Education News

Winners of the 2018 MTT-S Undergraduate/ Pregraduate Scholarships

■ Zlatica Marinković, Ping Jack Soh, Ramesh Gupta, and Rashaunda M. Henderson

The IEEE Microwave Theory and Techniques Society (MTT-S) Education Committee issues two calls for applications for the MTT-S undergraduate/pregraduate scholarships annually, one in April (cycle 1) and the other in October (cycle 2). To award the 2018 scholarships, application calls were issued in October 2017 and April 2018.


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Twelve excellent undergraduate/pregraduate students were selected to receive the awards, which consist of 1) a US$1,500 scholarship to be used for realizing the proposed project or as a stipend, 2) a free one-year MTT-S membership with a subscription to all MTT-S publications, and 3) a travel supplement to attend the next IEEE MTT-S International Microwave Symposium or a regional MTT-S conference.

Reviewers from academia and industry assessed the project proposals as well as the personal achievements of the student candidates. Each application was reviewed by three experts. Based on the review scores, six scholarships were awarded each for the spring 2018 and fall 2018 cycles. We congratulate all winners and thank the reviewers for their valuable assistance in selecting the recipients. Following are short bios of the awardees and descriptions of their projects.

Spring 2018

Blake Amacher

School: University of Akron, Ohio, United States

Advisor: Prof. Ryan Toone

Project topic: The interaction of millimeter-wave (mm-wave) Laguerre–Gaussian (LG) with monolayer graphene solid-state devices

Blake Amacher is a B.S. degree student in electrical engineering at the University of Akron. He joined Prof. Ryan Toonen's research lab and is conducting research in quasi-optics and mm-wave applications with solid-state devices. His research interests include microwave engineering, mm-wave applications, and quasi-optics.

Zlatica Marinković (zlatica.marinkovic@ieee.org) is with the Faculty of Electronic Engineering, University of Niš, Serbia. Ping Jack Soh (pjsoh@unimap.edu.my) is with the School of Computer and Communication Engineering, Universiti Malaysia Perlis. Ramesh Gupta (ramesh.gupta@ieee.org) is with Ligado Networks, Reston, Virginia, United States. Rashaunda M. Henderson is with the High Frequency Circuits and Systems Laboratory, University of Texas, Dallas, United States.

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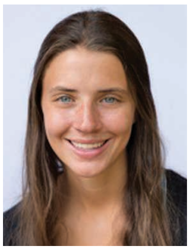
Project Description

The research goal is to observe the formation and interaction of mm-wave LG beams operating at frequencies centered on 61.25 GHz, with solid-state devices fabricated from monolayer graphene. LG beams are unique for experiments compared to fundamental Gaussian beams because they carry orbital angular momentum (OAM). The interaction of the LG beam with the graphene device while immersed in a static magnetic field will be experimentally analyzed using a four-point van der Pauw test structure as an OAM detector. A systematic approach will be used to observe the influence of LG-beam illumination on the graphene device to determine whether OAM can be used as another degree of freedom to control the properties of graphene.



Anna Broome

School: Princeton University, New Jersey, United States

Advisor: Prof. Kaushik Sengupta

Project topic: High-density terahertz (THz) imaging systems at 2.8 THz in silicon with quantum cascade laser (QCL)-based excitation sources

Anna Broome earned her B.S.E. degree from Princeton University. She completed her senior thesis research under the supervision of Prof. Kaushik Sengupta, developing a silicon CMOS-based THz imager. Anna's plans for her doctorate research focus on the design of novel high-frequency circuits and systems.

Project Description

THz imaging has emerged as a powerful tool for a wide range of applications in security, imaging, sensing, quality control, and biomedical sensing. Current THz detector technology consists of custom devices, which are often bulky and expensive and not sensitive enough to operate at room temperature. Technology for THz detection has been demonstrated in silicon, but these devices typically operate below 1 THz, can be power intensive (>300 mW/pixel), require high-resistivity substrates, or use modifications such as silicon lenses and substrate thinning. In recent years, silicon-based THz imagers have been demonstrated in the 100–1,000-GHz range, with noise equivalent power in the near-1-THz range of ~1 nW/Hz. Beyond 1 THz, there has been little work on enabling integrated imaging systems. Additionally, integrated chip-scale sources beyond 1.4 THz in silicon have never been demonstrated. This project focuses on the frequency range of 2.8 THz with a hybrid QCL–silicon integrated-circuit solution, using a fully integrated silicon-based THz imager and a QCL laser operating at 2.8 THz.

Ana Čović

School: University of Florida (UF), Gainesville, United States

Advisor: Dr. Yong Kyu Yoon

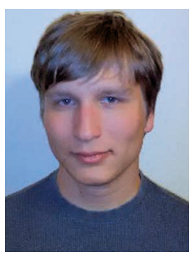
Project topic: Teeth grinding detection and intervention using bone conduction and wireless networks

Ana Čović, from Bosnia and Herzegovina, is an undergraduate student at UF majoring in electrical engineering. She has been a Davis United World College Scholar for four years, an honor she earned after completion of an international baccalaureate at the United World College in Mostar.

At UF, she has been interested in RF/microwave engineering, microelectromechanical systems, micro/nanofabrication, and control theory. In addition to research, she has been a teaching assistant for a class on control theory.

Project Description

The project targets covert detection of and intervention in bruxism for autistic children with the help of integrated sensors and wireless electronics. The proposed solution is a noninvasive, esthetically benign electronic wrist detector. The device would detect tooth grinding and provide instantaneous wireless feedback to a user's phone and/or computer through a Bluetooth or Wi-Fi connection. The detection mechanism involves the bone conduction of acoustic or ultrasonic signals. The simplified theory applied in this device is that the signal created by bruxism can be both heard (through the air) and transmitted through the bones, a demonstrably powerful acoustic conductor. By placing a sensing device at the wrist, the specific signature of grinding teeth could be detected as it propagates through the skull and down through the arm. The processed information is delivered to external health professionals, who will perform an intervention program to discontinue tooth grinding.



Silviu Gruber

School: University of Washington Bothell, United States

Advisor: Prof. Hung Cao

Project topic: Wireless power transfer and data communication for zebrafish electrocardiogram (ECG) monitoring

Silviu Gruber is a B.Sc. degree student in electrical engineering at the University of Washington Bothell. He is a researcher in Prof. Hung Cao's Hero Labs. His focus is inductive coupling, especially in near-field wireless power transfer for medical devices.

Project Description

Zebrafish (*Danio rerio*) have extraordinary regenerative abilities and, therefore, are very useful in numerous biological studies of organ injury. Recently, many studies have focused on tracking the zebrafish healing process by monitoring and analyzing ECG signals. However, in most of these studies, the zebrafish were sedated to obtain the ECG. This would result in affected nonintrinsic ECG readings. A proposed solution to this problem is to measure ECG signals wirelessly through the use of medical implants on nonsedated fish. The implant will be powered, and communicate wirelessly, through inductive-coupling transmit and receive antennas. Communication with the implant will be implemented through load modulation. This setup would ensure adequate power and information transfer for most misalignment angles between the transmitter and receiver.

Kae-An Liu

School: University of Toronto, Canada

Advisor: Prof. Costas Sarris

Project topic: Computation of high-order electromagnetic field derivatives with the multicomplex step derivative approximation

Kae-An Liu received his B.S. degree in electrical engineering from National Taiwan University in 2015. He is currently working toward his M.A.Sc. degree in the Electrical and Computer Engineering Department, University of Toronto, under the supervision of Prof. Costas Sarris. From June to December of 2017, he was a graduate technical intern with the electromagnetic compatibility (EMC)/RF team at Intel, Hillsboro, Oregon. His research interests include signal integrity, sensitivity analysis, EMC, and computational electromagnetics.

Project Description

This research focuses on a novel and efficient technique for the computation of high-order derivatives of electromagnetic fields over a broad frequency range. Based on the multicomplex step derivative (MCSD) approximation method, which is free of round-off errors associated with finite-difference methods, high-order electromagnetic field derivatives can be computed along with full-wave simulations. The MCSD approximation method is embedded and tested in finite-difference time-domain (FDTD) simulation, running in parallel with the time-stepping loop, to accurately calculate high-order field derivatives with respect to multidesign parameters. The accuracy, stability, and computation overhead of the proposed technique are analyzed. In addition to FDTD, the MCSD approximation solver can be further integrated with different simulation methods, introducing a powerful and versatile simulation environment for the applications of sensitivity analysis, uncertainty quantification, and multiparametric modeling of microwave structures.

Maxim S. Masyukov

School: ITMO University, St. Petersburg, Russia

Advisor: Dr. Anna Vozianova

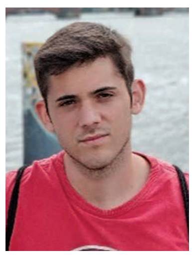
Project topic: The development of chiral metasurface with tunable polarizing properties in the THz frequency range

Maxim Masyukov is a B.Sc. degree student in photonics and optical information technologies at ITMO University in Russia. Currently, he is a laboratory assistant in the Terahertz Biomedicine Laboratory under the supervision of Dr. Anna Vozianova. His research interests include THz radiation, metamaterials, and graphene technologies.

Project Description

Over several decades, interest in THz radiation and its applications in biophotonics and biomedicine has been very high. Despite this, there is a lack of high-quality components, especially polarizing ones. Hence, the aim of this project is to make a tunable polarizer based on a chiral metasurface, which could be used in investigations of polarization-changing properties of biological objects, such as cancer and tooth disease.

Fall 2018



Luis Álvarez López

School: University of Seville, Spain

Advisor: Prof. Juan A. Becerra

Project topic: Mitigation of nonlinear effects in communication systems

Luis Álvarez López is a B.Sc. degree student in electrical engineering, majoring in telematics, at the University of Seville. Recently, he has worked with the Department of Signal and Communication Theory under the supervision of Prof. Juan A. Becerra. His research interests include advanced signal processing methods and techniques applied to the mitigation of nonlinearities in communication systems.

Project Description

Focusing on the application requirements of 5G communication systems with challenging constraints on spectral efficiency, this project will study, develop, and implement nonlinear mitigation of wireless communication systems through digital predistortion (DPD) by applying deep-learning signal processing techniques. The complexity of the behavioral models on which DPD is based demands obtaining algorithms that enable a sparse recovery of their coefficients while still enhancing the mitigation procedures available in modern wireless systems. This project will balance the theoretical part of DPD algorithms, implemented in Python, with the experimental evaluation of their performance, using specialized measurement setups with vector signal generators and vector signal analyzers.

Louis Grauwin

School: École nationale supérieure d'électronique, informatique, télécommunications, mathématique et mécanique (ENSEIRB-MATMECA), Bordeaux, France

Advisor: Prof. Anthony Ghiotto

Project topic: A dual-band transmitter and onboard camera for experimental rocket telemetry application

Louis Grauwin received his B.Sc. degree in electronics engineering, majoring in embedded systems, at ENSEIRB-MATMECA. As a member of the aeronautics association EirSpace, he has recently worked on an autonomous drone collecting materials and entered the French National Centre for Space Studies (CNES) contest. His research interests include analog integrated-circuit design, antennas, and radio waves.

Project Description

The project consists of designing and manufacturing a complete experimental rocket telemetry system based on a tracking base station. This system will be used to improve communication with experimental rockets launched by the EirSpace student association, of which Grauwin is a member, during the C'Space International Student Contest organized by the CNES/French Space Agency. The aim of this project is to establish a strong link for data transmission from the rocket to the ground and create video transmission. All measurements will be transmitted on a 138.5-MHz industrial, scientific, and medical (ISM) band, and a ground station will receive the data. The video transmission will use the 868-MHz ISM band, which allows a better flow rate. Grauwin will be in charge of designing, manufacturing, and testing an 868-MHz emitter based on off-the-shelf components as well as a diplexer, a splitter, and the dual-band blade antenna. The 138.5-MHz transmitter, the Kiwi Millennium telemetry system, is provided by the CNES.

France Gaspari Mbeutcha

School: University of Bologna, Italy

Advisor: Prof. Alberto Santarelli

Project topic: A high-side wideband current sensor for RF power amplifiers (PAs)

France Gaspari Mbeutcha received his B.Sc. degree in informatic engineering from Bologna University in 2013. He is currently pursuing his M.Sc. degree in electronic engineering there. His research interests include RF PAs, high-frequency electronics, instrumentation, and measurements.

Project Description

The power efficiency of RF PAs represents a key aspect in modern transmitters. In addition, increased power dissipation necessitates withstanding higher operating temperatures, which affect the dynamic behavior and reliability of the active devices (i.e., the transistors) within the RF PA. These issues are likely to worsen with the increase of signal modulation bandwidth up to several hundreds of megahertz, as planned for future telecom standards (e.g., 5G).

The aim of this project is to measure the dynamic voltage applied to the amplifier's supply terminal and the supply current dynamically drained by the amplifier. These measured quantities allow for monitoring the dynamic power dissipated by the device and, at the same time, can be used to gain insight into its behavior. This information can then be employed for synthesizing the optimal RF signal and supply inputs for the best PA operation. Notably, the bandwidth of both the dynamic supply voltage and the supply current can be several times larger than the bandwidth of the RF modulation signal. Whereas the acquisition of wideband dynamic voltage for several-hundred-megahertz bandwidths can be achieved with suitable high-impedance probes, current sensing involves several design challenges.

Dariia Yevtushenko

School: Kharkiv National University of Radio Electronics, Ukraine

Advisor: Prof. Alexander I. Nosich

Project topic: Electromagnetic engineering of plasmon-assisted optical nanowire sensors for electron-beam diagnostics

Dariia Yevtushenko received her M.Sc. degree in photonics and opto-informatics from the Kharkiv National University of Radio Electronics in February 2019. While there, she was an undergraduate research assistant in the Laboratory of Micro and Nano Optics under the supervision of Prof. Alexander I. Nosich. Her research interests include computational electromagnetics, plasmonics, photonics, and diffraction radiation.

Project Description

The aim of this project is to study the diffraction radiation that accompanies the motion of a modulated sheet of electrons near dielectric and noble-metal nanowire scatterers, in the optical wavelength range. If one can neglect the action of the field on the particles, then the electromagnetic field of such a 2D beam takes the form

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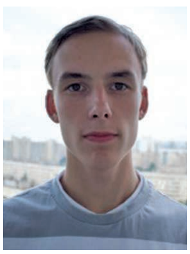
of a surface wave propagating along the beam trajectory. This wave induces polarization and surface currents on the local obstacles, and hence radiation occurs even if the beam does not touch the obstacle. In fact, the scatterer plays the role of optical or microwave antenna, which makes the beam of particles visible. In particular, a metal nanowire behaves as an open resonator, as a result of which the diffraction radiation is enhanced near the localized surface plasmon resonance wavelength. Measuring the spatial pattern of the diffraction radiation and its intensity, one can judge the energy and trajectory of the electrons. This study can be useful in the design of novel sensors for beam position and velocity. It is expected to lead to several conference papers and has the potential to be published as a journal paper.



Anton Zaitsev

School: ITMO University, St. Petersburg, Russia

Advisor: Prof. Mikhail Khodzitsky

Project topic: Development of optically tunable graphene-based THz devices

Anton Zaitsev is an M.Sc. student in photonics and optical information technologies at the ITMO University in Russia. Currently, he works in photonics research at the Terahertz Biomedicine Laboratory under the supervision of Prof. Khodzitsky. His research interests include THz photonics and optoelectronics devices and systems, metamaterials, graphene, and other 2D semiconductors.

Project Description

Since graphene's invention, 2D materials have attracted increasing interest within the research community. Graphene has some disadvantages, such as the absence of a band gap and the low efficiency of material characteristics controlled by optical pumping. To overcome these disadvantages, other 2D graphene-based modifications were proposed. In this project, the measurements of optical properties of 50-layer graphene under optical excitation will be performed. The tunability of such material is very efficient and depends on the substrate type, so it can be used in tunable THz devices—modulators, filters, phase shifters, attenuators, and so on. These devices, based on the suggested material, will be developed in this project. The proposed structures will find application in high-speed THz communication systems, spectroscopy, contactless diagnostics of objects (such as medications), fast-acting safe visualization systems, and medicine.

Keren Zhu

School: The Ohio State University, Columbus, United States

Advisor: Prof. Asimina Kiourti

Project topic: Body-worn vest for fully passive magneto-cardiogram monitoring

Keren Zhu received her B.Sc. degree in electrical and computer engineering from The Ohio State University in May 2017 and is pursuing her master's degree at the same university. While there, she has been a student research assistant at the Electro-Science Laboratory under the supervision of Prof. Asimina Kiourti. Her research interests include wearable medical sensors and body-area electromagnetics.

Project Description

Monitoring human-heart-generated electromagnetic fields can be challenging yet critical for detecting heart-related conditions. Comparing two of the most common practices for human cardiac assessment, magnetocardiography (MCG) and electrocardiography, reveals significant advantages of MCG, including higher sensitivity and accuracy in response to related conditions, more localized signals, and better deep-tissue penetration. However, superconducting quantum interference devices (or SQUIDs), the widely adopted technology for MCG detection, are bulky and expensive, and they require extensive shielding and cryogenic cooling, limiting their use to only in-hospital or medical environments. The proposed project aims to develop a fully passive sensor that is unobtrusively incorporated into a wearable vest to monitor human MCG in the prehospital environment. The wearable sensor will operate on the principle of the changing magnetic flux of the human heart to detect the MCG signal. Ultimately, a miniaturized full-passive MCG sensor will be developed, validated, and fabricated on a wearable vest.

Next Application Call

The next deadline for applying for the MTT-S undergraduate/pregraduate scholarships for the spring 2020 (cycle 1) competition is 15 October 2019. For more information, please visit: https://mtt.org/students.