Center for Wireless Technology Eindhoven (CWTe)

CWTe 2019 Research Retreat

October 9, 2019

Nature-Inspired Biomimetic MEMS/NEMS Sensors for Wireless Sensing Systems
Speaker: Ajay Kottapalli (RUG)

Abstract:

Many biological species found in nature are equipped with extraordinary sensing systems that work on diverse sensing principles. Some of these biological sensors demonstrate a range of multifaceted functionalities that exceed the sensing capabilities of most human engineered sensors. The fundamental motivation of my research work has been to study the ubiquitous yet novel sensing principles and nano-engineering of the biological sensors in nature and apply those lessons to design wireless micro and nanoelectromechanical systems (MEMS/NEMS) sensors to target a specific application. This talk will describe how through a biomimetic design I developed 1. Inner ear stereocilia inspired soft-polymer NEMS structures for artificial cochlea applications 2. Self-powered MEMS flow sensors inspired by neuromasts in blind cavefishes for use in intravenous drug infusions 3. Whisker-inspired ultrasensitive MEMS flow sensors and experimental validations that prove enhancement in signal-to-noise ratio of the sensor. In addition, the talk will also present the development and characterization of flexible and stretchable single and bundled PVDF nanofiber sensors and origami-inspired energy harvesters. Applications of such soft-polymer flexible and wireless sensors in myoelectric prosthetics and biomedical devices will be illustrated. The translational roadmap to bring some of these lab-developed biomimetic MEMS sensors wireless sensing applications and to commercialization and formation of a start-up company will be outlined.

Speaker's bio:

Ajay Kottapalli started as a tenure-track assistant professor in Micro/Nano Sensors, NEMS and Nanofabrication on 01 February 2018. In 2013, he received his Ph.D degree in Mechanical Engineering from the Nanyang Technological University (NTU), Singapore through the Singapore-MIT Alliance for Research and Technology (SMART) Graduate fellowship programme. During 2014-2015, he was as a Postdoctoral Associate at Singapore-MIT Alliance for Research and Technology (SMART). He then held positions as a Research Scientist and Principal Research Scientist at SMART during the years 2016 and 2017 respectively. Since 2014, he is a visiting scientist at Massachusetts Institute of Technology (MIT) through the SMART programme. He currently also holds the position as a Research Affiliate with the MIT Sea Grant College Program at MIT. Ajay's research focuses on nature-inspired micro/nano sensors, biomimetic materials and sensors, MEMS/NEMS, nanofabrication, flexible electronics, 2D sensing materials, biomedical sensors etc. A key aspect of his research work is to develop nanosensors with ultrahigh sensitivity and accuracy by imbibing designs of biological sensors in nature. In 2016 Ajay

founded a startup company named Sensornomics which utilizes the MEMS Biomedical flow sensors which he developed during his research. Through Sensornomics he envisions to create new standards of preventive care through flow sensing in Biomedical and healthcare domain. In 2018, Ajay was awarded the top 10 innovators under 35 in Asia Pacific by the MIT Technology Review. His research work was featured in the news in Singapore (The Straits Times) and at various research magazines (Asian Scientist). In 2014, he was awarded the best technology pitch award at the SMART Bootcamp and at the Japan TechPlanter. He was one of the outstanding reviewers of the year 2016 for the Biomimetics and Bioinspiration journal. He has published about 50 peer-reviewed papers, written 2 books and held 5 patents in sensor technology and medtech.

THz Resonances with Infinity Lifetime
Speaker: Jaime Gómez Rivas, TU/e

Abstract:

Small metallic particles behave as dipolar resonators with a resonant frequency determined by their size. When these resonators are placed in an array, they can couple with diffraction orders forming collective modes, which are called surface lattice resonances (SLRs). If two resonators that are detuned in frequency are placed in the same array, their SLRs will interfere leading to a Fano resonance. The linewidth of the resonance decreases by reducing the detuning between the two resonators. This linewidth should vanish when the resonators become equal in size. In this situation, the resonance becomes a bound state in the continuum (BIC). BICs cannot couple to far-field radiation and are characterized by infinite lifetimes, which makes them extremely interesting for applications in communication technology, sensing, non-linear optics and for enhancing light-matter interaction. Using THz time-domain far-field spectroscopy and THz near-field microscopy we demonstrate the formation of Fano resonances and their evolution towards BICs in arrays of gold dimers on quartz. The measurements show the electromagnetic field distribution around the dimers, elucidating the mechanism that leads to the increase of the resonance lifetime. The resonance linewidth vanishes when the two rods forming the dimer are equal in size, indicating a very long (infinite) lifetime of the BIC, which can be probed only with near-field excitation and detection.

Speaker's bio:

Jaime Gómez-Rivas received his PhD in 2002 from the University of Amsterdam for the investigation of light transport in disordered media. From 2002 until 2005, he worked as postdoctoral researcher at RWTH-Aachen, pioneering the field of THz plasmonics. He became group leader at the FOM Institute AMOLF in 2005. His group, which was partially located at Philips Research, introduced the concept of nanoantennas for solid state lighting. In 2010 Gomez-Rivas was appointed part-time professor at TU/e and in 2015 full professor. The research of Gómez Rivas group focuses on light-matter coupling at the nanoscale and on THz time-domain spectroscopy and microscopy for the investigation of fundamental and resonant phenomena in matter. Gómez-Rivas has received several prestigious grants and awards, such as ERC Starting and Proof of Concept grants, NWO-Vici grant and Facebook Academy Award. He is co-author of more than 150 articles. He also works as associate editor of the Journal of Applied Physics and is co-founder of the company TeraNova B.V.

5G developments & outlook
Speaker: Adrian Pais, TNO

Abstract:
The journey towards the 5G future is now well and truly underway. The first standards have been completed, trials are being conducted, and the first 5G networks and devices have been launched around the world. Yet despite this progress, there remain several technical, regulatory and business challenges to be resolved. This presentation will give an overview of the latest 5G developments, the challenges faced by the industry and what can be expected in the future. Special attention will be paid to 5Groningen, a multi-stakeholder partnership that aims to create new opportunities in North Groningen using 5G applications.

Speaker's bio:

Dr. **Adrian Pais** is Senior Telecom Consultant at TNO and Technical Manager of 5Groningen, a multi-stakeholder partnership that aims to create new opportunities in rural areas in the north of the Netherlands using 5G applications. In his activities he leads or contributes to research and consultancy in 5G for mobile operators, vendors, enterprises, and government. Adrian is active in 3GPP standardisation and as an IEEE member he has served as Director on the IEEE Foundation Board. He has a Bachelor of Engineering (BE) with First Class Honours and PhD, both from The University of Auckland, New Zealand.

Exploring the Unknown
Speaker: Peter Baltus, TU/e

Abstract:

Optimally exploring unknown environments is a “chicken and egg” problem: optimized sensors for such an exploration require knowledge of the unknown, which can only be obtained by using good sensors. The Phoenix EU project solved this problem in a similar way as chickens and eggs: by evolving both simultaneously. In this presentation the problem, the solution, its applications and the future of this technology will be unveiled and all your questions might be answered!

Speaker’s bio:

Peter Baltus worked for 22 years at Philips and later NXP in in Eindhoven, Nijmegen, Tokyo and Sunnyvale in various functions, including research scientist, program manager, architect, domain manager, group leader and fellow in the areas of data converters, microcontroller architecture, digital design, software, and RF circuits and systems. In 2007 he discovered that he could have even more fun at Eindhoven University of Technology and joined as full professor in high-frequency electronics and director of CWTe. As of 2017 he became chair of the Integrated Circuits group. Peter is interested in just about anything, but especially in low power wireless circuits and systems. He was born in 1960, received his MSc degree in 1985 and his PhD degree in 2004 from Eindhoven University of Technology, and currently holds 16 US patents and co-authored more than 100 papers.

Start-up pitches
Speaker: multiple

Abstract:

Short presentations around wireless start-up initiatives.

Connectivity needs in Ports 2030
Speaker: Henk Zwetsloot, Groningen Seaports

Abstract:

Digitization and robotization will enhance the needs for connectivity in Ports dramatically. Autonomous ships are bound to arrive in the ports before 2030. Sensor networks and camera's will guide these ships safely to the berths, planned by the harbor master. The current 4G networks in the ports will not be sufficient. On their routes from high seas to the entrance of ports, autonomous ships will need satellite connections or perhaps 5G technology attached to offshore constructions like windmills and gas or oil platforms. Groningen Seaports is currently testing 5G technology in the port, as one of the many steps on the roadmap to a digitized port in 2030.

Speaker's bio:

Henk Zwetsloot is CIO and Manager digital innovation of Groningen Seaports since 2015. He manages the digitization program for Groningen Seaports (Eemshaven and Delfzijl). He held positions with a wide variety of companies and institutions, like dean of the school of computer science, (Hanze University Groningen), dean of Hanze Institute of Technology, Director operations at Numeriek Centrum Groningen, IT manager and manager purchasing and contracting at Gasunie. He graduated at Wageningen University and research.

Integrated Microwave Photonics chip platform by hybrid integration of InP and TriPleX
Speaker: Chris Roeloffzen, LioniX

Abstract:

Integrated microwave photonics (IMWP) is a novel field in which the fast-paced progress in integrated optics is harnessed to provide breakthrough performances in well-established microwave photonic processing functions, which are traditionally realized using discrete optoelectronic components. A field where IMWP is expected to have a strong impact is the one of phased array antennas. Such arrays offer a number of attractive characteristics, including a conformal array profile, broadband beamforming (beam shaping and beam steering) and interference nulling. This, however, is very challenging to achieve using only electronics processing. For this reason, the last few years, an increasing amount of effort has been directed to the development of our hybrid chip platform where Si3N4-based-TriPleX and InP optical waveguides are combined to enable broadband and high frequency radio signal processing in the optical domain including conversion.

Speaker's bio:

Chris Roeloffzen is Chief Scientific Officer at LioniX International received his MSc degree in physics from the University of Twente in 1998 and his Ph.D. degree in electrical engineering in 2002. In 2002 he became assistant professor in the Telecommunication Engineering Group of the University of Twente, where he was involved with research and education on integrated microwave photonic systems. In 2009 he founded of the company SATRAX, a spin-off of the University of Twente. SATRAX provided integrated optical beam forming modules for antenna systems to enable the growing need for bandwidth and capacity in telecommunication. These antenna systems meet bandwidth requirements for broadband terrestrial and satellite communications. Chris acted as Chief Technology Officer within SATRAX.

Towards cooperative driving - Vehicular networking as an essential ingredient for intelligent transportation systems

Speaker: Geert Heijenk, UTwente

Abstract:

Mobility is taking an enormous toll on modern society, with over 25 000 annual fatalities in the Europe Union, a large impact on land use, and a significant contribution to greenhouse gas emissions. To significantly increase road capacity and safety, and to reduce the environmental impact of road transport, the use of information technology should not be limited to the functioning and comfort of an individual vehicle. In this talk, I will argue that wireless communications is an essential ingredient for future intelligent transportation systems, possibly culminating in cooperative autonomous vehicles. I will highlight possible solutions for vehicular networking and give an overview of important research challenges.

Speaker's bio:

Geert Heijenk is a full professor in Wireless Networks and Mobility at the University of Twente, the Netherlands. He received his Ph.D. degree in 1995 from the same university. He has held a part-time position at KPN Research from 1989 until 1991. From 1995 until 2003, he was with Ericsson EuroLab Netherlands, leading a networking research group. From 2015 until 2018 he has been program director of the Computer Science and Internet Science & Technology bachelor and master programs of University of Twente. Geert Heijenk is steering committee member of IFIP WWIC and IEEE VNC.