan*

Keywords: Smart Agriculture, IoT, Visualization, Sensor Information in Farm Fields, Usability, Web Application, User Interface.

Abstract: Semi-automated sensing and visualization of conditions and activities in farm fields have been actively pursued in recent years. There are three types of agricultural information: sensor information, farm work information, and plant biological information. Measuring and visualizing these agricultural information can provide valuable support to farm managers. In this study, we focus on sensor information and farm work information and develop a web application named SALATA (Sharing and AccumuLating Agricultural TAcit knowledge) that collects and shares sensor information and farm work information collected in farm fields and correlates the information in time series. SALATA need to have intuitive operation and quick response in order that people of various ages will use it on a daily basis. Therefore, there are two primary pages: the main page for visualizing simple information quickly and the analytical page for visualizing multiple pieces of information on one page. Usability evaluation experiments are performed, showing that SALATA can be operated intuitively and respond quickly.

Paper #24

ICT Technologies, Techniques and Applications to Improve Energy Efficiency in Smart Buildings

César Benavente-Peces[1] and Nisrine Ibadah[2]

[1] *ETS de Ingeniería y Sistemas de Telecomunicación, Universidad Politécnica de Madrid, Calle de Nikola Tesla sn, 28031 Madrid, Spain*

[2] *LRIT Laboratory, Associated Unit to CNRST (URAC 29), IT Rabat Center, Faculty of Sciences, Mohammed V University in Rabat, Morocco*

Keywords: Smart Building, Energy Supply, Energy Distribution, Energy Management, Energy Efficiency, Energy Savings, Sustainability, Green Energy, Energy Storage.

Abstract: Currently, most of the human activities impact the environment. Worldwide sustainable development is required to preserve a good quality of life. Energy efficiency is one of the most relevant issues that the scientific community and society must face along the next decades. This paper focuses on reviewing and noting the main factors which impact the optimization of electrical energy efficiency in Smart Buildings, including distribution, consumption analysis, strategies and management. Smart grids and smart buildings are playing a key role in the definition of the following generations of cities where the impact of energy consumption on the environment must be reduced as much as possible. Notwithstanding, all the factors impacting the production and distribution must be also taken into consideration by energy production companies and distribution companies as well. Green energies are being introduced in smart cities and buildings, only slower than required, and in general, focusing on the consumption side asking for higher performance monitoring and control techniques, and encouraging to incorporate energy harvesting initiatives to improve the overall efficiency. In this paper, the major target is pointing out all the relevant factors influencing smart building energy efficiency, up to the consumer side and, at the same time, paying attention on distribution and generation issues and, specifically, available communication standards, technologies, techniques, algorithms, which enable high performance systems to optimize energy consumption and occupant comfort.

Paper #26

Enhancing Vibroarthrography by using Sensor Fusion

Dimitri Kraft[1], Rainer Bader[2] and Gerald Bieber[3]

[1] *University of Rostock, Rostock, Germany*

[2] *Unimedizin, Rostock, Germany*

[3] *Fraunhofer IGD, Rostock, Germany*

Keywords: Endoprosthesis, VAG, Sensors, Mobile Device, Implants, Wear, Accelerometer, Microphone, Vibration.

Abstract: Natural and artificial joints of a human body are emitting vibration and sound during the movement. The sound and vibration pattern of a joint is characteristic and changes due to damage, uneven tread wear, injuries, or other influences. Hence, the vibration and sound analysis enables an estimation of the joint condition. This kind of analysis, vibroarthrography (VAG), allows the analysis of diseases like arthritis or osteoporosis and might determine trauma, inflammation, or misalignment. The classification of the vibration and sound data is very challenging and needs a comprehensive annotated data base. Current existing data bases are very limited and insufficient for deep learning or artificial intelligent approaches. In this paper, we describe a new concept of the design of a vibroarthrography system using a sensor network. We discuss the possible improvements and we give an outlook for the future work and application fields of VAG.

Paper #28

*papageno*X: Generation of Electronics and Logic for Embedded Systems from Application Software

Tobias Scheipel and Marcel Baunach

Institute of Technical Informatics, Graz University of Technology, Graz, Austria

Keywords: Embedded Systems, Printed Circuit Board, Design Automation, Hardware/Software Co-design, Systems Engineering, Reconfigurable Logic.

Abstract: Embedded systems development usually starts with hardware engineering based on specific requirements of the systems. These requirements are mainly derived from the needs of the not yet developed software to be executed on the system. This process is predictive and many iterations are thus needed, as new requirements often arise during the software development period. In the future, the market will demand more and more sophisticated embedded systems with a much reduced time to market. It will thus be inevitable that system prototypes and series products will need to be created as fast as possible. To enable this, we propose a top-down approach termed ***papageno***X, dealing with the question of “How to generate all layers X of the embedded systems stack including hardware and reconfigurable logic units from application software?”. The present work is a work in progress and deals with the definition of the research questions and several ideas and concepts of how to fundamentally solve them. Hence, it aims at introducing ideas to create a generator for

embedded systems electronics, reconfigurable logic and software.

Paper #31

Algorithmic State Machine Design for Timely Health Emergency Management in an IoT Environment

Fadi El-Hassan

College of Engineering, Al Ain University, Al Ain, Abu Dhabi, U.A.E.

Keywords: Smart Emergency, Prehospital Management, Algorithmic State Machine, Internet of Things, Embedded Systems, Health Emergency Management.

Abstract: In emergency cases related to massive accidents, environmental disasters, and war time, health professionals face considerable challenges due to the high number of patients who are in need of emergency treatment. Research works attempt to propose effective in-hospital and pre-hospital smart emergency systems to reduce the mortality rate among the patients who desperately wait to receive appropriate care. This paper presents a model of a timely prehospital emergency management system that can be implemented as an interface to an Internet of Things (IoT) environment. This work presents the necessary stages for prehospital emergency environments, where many factors may make the timely management of emergency systems very difficult. The proposed model is based on an Algorithmic State Machine (ASM) that can be implemented in either hardware or software, providing an embedded system interface for IoT. Moreover, this paper provides a timing analysis for either a single emergency event or multiple simultaneous emergency events. Embedded systems' developers can use the proposed model to produce an appropriate prehospital smart emergency solution.

Poster Session 1 **Open Communications**
16:30 - 17:30 **Room Exhibition Hall**

Paper #1

Gallium Nitride based Hall-effect Sensors for Automotive, Aerospace, and Embedded Power Systems

Hannah Alpert[1], Caitlin Chapin[1], Karen Dowling[2], Savannah Benbrook[2], Helmut Köck[3], Udo Ausserlechner[3] and Debbie Senesky[1]

[1] *Department of Aeronautics and Astronautics, Stanford University, Stanford, CA, U.S.A.*

[2] *Department of Electrical Engineering, Stanford University, Stanford, CA, U.S.A.*

[3] *Infineon Technologies Austria AG, Villach, Austria*

Keywords: Magnetic Sensor, Hall-effect, Gallium Nitride, Wide Bandgap, Semiconductor, High Temperature, Extreme Environment.

Abstract: Hall-effect sensors are widely used in the automotive industry, in power electronics, and within inertial measurement units (IMUs) for navigation and position sensing. There is a growing need for Hall-effect sensors that can operate under extreme conditions, specifically in high temperature environments such as deep underground (e.g., well-logging) and in outer space. Electronic components, including Hall-effect sensors, are typically made of silicon, but these components begin to breakdown at temperatures beyond 200℃, and thus external cooling is often required. However, implementing external cooling processes necessitates additional power and contributes further bulk and complexity to the system, leading to increased size, weight, and overall costs of the system. Thus, components that can operate at extreme temperatures without additional cooling are necessary for achieving higher efficiency, higher reliability, and lower cost. Wide bandgap semiconductors such as gallium nitride (GaN) and aluminum nitride (AlN) have been shown to operate up to 1000℃ in vacuum and thus are a prime candidate for electronics in harsh environmental conditions. We have developed GaN-based Hall-effect sensors with high sensitivity (similar to commercial silicon devices) and extremely low offsets. We characterized their voltage- and current-scaled magnetic sensitivities between room temperature and 600℃. Both devices showed decreasing voltage-scaled sensitivity at high temperature, corresponding to the decreasing electron mobility due to scattering effects at elevated temperatures. Alternatively, current-scaled sensitivities remained stable over the temperature range, only varying by 10% from their mean, due to a minimal dependence of sheet carrier concentration on temperature. Both devices showed consistency in their voltage- and current-scaled sensitivity over multiple temperature cycles as well as nearly full recovery when returned to room temperature after thermal cycling. Additionally, a sample held at 576℃ for 12 hours also showed nearly full recovery at room temperature, further suggesting that GaN-based Hall-effect sensors are a good candidate for use in high temperature applications.

Paper #2

Analysing Usage of Harvested Energy in Wireless Sensor Networks: A Geo/Geo/1/K Approach

O. Angwech[1], A. Alfa[2,3] and B. Maharaj[1]

[1] *Department of Electrical, Electronic and Computer Engineering, University of Pretoria, Pretoria 0002, South Africa*

[2] *Department of Electrical and Computer Engineering, University of Manitoba, Winnipeg, Manitoba, Canada*

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Keywords: Wirless Sensor Networks, Energy Harvesting, Markov Chain.

Abstract: A model that considers energy storage and usage in data transmission in Wireless Sensor Network applications is proposed. The system is modelled as a Geo/Geo/1/k system and analysed using standard finite Markov chain model tools. The stationary distribution of the queue length is obtained. In the model, the harvested energy is stored in a buffer and used as required by the packets. In addition to energy usage by the packets, leakage of energy is captured at each state. A situation that involves high and low priority data transmission is also captured in the model. For evaluation, the effects of the system parameters on the performance measures are analysed. The results show that the model accurately captures the energy usage and it can be used for the management of harvested energy in Wireless Sensor Networks.

Paper #3

Detecting Tunnels for Border Security based on Fiber Optical Distributed Acoustic Sensor Data using DBSCAN

Suleyman Aslangul

ASELSAN Homeland Security Programs Department, UGES Division ASELSAN Mehmet Akif Ersoy Mah. 296. Cad. No: 16 06370 Yenimahalle Ankara/ Turkey aaslangul@aselsan.com.tr

Keywords: Smart Border Security, Homeland Security, Intrusion Detection, DAS Fiber Optic Sensors, Data Mining, DBSCAN, Standard Deviation, Software, Situational Awareness, Machine Learning.

Abstract: The Border Situational Awareness may consist of many different features. Mainly, these features focus on detecting intrusion activities. New generation security systems are collecting important amount of data obtained from sensors. In general, the alarm confirmation mechanism is visual identification using cameras and Video Management Systems. On the other hand, this approach may not be enough to identify an invisible tunnel digging activity underground for trespassing the border. This paper is suggesting a new method to detect tunnels by using statically filtered alarm data and DBSCAN algorithm. In this particular case MIDAS® Fiber Optic based Distributed Acoustic Sensor (DAS) system is used, which is designed by ASELSAN Inc. The proposed approach is evaluated and positive results are seen on diverse areas of the Turkish borders.

Paper #9

Building an Open Source Access Control System for Fablabs based on odoo and openHAB

Fabian Meyer and Michael Schäfer

Institute of Computer Science, Hochschule Ruhr West, University of Applied Sciences, Lützowstraße 5 Bottrop, Germany

Keywords: Makerspaces, Fablab, Access Control.

Abstract: Controlling machine access in Fablabs and makerspaces is a crucial task. Different types of machines require different types of briefings. This is especially important to avoid damage and injury. Controlling access automatically is thereby desirable, as it is otherwise labor-intensive. Currently available software to organize Fablabs and makerspaces have either a rather high price tag or lacking the functionality for automated access control. Self-developed hardware is also quite common but often, due to regulatory constraints, not allowed to operate on mains. Also, there is a wide range of home automation devices that are certified for switching mains voltage. We have developed a prototypical system that makes these devices available for use in the access control of Fablabs and Makerspaces. We have identified openHAB as a useful solution for the abstraction of devices from various manufacturers.

Paper #10

Response of a SAW Sensor Array based on Nanoparticles for Measuring Ammonia in the Environment

D. Matatagui[1], I. Gràcia[2] and M. Horrillo[1]

[1] *SENSAVAN, Instituto de Tecnologías Físicas y de la Información (ITEFI), CSIC, Serrano 144, 28006 Madrid, Spain*

[2] *Instituto de Microelectrónica de Barcelona (IMB), CSIC, Campus UAB, 08193 Bellaterra, Spain*

Keywords: Sensor Array, Surface Acoustic Wave, Ammonia, Nanoparticles, Gas Sensors, Environment.

Abstract: Four surface acoustic waves (SAW) sensors based on sensitive layers of Fe_2O_3 nanoparticles, pure and combined with noble metals nanoparticles, composed an array sensor to measure ammonia in the environment. The sensor array was tested with nanostructured sensitive layers, which detected the changes of the elastic properties induced by ammonia interaction. The sensor with pure Fe_2O_3 nanoparticles exposed to 50 ppm of ammonia showed no significant effect, however the sensors with Fe_2O_3 nanoparticles combined with Au, Pt and Pd nanoparticles responded to these concentrations of this gas, which is so dangerous for the environment and the health, with a high sensitivity.

Paper #23

SALATA: A Web Application for Visualizing Sensor Information in Farm Fields

Nao Akayama[1], Daisaku Arita[2], Atsushi Shimada[1] and Rin-Ichiro Taniguchi[1]

[1] *Faculty of Information Science and Electrical Engineering, Kyushu University, 744 Motooka, Nishi-ku, Fukuoka 819-0395, Japan*

[2] *Faculty of Information Systems, University of Nagasaki, 1-1-1 Manabino, Nagayo, Nishisonogi, Nagasaki, 851-2195 Japan*

Keywords: Smart Agriculture, IoT, Visualization, Sensor Information in Farm Fields, Usability, Web Application, User Interface.

Abstract: Semi-automated sensing and visualization of conditions and activities in farm fields have been actively pursued in recent years. There are three types of agricultural information: sensor information, farm work information, and plant biological information. Measuring and visualizing these agricultural information can provide valuable support to farm managers. In this study, we focus on sensor information and farm work information and develop a web application named SALATA (Sharing and AccumuLating Agricultural TAcit knowledge) that collects and shares sensor information and farm work information collected in farm fields and correlates the information in time series. SALATA need to have intuitive operation and quick response in order that people of various ages will use it on a daily basis. Therefore, there are two primary pages: the main page for visualizing simple information quickly and the analytical page for visualizing multiple pieces of information on one page. Usability evaluation experiments are performed, showing that SALATA can be operated intuitively and respond quickly.

Paper #24

ICT Technologies, Techniques and Applications to Improve Energy Efficiency in Smart Buildings

César Benavente-Peces[1] and Nisrine Ibadah[2]

[1] *ETS de Ingeniería y Sistemas de Telecomunicación, Universidad Politécnica de Madrid, Calle de Nikola Tesla sn, 28031 Madrid, Spain*

[2] *LRIT Laboratory, Associated Unit to CNRST (URAC 29), IT Rabat Center, Faculty of Sciences, Mohammed V University in Rabat, Morocco*

Keywords: Smart Building, Energy Supply, Energy Distribution, Energy Management, Energy Efficiency, Energy Savings, Sustainability, Green Energy, Energy Storage.

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Paper #26

Enhancing Vibroarthrography by using Sensor Fusion

Dimitri Kraft[1], Rainer Bader[2] and Gerald Bieber[3]

[1] *University of Rostock, Rostock, Germany*

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Keywords: Endoprosthesis, VAG, Sensors, Mobile Device, Implants, Wear, Accelerometer, Microphone, Vibration.

Abstract: Natural and artificial joints of a human body are emitting vibration and sound during the movement. The sound and vibration pattern of a joint is characteristic and changes due to damage, uneven tread wear, injuries, or other influences. Hence, the vibration and sound analysis enables an estimation of the joint condition. This kind of analysis, vibroarthrography (VAG), allows the analysis of diseases like arthritis or osteoporosis and might determine trauma, inflammation, or misalignment. The classification of the vibration and sound data is very challenging and needs a comprehensive annotated data base. Current existing data bases are very limited and insufficient for deep learning or artificial intelligent approaches. In this paper, we describe a new concept of the design of a vibroarthrography system using a sensor network. We discuss the possible improvements and we give an outlook for the future work and application fields of VAG.

Paper #28

*papageno*X: Generation of Electronics and Logic for Embedded Systems from Application Software

Tobias Scheipel and Marcel Baunach

Institute of Technical Informatics, Graz University of Technology, Graz, Austria

Keywords: Embedded Systems, Printed Circuit Board, Design Automation, Hardware/Software Co-design, Systems Engineering, Reconfigurable Logic.

Abstract: Embedded systems development usually starts with hardware engineering based on specific requirements of the systems. These requirements are mainly derived from the needs of the not yet developed software to be executed on the system. This process is predictive and many iterations are thus needed, as new requirements often arise during the software development period. In the future, the market will demand more and more sophisticated embedded systems with a much reduced time to market. It will thus be inevitable that system prototypes and series products will need to be created as fast as possible. To enable this, we propose a top-down approach termed ***papageno***X, dealing with the question of "How to generate all layers X of the embedded systems stack including hardware and reconfigurable logic units from application software?". The present work is a work in progress and deals with the definition of the research questions and several ideas and concepts of how to fundamentally solve them. Hence, it aims at introducing ideas to create a generator for embedded systems electronics, reconfigurable logic and software.

Paper #31

Algorithmic State Machine Design for Timely Health Emergency Management in an IoT Environment

Fadi El-Hassan

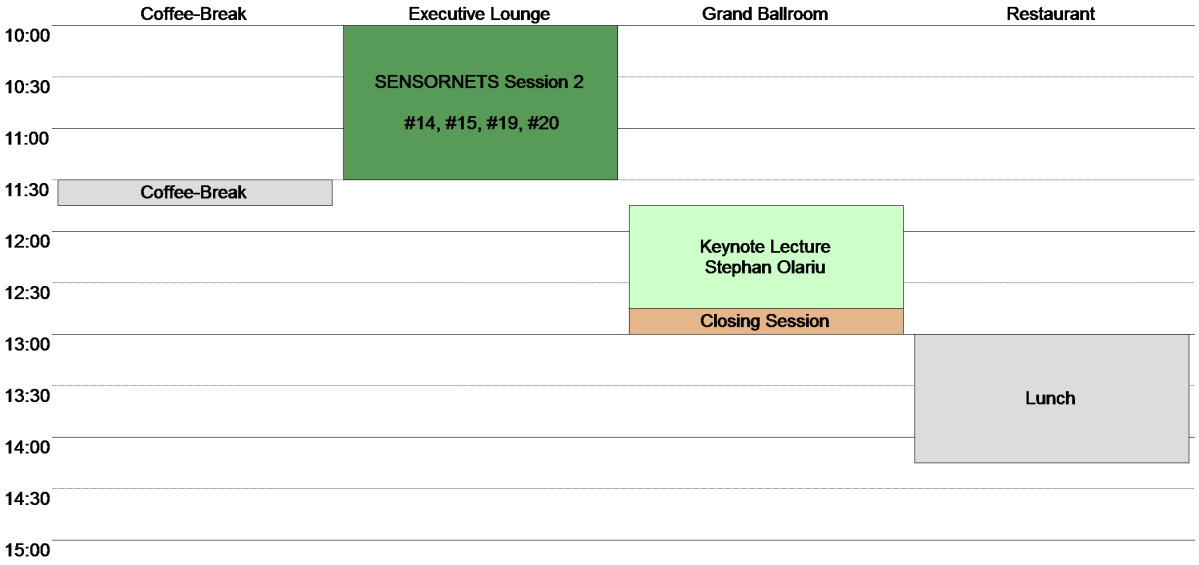
College of Engineering, Al Ain University, Al Ain, Abu Dhabi, U.A.E.

Keywords: Smart Emergency, Prehospital Management, Algorithmic State Machine, Internet of Things, Embedded Systems, Health Emergency Management.

Abstract: In emergency cases related to massive accidents, environmental disasters, and war time, health professionals face considerable challenges due to the high number of patients who are in need of emergency treatment. Research works attempt to propose effective in-hospital and pre-hospital smart emergency systems to reduce the mortality rate among the patients who desperately wait to receive appropriate care. This paper presents a model of a timely prehospital emergency management system that can be implemented as an interface to an Internet of Things (IoT) environment. This work presents the necessary stages for prehospital emergency environments, where many factors may make the timely management of emergency systems very difficult. The proposed model is based on an Algorithmic State Machine (ASM) that can be implemented in either hardware or software, providing an embedded system interface for IoT. Moreover, this paper provides a timing analysis for either a single emergency event or multiple simultaneous emergency events. Embedded systems' developers can use the proposed model to produce an appropriate prehospital smart emergency solution.

Saturday Sessions: February 29

Saturday Sessions: February 29 Program Layout



Session 2A **SENSORNETS**
10:00 - 11:30 **Room Executive Lounge**
Sensing for E-health and Environment

Paper #14

MultiSense: A Highly Reliable Wearable-free Human Fall Detection Systems

Avishek Mukherjee[1] and Zhenghao Zhang[2]

[1] *Dept. of Computer Science and Information Systems, Saginaw Valley University, U.S.A.*

[2] *Computer Science Department, Florida State University, U.S.A.*

Keywords: Fall Detection, Sensors.

Abstract: A reliable fall detection system has tremendous value to the well-being of seniors living alone. We design and implement MultiSense, a novel fall detection system, which has the following desirable features. First, it does not require the human to wear any device, therefore it is convenient to seniors. Second, it has been tested in typical settings including living room and bathroom, and has shown very good accuracy. Third, it is built with inexpensive components, with expected hardware cost around $150 to cover a typical room. Therefore, it has a key advantage over the current commercial fall detection systems which all require the human to wear some device, as well as over academic research prototypes which have various limitations such as lower accuracy. The high accuracy is achieved mainly by combining senses from multiple types of sensors that complement each other, which includes a motion sensor, a heat sensor, and a floor vibration sensor. As the activities that are difficult to classify for some sensors are often not difficult for others, combining the strength of multiple types of sensors brings the performance to a level that can meet the requirements in practice.

Paper #15

Validation of a Low-cost Inertial Exercise Tracker

Sarvenaz Salehi[1] and Didier Stricker[2]

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Keywords: Inertial Sensors, Body-IMU Calibration, Body Motion Tracking, Exercise Monitoring.

Abstract: This work validates the application of a low-cost inertial tracking suit, for strength exercise monitoring. The procedure includes an offline processing for body-IMU calibration, online tracking and identification of lower body motion. We proposed an optimal movement pattern of the body-IMU calibration method from our previous work. Here in order to reproduce real extreme situations, we used data from different types of movements with high acceleration intensity. For such movements, an optimal orientation tracking approach is introduced which requires no accelerometer measurements and it thus minimizes error of existing outliers. The online tracking algorithm is based on an extended Kalman filter(EKF), which estimates the position of upper and lower legs with respect to the pelvis along with hip and knee joint angles. This method benefits from the estimated values in calibration process i.e. joint axes and positions, as well as biomechanical constraints of lower body. Therefore it requires no aiding sensors such as magnetometer. The algorithm was evaluated using optical tracker for two types of exercises:squat and abd/adduction which resulted average Root Mean Square Error(RMSE) of 9cm. Additionally, this work presents a personalized exercise identification approach, where an online template matching algorithm is applied and optimised using Zero Velocity Crossing(ZVC) for feature extraction. This results reducing the execution time to 93% and improving the accuracy to 33%.

Paper #19

Application of Virtual Travel for Alzheimer's Disease

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Keywords: Healthcare Applications, Sensor Networks Applications, Virtual Travel, Cognitive Environments, Alzheimer's Disease, Immersive Environments, Emotions, EEG Sensors.

Abstract: Negative emotions such as anxiety, frustration, or apathy can have an impact on the brain capability in terms of memory and cognitive functions. This is particularly visible in Alzheimer's disease where the participants can have a deterioration of their brain connections which are often the cause of the disorders detected in Alzheimer's participants. It seems important to reduce these symptoms to allow better access to memory and cognitive abilities. Immersion in Virtual Reality is a means of providing the participant with a sense of presence in an environment that isolates them from external factors that can induce negative emotions. The virtual travel is a method that can mobilize the attention of the subject and revive their interest and curiosity. We present here, an experiment in which a participant is immersed in a virtual train using a virtual headset and EEG device to measure the brain signals. To measure the impact of this train on the memory and cognitive functions, some cognitive tasks have been included before and after the travel. Experiments have been done on participants with mild cognitive disorder. Preliminary results show an increase of memory functions and in certain cases of cognitive functions, while negative emotions are reduced.

Paper #20

A Sensor Network for Existing Residential Buildings Indoor Environment Quality and Energy Consumption Assessment and Monitoring: Lessons Learnt from a Field Experiment

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Keywords: Sensor Network, Energy Monitoring, Building Energy Efficiency, Energy Retrofit.

Abstract: Enhancing residential buildings energy efficiency has become a critical goal to take up current challenges of human comfort, urbanization growth and the consequent energy consumption increase. In a context of integrated smart infrastructures, sensor networks offer a relevant solution to support building energy consumption monitoring, operation and prediction. The amount of accessible data with such networks also opens new prospects to

better consider key parameters such as human behaviour and to lead to more efficient energy retrofit of existing buildings. However, sensor networks planning and implementation in general, and in existing buildings in particular, is a particularly complex task facing many challenges and affecting the performances of such a promising solution. In the present paper, we report on a field experiment of a sensor network deployment involving more than 250 sensors in three collective residential buildings in Paris region for the evaluation of a deep energy retrofit. More specifically, we describe the whole process of the sensor network design and roll-out and highlight the main critical aspects in such complex process. We also provide a feedback after several months of the sensor network operation and preliminary analysis of collected data. Reported results path the way for an efficient and optimized design and deployment of sensor networks for energy and indoor environment quality monitoring in existing buildings.

Keynote Lecture	**SENSORNETS**
11:45 - 12:45	**Room Grand Ballroom**

Smart Communities: From Sensors to Internet of Things and toan Internet of Services

Stephan Olariu
Old Dominion University, Norfolk, U.S.A.

Abstract: This keynoteaddress promotes the vision of Smart Communities (SC)as Internet of Servicessynthesized from interconnected hierarchies of resources available primarily within the corresponding community. At the basic level, resource may be physical, cyber or human entities. Our vision extends and generalizes the concept of cloud computing, where computational resources are bundled and offered as services on a metered basis. In our vision, in the Smart Communities of the (near) future a large number of services will be offered as utilities and sold on a metered basis. Importantly, most of these services will be aggregated and synthesized from a hierarchy of resources produced and shared by the community itself. In a nutshell, Smart Communities will offer various levels of service aggregations as utilities. In our vision, the members of the Smart Community or the visitors, will purchase as much or as little of these services as they find suitable to their needs and are billed accordingly. We suggest that the services offered by the SC are built on top of the resources of various IoT systems within the metropolitan community. In turn, these IoT systems will make their resources available to the SCin the context of a resource marketplace. Resources that can be sold in the marketplace include, but are not limited to, raw or aggregated sensor data at various resolution levels, shared and self-driven vehicles, private and public spaces and products, professional skills, traffic flow data, among many others. include but are not limited to sensor data, actuation capabilities, traffic views, etc.

Closing Session	**SENSORNETS**
12:45 - 13:00	**Room Grand Ballroom**

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