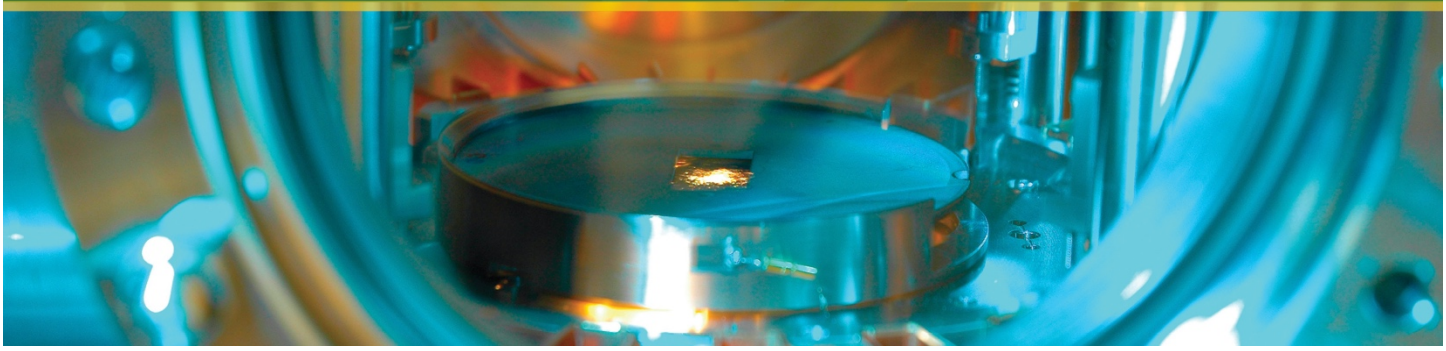
UNC CHARLOTTE

Electrical And Computer Engineering

The William States Lee College of Engineering

Newsletter Fall 2019



Asis Nasipuri, Chair

Dear Friends:

I am excited to share with you the highlights of accomplishments of faculty and students from ECE at UNC Charlotte for the year.

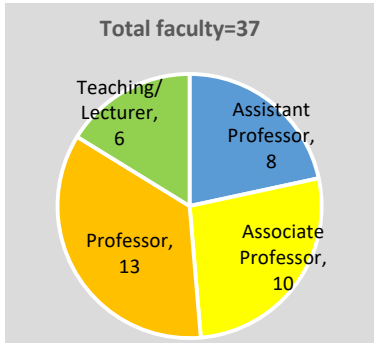
ECE faculty secured close to $5M of new research funding in the 2019 fiscal year. Our faculty continue to be successful in sponsored research in the current fiscal year as well, bringing in nearly $2.5M of new research funding since July 2019. This includes a new NSF/CPS award by Dr. Tabkhi, three NSF/CNS awards by Dr. Han and Dr. Xie, a DoD/ARL award by Dr. Parkhideh, and awards from the NC Department of Transportation and DOE by Dr. Zhao. ECE faculty associated with the Energy Production and Infrastructure Center (EPIC) also achieved admirable success, most notably by Dr. Mike Mazzola, Dr. Badrul Chowdhury, and Dr. Tiefu Zhao.

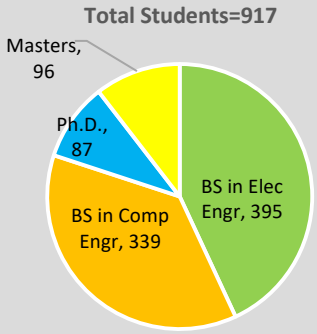
Professor Jiang (Linda) Xie was elevated to IEEE Fellow. Dr. Sukumar Kamalasadan was named the 2019-2022 Duke Energy Distinguished Professor. Dr. Hamed Tabkhi was awarded the 2019 Maxheim Award from the College of Engineering. ECE added two new faculty members in 2019: Dr. Ahmed Arafa in communications and information theory, and Dr. Mario Mencagli in electromagnetics, metamaterials, and metasurfaces.

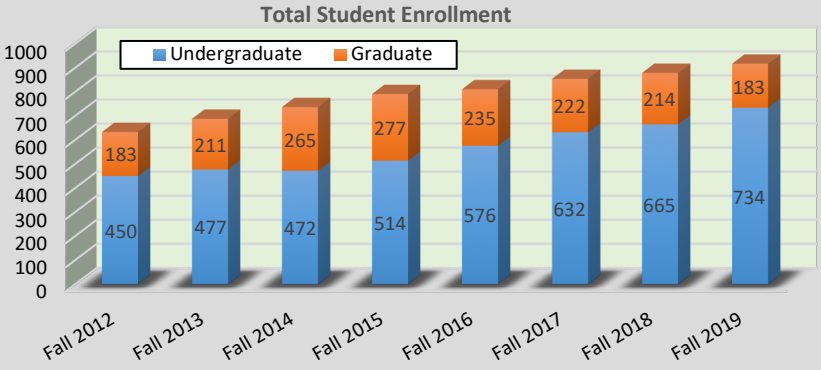
Some of these highlights and more are included in this Newsletter. Thank you for your interest in the ECE Department at UNC Charlotte.

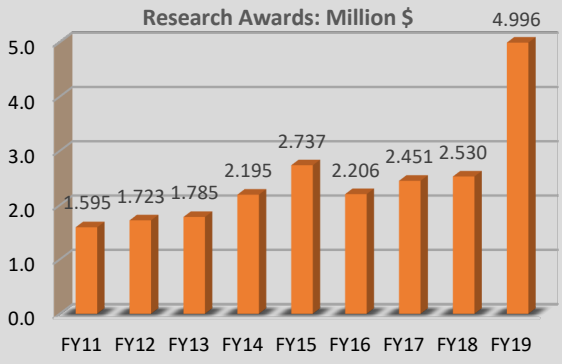
Hearty wishes to all for the Holidays and a prosperous New Year!

Kind regards









Faculty Highlights

Dr. Jiang (Linda) Xie elevated to IEEE Fellow

Dr. Jiang (Linda) Xie, Professor of Electrical and Computer Engineering, was elevated to IEEE Fellow, effective January 1, 2020. In making the recommendation for this distinction, the IEEE Board of Directors cited her contributions to mobility and resource management in wireless networks. The IEEE elects no more than one-tenth of one percent of the total voting members annually for this prestigious recognition.

Dr. Xie joined the ECE Department at UNC Charlotte in August 2004. Her research is focused on the design of communication protocols and algorithms for network management in heterogeneous wireless networks, in particular, mobility management, radio resource management, and Quality-of-Service (QoS) management in next-generation cellular networks, cognitive radio networks, Internet of Things (IoT) based on cloud/edge computing, and mobile augmented reality (AR)/mixed reality (MR)/virtual reality (VR) systems. Dr. Xie has secured over $3.6 Million of external research funding as a Principal Investigator (PI), which includes the prestigious NSF CAREER award. She has also been awarded the Bonnie Cone Fellowship from the NSF ADVANCE Program at UNC-Charlotte for women faculty members in STEM disciplines, and numerous best paper awards and professional recognitions. Dr. Xie has published over 100 technical articles on her research. She is a senior member of the Association of Computing Machinery (ACM).

Dr. Sukumar Kamalasadan selected as the 2019-2022 Duke Energy Distinguished Professor

Dr. Sukumar Kamalasadan, Professor of Electrical and Computer Engineering, was named as the 2019-2022 Duke Energy Distinguished Professor of the Williams States Lee College of Engineering.

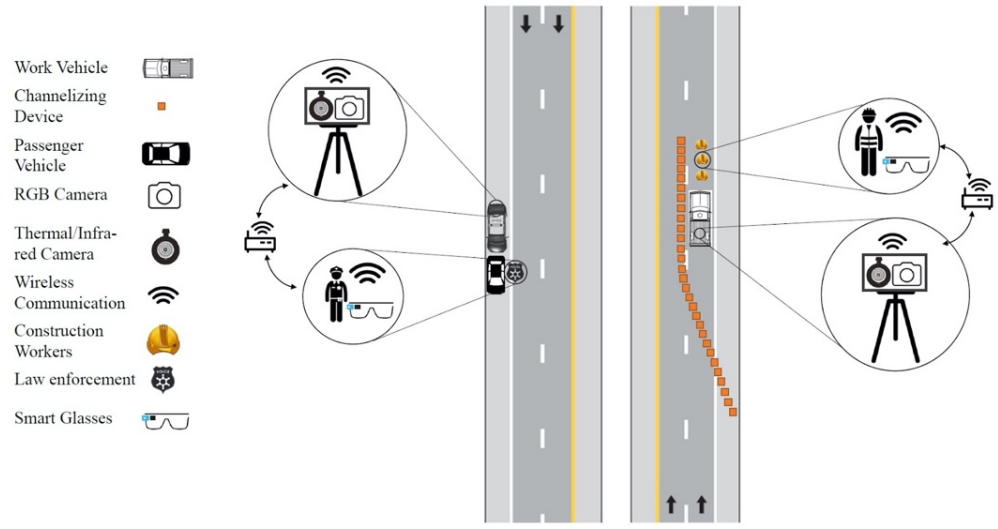
Dr. Kamalasadan has over 25 years research experience on power grid modernization, including smart grid, microgrid, power system operation and optimization, power system dynamics, stability and control, and renewable-energy-based distributed generation. He contributed to the development of a $5M Grid Modernization laboratory, advised around 49 graduate students and around 100 undergraduate students, published more than 150 research articles, and contributed towards $11M in grants and contracts at UNC Charlotte. He has also introduced graduate courses in the field of power and energy systems, led power technical thrust group, developed undergraduate and graduate power and energy concentrations, and advised industry-sponsored senior design teams. He has led several research projects with Duke Energy for the last six years, which led to implementation of patented controllers and workforce development for Duke Energy. He has received several awards including the NSF CAREER award and multiple best paper awards.

Dr. Hamed Tabkhi wins College of Engineering Maxheim Fellowship Award

Dr. Hamed Tabkhi, Assistant Professor of ECE, was awarded the 2019 Maxheim Fellowship from the Williams States Lee College of Engineering. Dr. Tabkhi joined the ECE Department in August 2016 and is actively engaged in research in novel architectures for emerging deep learning and machine learning algorithms, real-time embedded vision, mobile edge computing, and cyber-physical systems. He received over $3.6M of external research grants at UNC Charlotte. His funding sources include NSF, Office of Naval research (ONR), Airforce Research Lab (ARL), Virginia Department of Transportation, and Xilinx Inc. Notable awards include a $1.9M NSF/S&CC grant and a $500K NSF/CPS grant. He developed the Transformative Computer Systems and Architecture Research (TeCSAR) laboratory, where he supervises over 17 graduate students and six undergraduate students for their research. To date, Dr. Tabkhi has published over 50 papers in highly competitive journals and conferences in his area.

Research Highlights

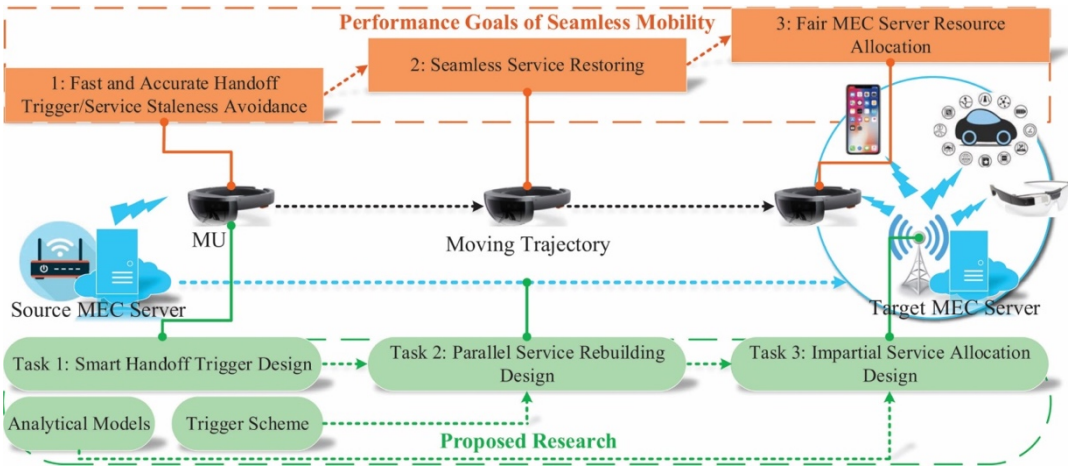
New NSF/CPS Project on Worker-in-the-loop Real-time Safety System for Short Duration Highway Workzones



Researchers from UNC Charlotte received funding from the NSF on a project to develop a novel safety system that enables real-time prediction for safety risks near highway work zones, through recent advances in Artificial Intelligence (AI). The project led by ECE faculty Dr. Hamed Tabkhi (Co-PI: Dr. Omidreza Shoghli, Engineering Technology and Construction Management) proposes a safety system that provides real-time notification to highway workers through smart glasses when a work zone intrusion is about to happen. In particular, this project focuses on short-duration highway work zones which cause higher safety risks due to lack of proper safety mechanisms. This project enhances the health and prosperity of the nation by making highways safer places for workers and preventing potential fatalities or injuries caused by highway work zones. This project departs from existing reactive safety systems to a true proactive safety system. It makes fundamental contributions in real-time deep learning algorithm design and processing, edge computing, and assisted reality systems to enable real-time prediction of work zone intrusions and notification of highway workers. The proposed worker-in-the-loop safety system will be co-designed and co-created with the direct help of highway work zone workers, leading industries, and human factors experts to identify the best feedback mechanisms for alarming workers regarding upcoming safety risks. This project will play a key role in the development of the next-generation cyber-physical systems with powerful edge computing for many emerging safety and security-related applications.

New Projects on Mobile Edge Computing and Cognitive Radio Networks

Dr. Jiang (Linda) Xie, Professor of Electrical and Computer Engineering, received funding from the NSF for research in mobile edge computing (MEC) networks. This 3-year project, entitled "Towards Seamless Mobility in Mobile Edge Computing Networks" will design, analyze, and evaluate new algorithms for providing seamless mobility support in MEC networks with integrated computing and communication activities. Mobile edge computing (MEC) has emerged as a promising technology to overcome the challenges of executing latency-sensitive and computation-intensive applications at resource-limited mobile devices, by pushing mobile computing, network control, and storage resources to the edge of mobile wireless networks. The mobility support issue is considered as a critical component to ensure the success of MEC. This research is aimed at minimizing service disruptions and performance degradation caused by user mobility in MEC. It will help generate innovative mobility support techniques for

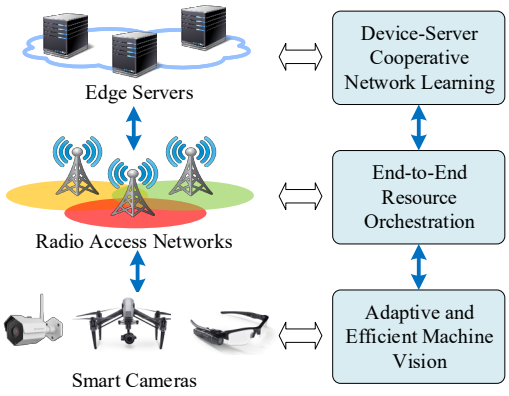


numerous applications, e.g., autonomous driving, cognitive assistance, mobile health, and Internet of Everything. It will also have significant impacts on research in emerging technologies with high mobility scenarios, such as connected vehicles and unmanned aerial systems.

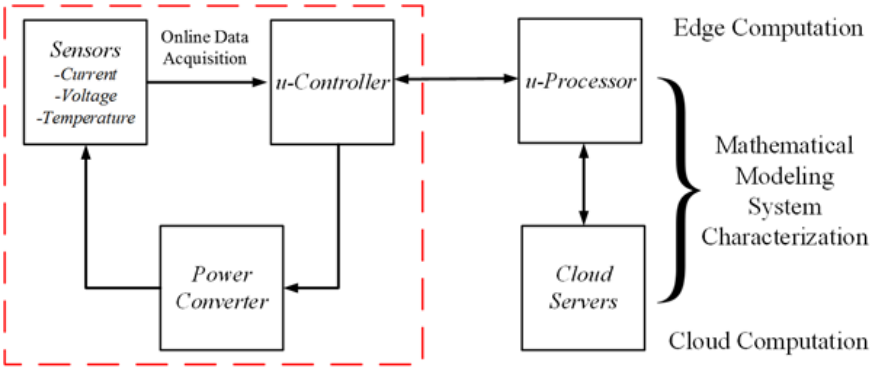
Dr. Jiang (Linda) Xie has also received funding from NSF for research in cognitive radio networks (CRNs). This 3-year project entitled "MAC Layer Failure Control and Avoidance in Cognitive Radio Networks" will design new medium access control (MAC) layer failure control and avoidance protocols for CRNs without a common control channel. This project was also selected for funding by NSF's Computer and Network Systems (CNS) CORE program under the Directorate for Computer and Information Science & Engineering. Cognitive radio has recently emerged as a promising technology to overcome the imbalance between the increase in spectrum access demand and the inefficiency in spectrum usage by allowing dynamic spectrum access. However, a fundamentally unexplored issue in cognitive radio networking design is how to avoid and control the failures at the MAC layer during spectrum access. This research aims at minimizing the failure rate caused by various factors during spectrum access and minimizing the average spectrum access delay.

Ubiquitous Machine Vision with Adaptive Wireless Networking and Edge Computing

ECE researchers Dr. Tao Han and Dr. Chen Chen received funding from the NSF to realize ubiquitous machine vision (UbiVision) and enable efficient utilization of networked cameras for information extraction and sharing. To research this goal, the PIs are using techniques and perspectives from wireless networking, computer vision, and edge computing to solve fundamental research problems in the ubiquitous camera system. The project proposes to design and develop new methods to dynamically manage highly coupled resources and functions across multiple technology domains, i.e., camera functions, network resources, and computation resources, and enable efficient and reliable machine vision analysis over resource-constrained over wireless edge computing networks. This project fosters interdisciplinary research, provides a unique training program to undergraduate and graduate students, and has a high potential to introduce transformative technologies that enable new real-life products and services.



Deep Learning Reliability Awareness of Converters at the Edge

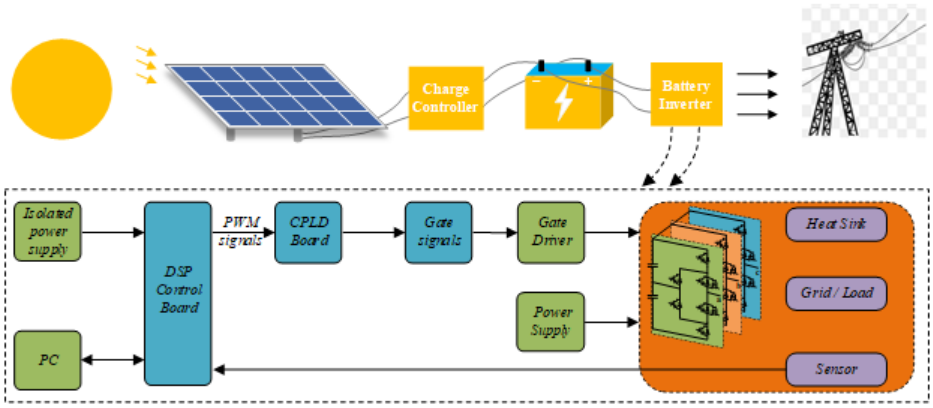


Online monitoring of power electronic converters enables the user to optimize the efficiency and operation of the system over its lifetime. Sensors and efficient characterization of the system are the keys to achieve this optimization. The main challenge is the non-scalability of solutions mainly because of diverse architectures for different applications.

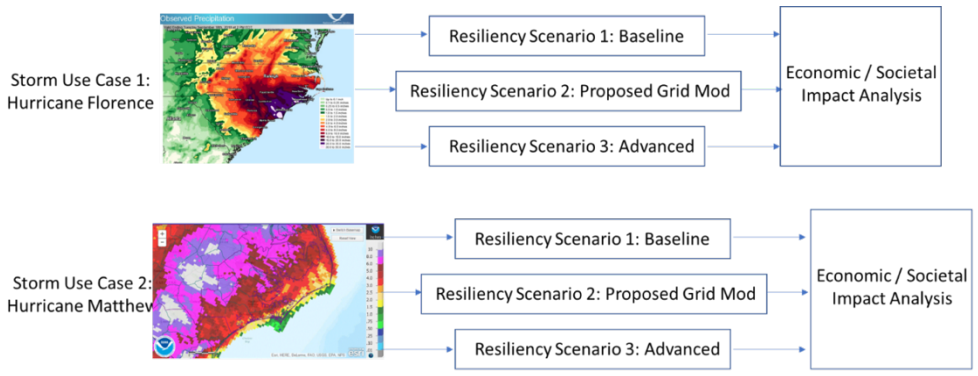
This DoD-funded project sets to move beyond mainstream device modeling and traditional reliability analysis (i.e. Weibull distributions, mean-time-to-failure, etc.) and looking to more applicable analytical tools through introducing advanced sensing solutions and combining it with cutting-edge deep learning techniques. In the next three years, lead PI Dr. Babak Parkhideh will collaborate with Dr. Hamed Tabkhi and Dr. Robert Cox of the ECE Department to investigate advanced sensors and data processing units to measure and process the characteristics of emerging semiconductor devices at very high frequency/resolution empowered by cutting-edge computing technology for Just-In-Time (JIT) behavioral modeling and decision making. Through a tightly-coupled integrated research collaboration, this project will co-design and co-create an advanced real-time characterization architecture. The architecture that can be integrated into the next generation of power electronics for online reliability assessment and improving the efficiency or lifetime of the system by means of proper corrective actions.

Modular Hybrid SiC and Si based Battery Inverter for Energy Storage Integration

Researchers at the University of North Carolina at Charlotte have been awarded funding from Department of Energy (DOE) Power America to develop a high efficiency, high power density battery inverter for low cost and efficient integration of energy storage. The project, entitled "Modular Hybrid SiC and Si based Battery Inverter for Energy Storage Integration", is led by Dr. Tiefu Zhao from the Department of Electrical and Computer Engineering and Energy Production and Infrastructure Center (EPIC). Co-principal investigator is Dr. Madhav Manjrekar from the Department of Electrical and Computer Engineering. The project will develop, test and demonstrate a modular hybrid Silicon Carbide (SiC) and Silicon based battery inverter for energy storage integration. The project facilitates the partnership between UNC Charlotte and LS Energy Solutions (formerly Parker EGT Division) to advance the technology to the system level and extend the R&D toward commercially viable products. Results from the project will help promote large-scale adoption of SiC devices in the grid-tie inverter application, which is fully consistent with the Power America's goals of large-scale manufacturing of Wide Bandgap (WBG) semiconductor devices in power electronics systems and improves the U.S. competitiveness on renewable and energy storage technologies.



Planning an Affordable, Resilient and, Sustainable Grid in North Carolina



The North Carolina Department of Environmental Quality (DEQ) is partnering with UNC Charlotte and the NC Clean Energy Technology Center at NC State University on a project that will focus on developing and evaluating metrics that allow regulators to better determine the value of investments in grid resiliency.

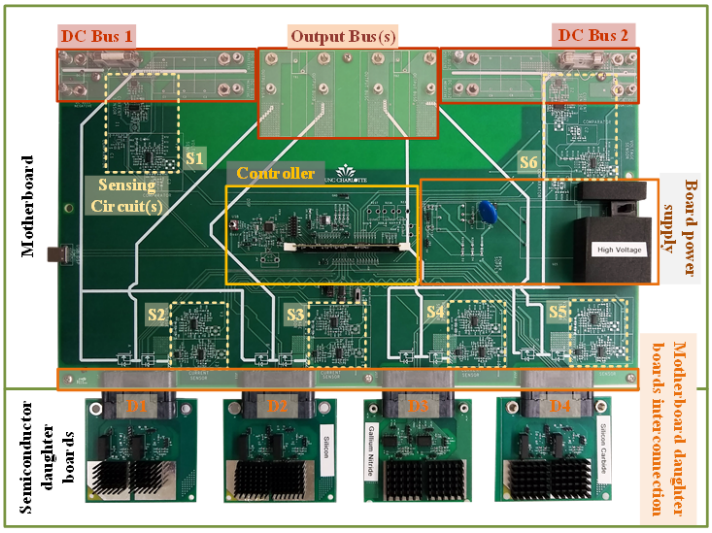
The goal of the two-year project is to evaluate metrics that can be used for valuing investments in grid resiliency. The focus will be on metrics that value the economic impact of various investments. It will include opportunities for interested stakeholders to review the metrics developed by the research team and to provide input into an advanced grid scenario focused on enabling a more decentralized resilient grid, including micro/mini grids that can support critical services, such as hospitals, in the case of power outages.

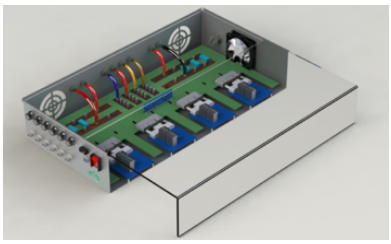
Led by Drs. Badrul Chowdhury, Robert Cox, Mike Mazzola, and Madhav Manjrekar of ECE, the project will analyze outage data provided by Duke Energy following major weather-related disasters that have impacted North Carolina over the last several years. One this baseline information is known, the team will consider the potential impact of Duke Energy's proposed grid-hardening measures, including distribution automation and undergrounding power lines. The team will

also consider the potential impact of the advanced grid scenario that would include incentives for microgrids and other advanced technologies.

Revamping Power Electronics Hands-on Education

The "WBG Power Electronics Teaching Lab" follows a Do-It-Yourself model that the PIs have successfully deployed at UNC Charlotte to spark students' interest in power electronics and enhance their hands-on experience with a real-hardware setup. The materials are used to demonstrate important concepts in power electronics, including switching pulse generation, shoot-through protection, voltage and current sensing, passive component design, power converter operation (both DC/DC and DC/AC), and microcontroller-based control design. The materials have been used to teach students through external workshops as well as in Power Electronics classes at UNC Charlotte. Modular and plug & play design provides a flexible platform for semiconductor manufacturers to contribute with their latest technologies.





This project is to develop the resources needed for wide dissemination of the Wide-Bandgap (WBG) power electronics education materials being developed by the PIs, Dr. Babak Parkhideh and Dr. Robert Cox at UNC Charlotte. The main objectives of this project are (1) to develop rugged, manufacturing-ready educational boards and (2) to create an online repository containing videos, hardware design materials, and teaching lab documents. These will be made available to any institutions interested in adopting the materials in their curriculum.

Massive Open Online Course in Basic Electromagnetics

Dr. Kathryn Smith of ECE is leading a project sponsored by Ansys to develop materials for online delivery of two classes covering the fundamental principles of electromagnetics. The intent of this work is to transform the delivery of complex electromagnetic concepts from the traditional presentation of written equations and derivations to a more interactive, intuitive, and visual format. Online delivery allows seamless integration of illustrative graphics, animations, and field simulations with the spoken and written lecture material, as well as with interactive applets and simulations. This presentation style is targeted to appeal to the modern student, who is accustomed to a more visually stimulating technological environment than the traditional classroom can provide. Emphasis will be placed on establishing context, even at this introductory level, through frequent references to real-world applications and related employment opportunities, and through integration of industry-standard simulation tools to provide examples and demonstrations.

New ECE Faculty in 2019

Dr. Ahmed Arafa
Assistant Professor
Ph.D., University of Maryland, College Park, 2017

Research Interests: Energy harvesting communications, information theory, physical layer security, non-orthogonal multiple access systems.

Dr. Mario J. Mencagli
Assistant Professor
Ph.D., University of Siena, 2016

Research Interests:
Metamaterials and metasurfaces, transformation optics, reconfigurable devices, analog computing, space/time-varying media.

Other News

- Forest Atchison, a Junior BSEE student in ECE, was selected as a recipient of the *IEEE Power & Energy Society Scholarship Plus Initiative John W. Estey Outstanding PES Scholar Award*. This award is presented to the top PES Scholar in each Region. Forest's application was reviewed by a committee of industry and academic representatives who identified him as a high-achieving undergraduate student in an electrical engineering program
- Anjus George and Dr. Arun Ravindran won the Best Paper award at the *International 2019 International Conference on Edge Computing,* June 25 - June 30, 2019, San Diego, for their paper "Latency Control for Distributed Machine Vision at the Edge through Approximate Computing".
- ECE student David Grabowsky won the DoD *Science, Mathematics, and Research for Transformation (SMART)* scholarship.
- IEEE student branch members Collin Hall, Aaron Pascua, Ed Nava were finalists for the Ethics competition at *IEEE SoutheastCon* 2019 in Huntsville, AL, April 2019.
- ECE students Bryce Readyhough, Michael Stetzler, Salma Hanafi, Josias Cruz were placed 3rd in the Software competition at *SoutheastCon 2019* in Huntsville, AL, April 2019.
- ECE graduate students Bryson Shannon, Spandana Etikala, Yutian Gui, Ali Shuja Siddiqui, supervised by Dr. Fareena Saqib won third position on the Best Poster award in the *IEEE Hardware Oriented Security and Trust (HOST)* collocated workshop on WISE, Washington D.C, May 2019.
- Dr. Fareena Saqib presented a tutorial on side channel analysis and secure grid at the *IEEE Hardware Oriented Security and Trust (HOST)* workshop 2019.
- Dr. Fareena Saqib presented a Tutorial on Hardware security for smart Grids at the *IEEE CyberPELS Workshop*, 2019.