International Conference on Embedded Wireless Systems and Networks (EWSN) 2021

Delft, The Netherlands 17-19 February 2021

Proceedings

Edited by

Polly Huang Marco Zuniga Guoliang Xing Chiara Petrioli © 2021 Copyright is held by the authors. Permission is granted for indexing in the ACM Digital Library All rights reserved.

Copyright and Reprint Permission: Abstracting is permitted with credit to the source.

The papers in this book comprise the proceedings of the meeting mentioned on the cover and title page. They reflect the authors' opinions and, in the interests of timely dissemination, are published as presented and without change. Their inclusion in this publication does not necessarily constitute endorsement by the editors or the International Conference on Embedded Wireless Systems and Networks (EWSN).

ISBN: 978-0-9949886-5-2 ISSN: 2562-2331

International Conference on Embedded Wireless Systems and Networks (EWSN) 2021 17–19 February 2021, Delft, The Netherlands

Message from the General and Technical Program Chairs	v
Organization and Technical Program Committee	vi
Keynote Speaker: Cecilia Mascolo	vii
Keynote Speaker: Johan Stokking	viii
Keynote Speaker: Mérouane Debbah	ix

Papers

Paper Session 1: S1: Connectivity

Session Chair: Gian Pietro Picco, University of Trento

Discovering the Hidden Anomalies of Intermittent Computing	Article 1
Andrea Maioli, Luca Mottola, Muhammad Hamad Alizai, Junaid Haroon Siddiqui	

Hermes: Decentralized Dynamic Spectrum Access System for Massive Devices Deployment in 5G.....Article 2 Zhihui Gao, Ang Li, Yunfan Gao, Yu Wang, Yiran Chen

6TiSCH++ with Bluetooth 5 and Concurrent Transmissions.....Article 3 Michael Baddeley, Adnan Aijaz, Usman Raza, Aleksandar Stanoev, Yichao Jin, Markus Schuß, Carlo Alberto Boano, George Oikonomou

S2: Applications

Session Chair: Rui Tan, Nanyang Technological University

Philipp Sommer, Felix Sutton

Condor: Mobile Golf Swing Tracking via Sensor Fusion using Conditional Generative Adversarial NetworksArticle Hong Jia, Jun Liu, Yuezhong Wu, Tomasz Bednarz, Lina Yao, Wen Hu
LightTour: Enabling Museum Audio Tour with Visible LightArticle Lennert Vanmunster, Jona Beysens, Qing Wang, Sofie Pollin
Ensuring End-to-End Dependability Requirements in Cloud-based Bluetooth Low Energy ApplicationsArticle Michael Spörk, Markus Schuß, Carlo Alberto Boano, Kay Römer
S3: Security Session Chair: Zhenjiang Li, <i>City University of Hong Kong</i>
Adding Security to Implantable Medical Devices: Can We Afford It?Article Muhammad Ali Siddiqi, Angeliki-Agathi Tsintzira, Georgios Digkas, Miltiadis Siavvas, Christos Strydis
A Performance Study of Crypto-Hardware in the Low-end IoTArticle Peter Kietzmann, Lena Boeckmann, Leandro Lanzieri, Thomas C. Schmidt, Matthias Wählisch
Application-driven Privacy-preserving Data Publishing with Correlated AttributesArticle Aria Rezaei, Chaowei Xiao, Jie Gao, Bo Li, Sirajum Munir
S4: Testbed Session Chair: Xiangmao Chang, Nanjing University of Aeronautics & Astronautics, China
VIADUCT: Bridging the Gap between Testbeds and Real-World Cyber-Physical SystemsArticle 1

ChirpBox: An Infrastructure-Less LoRa TestbedArticle 11 Pei Tian, Xiaoyuan Ma, Carlo Alberto Boano, Ye Liu, Fengxu Yang, Xin Tian, Dan Li, Jianming Wei

S5: Networking

Session Chair: Julie A. McCann, Imperial College London

Mobility in Low-Power Wide-Area Network over White Spaces Dali Ismail, Abusayeed Saifullah	Article 12
Power Clocks: Dynamic Multi-Clock Management for Embedded Systems Holly Chiang, Hudson Ayers, Daniel Giffin, Amit Levy, Philip Levis	Article 13
SERVOUS: Cross-Technology Neighbour Discovery and Rendezvous for Low-Power Wireless Devices Rainer Hofmann, Carlo Alberto Boano, Kay Römer	Article 14
Posters	
Poster: Maestro – An Ambient Sensing Platform With Active Learning To Enable Smart Applications Tahiya Chowdhury, Murtadha Aldeer, Shantanu Laghate, Justin Yu, Qizhen Ding, Joseph Florentine, Jorge Ortiz	Article 15
Poster: Communication Failover Strategies for Dependable Smart Grid Operation Elisei Ember, Konrad Diwold, Kay Römer, Carlo Alberto Boano, Markus Schuß, Albin Frischenschlager, Alfred Ein	Article 16 falt
Poster: RSSI-based antenna evaluation for robust BLE communication in in-car environments Daniel Kraus, Konrad Diwold, Erich Leitgeb	Article 17
Poster: Trace Yourself - It Could Be Easy Patrick Rathje, Olaf Landsiedel	Article 18
Poster: Exposure Notification at Hand Patrick Rathje, Olaf Landsiedel	Article 19
Poster: Comparison of Channel State Information driven and RSSI-based WiFi Distance Estimation Elisabeth Salomon, Leo Happ Botler, Konrad Diwold, Carlo Alberto Boano, Kay Römer	Article 20
Poster: An Internet of Things-based Vehicle Counting System Lanny Sitanayah, Apriandy Angdresey, Jeri Wahyu Utama	Article 21
Poster: A Neural Network based Cluster Ensemble Approach for Anomaly Detection in Dynamic Weighted Graphs Diya Thomas, Rajan Shankaran	Article 22
Poster: A Real-time Social Distance Measurement and Record System for COVID-19 Weijun Wang, Tingting Yuan, Minghao Han, Meng Li, Han Zhang, Yu Ma, Sripriya Srikant Adhatarao, Xiaoming	Article 23 Fu
Demos	
Demo: Large Scale Wireless Network Simulations with TSCH-Sim	Article 24
Demo: SOCRAETES: SOlar Cells Recorded And EmulaTed EaSily Sayedsepehr Mosavat, Matteo Zella, Pedro José Marrón	Article 25
Ph.D. Forum	
Session 1	
Enabling Daily Tracking of Individual's Cognitive State with Eyewear	Article 26

An Adaptive And Low-Complexity Routing Protocol For Distributed Airborne Networks.....Article 27 Shivam Garg Opportunities of Motion-Powered IoTSystemsArticle 28 Xin Li

Session 2

A Dynamic Graph-based Cluster Ensemble Approach to Detect Security Attacks in Surveillance NetworkArticle 29 Diya Thomas

Routing in Multi-Technologies Wireless Sensor NetworksArticle 30 Brandon Foubert

Workshop Proposal

CHIIoT:1st Workshop on Computer Human Interaction in IoT Applications......Article 31 Rong-Hao Liang, Alessandro Chiumento, Marco Zuniga, Przemysław Pawełczak, Mathias Funk, Yaliang Chuang

Message from the General and Technical Program Chairs

GENERAL CHAIRS

Polly Huang National Taiwan University Guoliang Xing Chinese University of Hong Kong

TPC CO-CHAIRS

Marco Zuniga Delft University of Technology Chiara Petrioli Universita' degli Studi di Roma "La Sapienza"

Welcome to EWSN 2021, the International Conference on Embedded Wireless Systems and Networks, held on February 17-19, 2021. For eighteen years, our community has been bringing together researchers in a wide range of areas with a particular focus on embedded systems and wireless networking.

This year the conference has a virtual format. We will certainly miss the lively in-person discussions and interactions, but a virtual gathering also offers opportunities for improvement. For the first time, EWSN will archive the videos of the presentations and allow attendees to register for free, facilitating in this manner the dissemination of knowledge generated by our community.

The bedrock of our technical program is the set of highquality peer-reviewed papers accepted for the main track. That important job is entrusted to the technical program committee, which consists of 39 members coming from Europe, Asia, North America and Oceania. The committee reviewed a total of 44 submissions spanning 24 countries. Each paper received at least four reviews during a five-week period. In the end, 22 papers were discussed at the TPC meeting. Fourteen papers were finally accepted among which 7 underwent a shepherding process, leading to an acceptance rate of 31.8%.

The main track is supported by a wide variety of engaging events. This year we are thrilled to have three renowned researchers and industry leaders presenting keynotes, Cecilia Mascolo from the University of Cambridge, Johan Stokking from The Things Network and Mérouane Debbah from Huawei. The program also includes a session with eleven posters and demos, and a PhD forum where five early researchers will present their work. These sessions and forum are valuable activities to strengthen the connection between junior and senior researchers.

Every year the program is enriched with co-located tutorials and workshops. This year we have two exciting tutorials and a workshop. One tutorial involves a hands-on experience with IoT microcontroller programming, from object to cloud; and the second introduces the use of sound and coupling technologies for intra-body communication. The workshop aims at connecting researchers from the Internet-of-Things and Human-Computer-Interaction communities to investigate human-centered applications using emerging connectivity and sensing technologies.

A conference success is the result of the joint effort of multiple people and institutions. Our deepest gratitude goes to the TPC and authors, in particular during this year full of hardship. Without your valuable work, EWSN 2021 would not have been possible. Olaf Landsiedel and Jorge Ortiz (Poster & Demo Co-Chairs) and Marco Zimmerling and Akshay Nambi (PhD Forum Co-Chairs) put an extra-effort to provide the best possible online experience for their sessions. Domenico Giustiniano and Jeremy Gummeson acted as EWSN ambassadors to gather a diverse and valuable program for the workshop and tutorials, in spite of the hurdles posed by organizing such events in an online manner. No conference can run well without the committed work of Publicity Chairs, so big thanks go to Carlo Alberto Boano, Shijia Pan, and JeongGil Ko for the many times we had to rely on them. We were also fortunate to have Delphine Reinhardt as Publication Chair, thanks for keeping us on track. The Finance Chair, Qing Wang, and Social Media Chair, Przemysław Pawełczak, were particularly valuable this year to obtain sponsorships and build a strong online presence. The face of EWSN is its webpage and our web chair, Miguel Chávez, responded graciously and promptly to the many requests for updates. Planning, testing and coordinating the use of online tools is a demanding task, our local organizers play an invaluable role on this front, many thanks to Talia Xu, Hanting Ye, Jasper de Winkel and Vito Koortbeek.

Our last words of gratitude go to our sponsors: ACM, especially SIGMOBILE and SIGBED, for granting us the incooperation status; and Huawei (Industry, Platinum), CHIIOT (Academic, Gold) and CPI (Academic, Silver) for their economic support, your gracious contribution allows EWSN to be free this year.

Enjoy EWSN 2021, get comfortable at home or your office and see you online!

Organization

GENERAL CHAIRS

Polly Huang National Taiwan University

Marco Zuniga TU Delft

TPC CO-CHAIRS

Guoliang Xing Chinese University of Hong Kong

Chiara Petrioli Universita' degli Studi di Roma "La Sapienza" Poster and Demo Co-Chairs

Jorge Ortiz Rutgers University

Olaf Landsiedel Kiel University

PUBLICITY CO-CHAIRS

Carlo Alberto Boano *TU Graz*

Shijia Pan University of California, Merced

JeongGil Ko Yonsei University

Workshop and Tutorial Co-Chairs

Domenico Giustiniano IMDEA Networks

Jeremy Gummeson University of Massachusetts Amherst PhD Forum Co-Chairs

Akshay Nambi Microsoft Research India

Marco Zimmerling TU Dresden

FINANCE CHAIR

Qing Wang

TU Delft

Social Media Chair

Przemysław Pawełczak TU Delft

PUBLICATION CHAIR

Delphine Reinhardt University of Goettingen

Web Chair

Miguel Chavez TU Delft

LOCAL ARRANGEMENTS CO-CHAIRS

Talia Xu TU Delft

Hanting Ye TU Delft

Jasper de Winkel TU Delft

Vito Kortbeek TU Delft

Technical Program Committee

Matteo (Ceriotti) Zella University of Duisburg-Essen (Germany)

Mun Choon Chan National University of Singapore (Singapore)

Xiangmao Chang Nanjing University of Aeronautics & Astronautics (China)

Jiming Chen Zhejiang University (China)

Octav Chipara University of Iowa (USA)

Mauro Conti University of Padua (Italy)

Xenofon (Fontas) Fafoutis Technical University of Denmark (Denmark)

Jie Gao Stony Brook University (USA)

Jinsong Han Zhejiang University (China)

Vlado Handziski TU Berlin (Germany) Yuan He Tsinghua University (China)

Oana Iova INSA Lyon (France)

Salil Kanhere UNSW (Australia)

JeongGil Ko Yonsei University (Korea)

Olaf Landsiedel Kiel University (Germany) and Chalmers University (Sweden)

Zhenjiang Li City University of Hong Kong (China)

Vincenzo Mancuso IMDEA (Spain)

Andrew Markham University of Oxford (UK)

Julie McCann Imperial College London (UK)

Luca Mottola Politecnico di Milano (Italy) and SICS (Sweden) Edith Ngai University of Hong Kong (China)

Thomas Noel Université Strasbourg (France)

Gian Pietro Picco University of Trento (Italy)

Andreas Reinhardt Technische Universität Clausthal (Germany)

Utz Roedig University College Cork (Ireland)

Kay Römer TU Graz (Austria)

Olga Saukh TU Graz (Austria)

Leo Selavo University of Latvia (Latvia)

Mo Sha Binghamton University (USA)

Longfei Shangguan Microsoft Research (USA) Rui Tan Nanyang Technological University (Singapore)

Eduardo Tovar University of Porto (Portugal)

Thiemo Voigt Uppsala University and RISE SICS (Sweden)

Hongkai Wen University of Warwick (UK)

Weitao Xu City University of Hong Kong (China)

Desheng Zhang Rutgers University (USA)

Lan Zhang, University of Science and Technology of China (China)

Mi Zhang Michigan State University (USA)

Yuanqing Zheng Hong Kong Polytechnic University (China)

Keynote Address

Sounding Out Wearable And Audio Sensing For Health Diagnostics.

Cecilia Mascolo University of Cambridge

Abstract

What can data from devices we carry with us in our daily activities really reveal about our health and wellbeing? Considerable research has been conducted into mobile and wearable sensing systems for human health monitoring. This concentrates on either devising sensing and systems techniques to effectively and efficiently collect data about users, and patients or in studying mechanisms to analyse the data coming from these sensors accurately. In both cases, these efforts raise important technical as well as ethical issues.

In this talk, I plan to reflect on the challenges and opportunities that mobile and wearable health sensing systems are introducing for the community, the developers as well as the users. I will use examples from my group's ongoing research on exploring machine learning and sensor data analysis for health applications in collaboration with epidemiologists and clinicians. In particular, I will discuss our project on using audio signals for disease diagnostics and our recent work in the context of COVID-19: a crowdsourced collected through mobile apps (covid-19-sounds.org) of respiratory sounds (coughs, breathing and voice) to prescreen and diagnose COVID-19.

Presenter

Cecilia Mascolo is the mother of a teenage daughter but also a Full Professor of Mobile Systems in the Department of Computer Science and Technology, University of Cambridge, UK. She is co-director of the Centre for Mobile, Wearable System and Augmented Intelligence and Deputy Head of Department for Research. She is also a Fellow of Jesus College Cambridge and the recipient of an ERC Advanced Research Grant. Prior to joining Cambridge in 2008, she was a faculty member in the Department of Computer Science at University College London. She holds a PhD from the University of Bologna. Her research interests are in mobile and sensor systems and machine learning for mobile health. She has published in a number of top-tier conferences and journals in the area and her investigator experience spans projects funded by Research Councils and industry. She has received numerous best paper awards and in 2016 was listed in "10 Women in Networking /Communications You Should Know". She has served as steering, organizing, and program committee member of mobile and sensor systems, data science and machine learning conferences. More details at www.cl.cam. ac.uk/users/cm542

Keynote Address

LoRaWAN: what is it and where are we today

Johan Stokking The Things Network



Abstract

LoRaWAN is a protocol for connecting IoT devices over the long range low power modulation LoRa. With a global community of over 130K developers and 17K gateways connected, The Things Network is routing over 500 LoRaWAN messages per second. This gives a lot of insight in how LoRaWAN is used globally, not only by The Things Network community but also by other networks, as LoRa is using the shared spectrum. In this talk, in the sixth year that The Things Network is active, Johan will present where we are today and where LoRaWAN is going based on data.

Presenter

Johan is co-founder and technical lead of The Things Network, the leading LoRaWAN developer community, and CTO of The Things Industries, the company that makes The Things Network a sustainable initiative. Johan is also chair of the Security Work Group of the LoRa Alliance, overseeing security related matters of the LoRaWAN specification.

Keynote Address

Mobile AI: From Cloud AI to On-Device AI

Mérouane Debbah Huawei

Presenter

Mérouane Debbah received the M.Sc. and Ph.D. degrees from the Ecole Normale Supérieure Paris-Saclay, France. He was with Motorola Labs, Saclay, France, from 1999 to 2002, and also with the Vienna Research Center for Telecommunications, Vienna, Austria, until 2003. From 2003 to 2007, he was an Assistant Professor with the Mobile Communications Department, Institut Eurecom, Sophia Antipolis, France. In 2007, he was appointed Full Professor at CentraleSupelec, Gifsur-Yvette, France. From 2007 to 2014, he was the Director of the Alcatel-Lucent Chair on Flexible Radio. Since 2014, he has been Vice-President of the Huawei France Research Center. He is jointly the director of the Mathematical and Algorithmic Sciences Lab as well as the director of the Lagrange Mathematical and Computing Research Center. He has managed 8 EU projects and more than 24 national and international projects. His research interests lie in fundamental mathematics, algorithms, statistics, information, and communication sciences research. He is an IEEE Fellow, a WWRF Fellow, and a Membre émérite SEE. He was a recipient of the ERC Grant MORE (Advanced Mathematical Tools for Complex Network Engineering) from 2012 to 2017. He was a recipient of the Mario Boella Award in 2005, the IEEE Glavieux Prize Award in 2011, the Qualcomm Innovation Prize Award in 2012, the 2019 IEEE Radio Communications Committee Technical Recognition Award and the 2020 SEE Blondel Medal. He received more than 20 best paper awards, among which the 2007 IEEE GLOBECOM Best Paper Award, the Wi-Opt 2009 Best Paper Award, the 2010 Newcom++ Best Paper Award, the WUN CogCom Best Paper 2012 and 2013 Award, the 2014 WCNC Best Paper Award, the 2015 ICC Best Paper Award, the 2015 IEEE Communications Society Leonard G. Abraham Prize, the 2015 IEEE Communications Society Fred W. Ellersick Prize, the 2016 IEEE Communications Society Best Tutorial Paper Award, the 2016 European Wireless Best Paper Award, the 2017 Eurasip Best Paper Award, the 2018 IEEE Marconi Prize Paper Award, the 2019 IEEE Communications Society Young Author Best Paper Award and the Valuetools 2007, Valuetools 2008, CrownCom 2009, Valuetools 2012, SAM 2014, and 2017 IEEE Sweden VT-COM-IT Joint Chapter best student paper awards. He is an Associate Editor-in-Chief of the journal Random Matrix: Theory and Applications. He was an Associate Area Editor and Senior Area Editor of the IEEE TRANSACTIONS ON SIGNAL PROCESSING from 2011 to 2013 and from 2013 to 2014, respectively. From 2021 to 2022, he serves as an IEEE Signal Processing Society Distinguished Industry Speaker.

Abstract

Fueled by the availability of more data and computing power, recent breakthroughs in cloud-based machine learning (ML) have transformed every aspect of our lives from face recognition and medical diagnosis to natural language processing. However, classical ML exerts severe demands in terms of energy, memory, and computing resources, limiting their adoption for resource-constrained edge devices. The new breed of intelligent devices requires a novel paradigm change calling for distributed, low-latency, and reliable ML at the wireless network edge. This talk will explore the potential of the Mobile AI paradigm to unlock the full potential of next-generation networks.