TOPICAL WORKSHOP ON ELECTROMAGNETICS IN HEALTH AND MEDICINE

sponsored by
IEEE AP/MTT/EMC/ED Turkey Joint Chapter
IEEE AP-S Technical Committee on Health and Medicine

SPEAKERS

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Middle East Technical University,
EE Eng, Sevim Tan Auditorium (D-231), Ankara
22 December 2025

All interested are welcome
Registration is required
the event is free of charge!

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TOPICAL WORKSHOP ON ELECTROMAGNETICS IN HEALTH AND MEDICINE WORKSHOP

09.00	Opening Speech by Prof. Qammer H. Abbasi
09:30	Prof. Akram Alomainy Resilient, Scalable and Flexible Wearable & EM Technologies for Next Generation Healthcare
10:20	Prof. Emine Ülkü Sarıtaş Magnetic Particle Imaging: A New Frontier for Neuroimaging
11:10	Assoc. Prof. Sema Dumanlı Oktar Wireless In-body Sensing Through Genetically Engineered Bacteria
12:00	Break
13:30	Prof. Haluk Kulah Advancements in Microsystems at METU: From Sensors to Implants
14:20	Dr. Erdem Çil Design and Analysis of Ingestible Antennas for Multiplexed Gastrointestinal Biosensing and Wireless Capsule Endoscopy
15:10	Coffee Break
15:40	Prof. Stavros Koulouridis On Pneumothorax Detection in Microwave Frequencies Region
16:30	Dr. Damla Alptekin & Dr. Can Barış Top Novel EM-Based Approaches for Breast Cancer Detection

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Resilient, Scalable and Flexible Wearable & EM Technologies for Next Generation Healthcare

Biography

Akram Alomainy
QMUL
UK

Professor Akram HM Alomainy (CEng, FRSA, FHEA, SMIEEE) is a leading academic in antennas, applied electromagnetics, and body-centric wireless communications, recognised internationally for his research, innovation, and leadership. He is Deputy Dean for Postgraduate Research in the Faculty of Science and Engineering at Queen Mary University of London (QMUL), Lead of the Centre for Electronics, and Head of the Antennas and Electromagnetics Research Group. He oversees postgraduate research strategy across five schools, directing doctoral training, funding allocation, and research culture initiatives, while leading a team of over 70 staff and researchers supported by state-of-the-art facilities, including a £3.5 million antenna measurement laboratory. His research spans antennas, electromagnetic materials, terahertz communications, wearable and implantable devices, and nanoscale wireless networks, with applications in healthcare, defence, communications, and the creative industries. He has secured more than £16 million in competitive research funding — including over £6 million as Principal Investigator. His leadership and scholarship have been recognised with the QMUL Research Excellence Award (2022), Education Excellence Award (2019), multiple Abu Dhabi Research Excellence Awards (2017, 2018), and the Isambard Kingdom Brunel Award for science communication (2011). A Fellow of the Royal Society of Arts and Chartered Engineer, he serves on editorial boards including IEEE Access and IEEE Antennas and Wireless Propagation Letters, reviews for major funding bodies, and has chaired international research panels. He is also a Visiting Fellow at Goldsmiths, University of London, fostering interdisciplinary collaborations between science and the creative arts.

Abstract

With the advent of commercial products, such as Google Glass, Samsung Galaxy Gear and the expected iWatch, body-centric communication has increasingly garnered the public attention and smoothly translated state-of-the-art research work into reality. With the development of nanotechnology, the idea of connecting nano-devices to conduct complicated tasks and communicate the information collected by these sesnors was a natural progression in order to complete the overall picture of a new generation of body-centric wireless networks. Connecting these nano-machines (or nano-devices) together in order for them to execute a useful function and deliver information between nano-nodes and ultimately interfacing to users or the outside world, the birth of nano-communication and networking was a necessity. Nano-scale communication is referred to the exchange of information at the nanoscale and it is the basis of any wired/wireless interconnection of nano-devices in a nano-network. The way the nano-devices communicate with each other has strong dependence on the way in which they are realised. In addition, the specific application of the nano-network determines the deployment of the nano-networks, thus constraining the choice on the particular type of nano-communication. The talk will present development of reliable and comprehensive channel modelling, human tissue electric properties in the THz band and networking technologies to address the major challenges of the nano-scale electromagnetic channels needed for body-centric wireless nano-networks deployed in future healthcare applications. With the advancement of nano-scale machine fabrication and the deep understanding of molecular behaviour within the human body, future healthcare monitoring and feedback systems are expected to be comprehensive, efficient and ubiquitous hence coupling existing wireless wearable sensors and implantable units with nano-machines and networks.

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Magnetic Particle Imaging: A New Frontier for Neuroimaging

Emine Ülkü Sarıtaş
BILKENT UNIVERSITY
Turkiye

Biography

Emine Ulku Saritas is an Associate Professor at the Department of Electrical and Electronics Engineering and the National Magnetic Resonance Research Center (UMRAM) at Bilkent University. She received her PhD degree in Electrical Engineering from Stanford University in 2010 and completed her postdoctoral research at University of California, Berkeley, before joining Bilkent in 2013. She currently serves as the chair of ISMRM Turkish Chapter and previously served as the chair of IEEE Turkey EMB, as an Associate Editor for IEEE TMI, and as an Editorial Board Member for Nature Scientific Reports. She is the recipient of numerous awards including the 2015 TÜBA-GEBİP Young Scientist Outstanding Achievement Award, the 2016 BAGEP Young Scientist Award, the 2019 TÜBİTAK Incentive Award, the 2020 METU Parlar Foundation Research Incentive Award, and the 2020 IEEE Turkey Research Incentive Award. She has also received the Distinguished Teaching Award of Bilkent University in 2018. Her research focuses on developing novel biomedical imaging techniques, contrast mechanisms, and image reconstruction methods, as well as the safety limits of magnetic fields used in medical imaging systems.

Abstract

Magnetic Particle Imaging (MPI) is an emerging medical imaging modality distinguished by its exceptional contrast and high sensitivity. It already supports several important clinical and research applications, including stroke and traumatic brain injury assessment, cancer imaging, stem-cell tracking, and interventional imaging. MPI does not utilize ionizing radiation; instead it uses safe, low-frequency magnetic fields for imaging the spatial distribution of magnetic nanoparticles (MNPs). These iron-oxide-based MNP tracers are also established as safe for human use. In recent years, the increasing availability of preclinical MPI scanners has enabled pivotal studies demonstrating the promise of MPI for neuroimaging. Building on these advances, human-head-sized MPI systems for neuroimaging are now under active development in both research and commercial settings, with particular interest in applications such as functional imaging. This talk will introduce the principles of MPI, discuss its emerging neuroimaging applications, and highlight our ongoing MPI research efforts at the National Magnetic Resonance Research Center (UMRAM) at Bilkent University.

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Wireless in-body sensing through genetically engineered bacteria

Sema Dumanlı Oktar
BOGAZICI UNIVERSITY
Turkiye

Biography

Sema Dumanli received the B.Sc. degree in electrical and electronic engineering from Orta Dogu Teknik Universitesi, Ankara, Turkey, in 2006, and the Ph.D. degree from the University of Bristol, Bristol, U.K., in 2010.

She was with Toshiba Research Europe, Bristol, as a Research Engineer and a Senior Research Engineer from 2010 to 2017. She is currently an Associate Professor at Bogazici University, Istanbul. She is the founder and the director of Antennas and Propagation Research Laboratory (BOUNtenna) and Bioelectromagnetics Laboratory (AntennAlive). Her current research interests include antenna design for implantable and wearable devices, in-body sensor design, biohybrid implants, chipless RF-ID sensors and multi-scale communications.

Dr Dumanli is the recipient of Science Academy's Young Scientist Award (BAGEP) 2025, the IEEE APS Donald G. Dudley Jr. Undergraduate Teaching Award 2022, and three times recipient of "Boğaziçi University, Faculty of Engineering's Excellence in Teaching Award". She currently serves as the chair of IEEE APS/MTT/EMC/ED Turkey Joint Chapter, the vice-chair of the IEEE APS Young Professionals Committee, and the Associate Editor to IEEE AP-S Digital Communications. She is a member of the IEEE AP-S Technical Committee on Health and Medicine, IEEE MTT RFID, Wireless Sensor and IOT Committee and IEEE AP-S Distinguished Lecturer Committee. Dr Dumanli also serves as a board member and the secretary of URSI Turkey and the chair of URSI Turkey Commission K.

Abstract

This talk introduces a class of wireless implantable sensors that integrate genetically engineered cells capable of detecting specific molecules for continuous monitoring. While synthetic biology enables cells to sense molecular targets, wireless communication of this information remains a challenge. Electromagnetic (EM) waves at cellular-scale wavelengths are strongly attenuated in tissue, necessitating centimeter-scale wavelengths for in-body links. Aligning cellular responses with these longer EM wavelengths enables effective interaction.

In this talk, the response of Escherichia Coli is harnessed to trigger the controlled degradation of a passive microwave antenna, which is then monitored via backscatter communication. This approach converts cellular activity into detectable EM signals, eliminating the need for batteries or circuits. We demonstrate a wireless link between a passive, cell-based sensor in a human body phantom and an external receiver, achieving molecular-level sensing at 25 mm implant depth. Future implementations could couple bacterial responses to diverse molecular targets.

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Advancements in Microsystems at METU: From Sensors to Implants

Haluk Külah
METU
Turkiye

Biography

Prof. Dr. Haluk Külah received his B.Sc. and M.Sc. degrees in Electrical Engineering from METU in Ankara, and his Ph.D. from the University of Michigan, Ann Arbor. Since 2004, he has been a faculty member at METU, where he also serves as an executive board member of the METU MEMS Research Center, a national research infrastructure in micro- and nanotechnologies.

His research focuses on micro- and nanosystems for biomedical applications, including neural implants, energy harvesting, microfluidics, and mixed-signal interface circuits. He has published more than 250 papers, holds over 30 patents, and has received several awards, including the TÜBİTAK Research Incentive Award, the IBM Faculty Award, METU Academic Performance Awards, and the Young Scientist Award of the Turkish Academy of Sciences. Dr. Külah is also a member of the Science Academy, Türkiye.

He is the recipient of multiple ERC grants, including the Consolidator Grant FLAMENCO and the Proof of Concept projects OPERA and ARIA, all on fully implantable cochlear implants. In addition, he is the founder and CEO of deep-tech start-ups Mikro Biyosistemler in Türkiye and Cellsway in the UK, developing CTC-based liquid biopsy platforms for oncology applications.

Abstract

At the METU MEMS Center and within the BioMEMS Research Group, we advance microsystems and sensor technologies across multiple domains. Our work spans mixed-signal IC design, energy harvesting, inertial sensors, and biomedical microsystems — with applications ranging from neural interfaces and smart implants to microfluidic and lab-on-a-chip platforms.

A central case study will be the ERC Consolidator Grant FLAMENCO, which pioneered the world's first concept of a fully implantable, autonomous cochlear implant. By mimicking natural hair cell function with piezoelectric transducers, the system achieves both acoustic sensing and energy harvesting, combining ultra-low-power electronics, a wireless power transfer unit, a rechargeable battery, and an intracochlear electrode array. In vivo studies confirmed the feasibility of this radically new architecture, eliminating the need for external microphones and continuous RF transmission.

Through this example, the talk will illustrate how advances in MEMS sensor systems can progress from fundamental research to disruptive biomedical technologies, demonstrating the translational power of interdisciplinary engineering and its potential to create real-world clinical impact.

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Design and Analysis of Ingestible Antennas for Multiplexed Gastrointestinal Biosensing and Wireless Capsule Endoscopy

Erdem Çil
UNIVERSITY OF RENNES
France

Biography

Erdem Cil was born on January 5, 1993, in Samsun, Turkey. He received the B.Sc. degree in electronics and communication engineering from Istanbul Technical University, Istanbul, Turkey, in 2017, the M.Sc. degree in electronics engineering from the Electronics Department, Boğaziçi University, Istanbul, Turkey, in 2020, and the Ph.D. degree in electronics engineering from the Université de Rennes, Rennes, France, in 2024.

Currently, he is a postdoctoral fellow at the Institut d'Electronique et des Technologies du numéRique (IETR), Université de Rennes, Rennes, France. He was also a Research Assistant with the Electronics Department, Boğaziçi University and a research engineer in BodyCAP, Hérouville St Clair, France. His current research interests include ingestible and implantable antenna design for body-centric communications, in-body electromagnetic propagation, gastrointestinal biosensing, and wireless bioelectronics. He authored 1 book chapter, 5 journal papers, and 11 papers in international conference proceedings.

Abstract

Ingestible telemetry and biosensor devices enable continuous monitoring of physiological conditions within the gastrointestinal (GI) tract by collecting in-body data and wirelessly transmitting it to external receivers. Among many components these devices must incorporate for efficient operation, the ingestible antenna has a critical role both in the communication with the external monitor and in the sensing performance of the entire system.

This talk presents recent advances in the analysis and design of ingestible antennas for biotelemetry and multiplexed GI biosensing in wireless capsule endoscopy. It offers a detailed examination and comparison of antenna types, evaluating their suitability for multiplexed GI biosensing through several antenna parameters. Novel techniques for real-time capsule localization based solely on antenna parameters are introduced, alongside methods to improve sensing accuracy and radiation efficiency in the challenging in-body environment. Finally, the talk presents newly developed miniaturized ingestible antenna designs that achieve enhanced sensing performance, robustness, and communication efficiency, paving the way for more reliable and versatile GI biosensing systems.

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On Pneumothorax Detection in Microwave Frequencies Region

Stavros Koulouridis
UNIVERSITY OF PATRAS
Greece

Biography

Stavros Koulouridis (Member, IEEE) received the Diploma degree in electrical and computer engineering and the Ph.D. degree in microwave engineering from the National Technical University of Athens, Greece, in 1999 and 2003, respectively.

From 2004 to 2008, he was a Senior Research Associate with the Electroscience Laboratory, The Ohio State University, Columbus, OH, USA. In 2009, he joined the Department of Electrical and Computer Engineering, University of Patras, Greece, where he is currently a Professor and Head of the RF, Microwave, and Mobile Communications Laboratory. Since September 2025, he has also been the Director of the Telecommunications and Information Technology Division of the department. From 2022 to 2023, he was Visiting Professor with Florida International University, Miami, FL, USA, where he currently holds a Courtesy Associate Professor appointment. From 2015 to 2016, he was Visiting Professor with the Group of Electrical Engineering–Paris (GeePs)/CNRS-CentraleSupélec–Université Paris-Sud–Université Paris-Saclay–Sorbonne Université.

He has authored or coauthored more than 150 refereed journal and conference papers. He holds one patent. His research interests include antenna and microwave device design, development and fabrication of novel materials, microwave applications in medicine, electromagnetic optimization techniques, and applied computational electromagnetics.

Prof. Koulouridis was the recipient of a three-year Ph.D. Scholarship in Biomedical Engineering from the Hellenic State Scholarships Foundation in 2001. In 2005 he received the Annual Award for the Best Dissertation from the National Technical University of Athens. From 2013 to 2019, he chaired the IEEE AP/MTT/ED Joint Local Greek Chapter. He was the General Chair of the International Workshop on Antenna Technology (iWAT) 2017. He has served on the Technical Program Committees of the IEEE Antennas and Propagation Symposium (since 2010) and the European Conference on Antennas and Propagation (EuCAP, since 2015 as a Meta-Reviewer). He is Topic Editor of Electronics (MDPI), on the Editorial Board of Telecom (MDPI), and Associate Editor of the IEEE Antennas and Wireless Propagation Letters (AWPL) and the IEEE Journal of Electromagnetics, RF, and Microwaves in Medicine and Biology (J-ERM).

Abstract

Pneumothorax is caused by air concentration inside the pleural cavity—the space between the lung and chest wall. The trapped air compresses the lung, affects normal respiration, can obstruct venous return to the heart, and may lead to circulatory instability and traumatic cardiac arrest. Pneumothorax is typically diagnosed through X-rays, Computed Tomography (CT), or ultrasound imaging. However, detection in emergency situations must be rapid and at the point of care, while these methods are costly, time-consuming, and generally unavailable outside hospital settings. Microwave sensors can provide a solution for such cases, potentially enabling a lightweight, non-invasive, low-power assistive device. The sensor could monitor reflected waves differentially—which change in phase and amplitude due to the presence of air cavities near the skin surface—to detect pneumothorax. Such a sensor must accommodate variabilities associated with body composition, gender, and age while simultaneously providing severity estimation. Several parameters require careful consideration, including the frequency band, antenna type, and number of antenna elements. In this work, we discuss the steps necessary for pneumothorax detection and quantification at microwave frequencies. To this end, different antenna types—including planar and directional antennas—will be employed, in conjuction with thorax models ranging from simplified rectangular phantoms to realistic MRI-image-based models. Measurements with phantoms and in vivo studies will be discussed. The multitude of results presented demonstrates the feasibility of the proposed approach.

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Novel EM-Based Approaches for Breast Cancer Detection

Biography

Damla Alptekin Soydan
ASELSAN
Turkiye

Dr. Damla Alptekin Soydan is a chief engineer at ASELSAN, Ankara. She received her B.Sc. (2012), M.Sc. (2015), and Ph.D. (2024) degrees in Electrical and Electronics Engineering from Middle East Technical University. In 2020, she joined ASELSAN as a Research and Development Engineer. She is a member of the nexMPI (Next Generation of Magnetic Particle Imaging) COST Action and a co-leader of the Software and Tooling Working Group. She has expertise in implantable antennas, electromagnetic and acoustic medical imaging methods (microwave imaging and shear wave elasticity imaging), and magnetic particle imaging and therapy. She was a Best Student Paper finalist at the 43rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC 2021).

Can Barış Top
ASELSAN
Turkiye

Dr. Can Barış Top is a team leader in Sensor Subsystems Design Department in ASELSAN. He worked as postdoctoral research fellow with the Focused Ultrasound Laboratory in Harvard Medical School between 2014-2016. He received his B.Sc. (2003), M.Sc. (2006), and Ph.D. (2013) degrees in Electrical and Electronics Engineering from METU. and has been working in ASELSAN since 2004. His research interests include biomedical applications of electromagnetics and acoustics, magnetic particle imaging, and nanoagents for imaging and therapy. Dr. Top is the recipient of the 2013 Parlar Foundation Thesis of the Year and the 2014 Serhat Ozyar Young Scientist of the Year Awards.

Abstract

Clinical imaging methods for breast cancer screening, x-ray-based mammography and ultrasound imaging, have relatively low sensitivity and specificity in dense (high fibro-glandular content) breast tissues. Microwave Imaging methods have emerged as an alternative tool for breast tumor detection, based on the dielectric contrast between normal and malignant breast tissues. Yet, initial patient experiments show that there is still a need for improvement in terms of sensitivity. In this talk, we will present three different methods that may overcome the limitations of the current imaging methods: Harmonic Motion Microwave Doppler Imaging, Hybrid Microwave and Ultrasound Elasticity Imaging, and Magnetic Particle Imaging. The first two make use of tissue elastic properties in addition to dielectric properties for tumor discrimination. The latter one uses magnetic nanoparticle tracers, which may be engineered to actively accumulate in tumors. We will show the results from our numerical and experimental studies, and discuss the potential of each method for clinical translation.

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