UNC CHARLOTTE

The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

ELECTRICAL AND COMPUTER ENGINEERING
2020 ECE NEWSLETTER

Dear Friends

I hope you are all staying safe and healthy while dealing with the unprecedented challenges of the pandemic. At UNC Charlotte, we are proud of the admirable resilience demonstrated by faculty, staff, and students in conducting majority of the operations remotely this fall. This message contains highlights of the achievements and accomplishments of faculty and students of ECE at UNC Charlotte from this difficult year. Please read and share as you please.

ECE's undergraduate student enrollment remained relatively unchanged this fall, while the graduate student enrollment dropped, primarily at the Master's level. The new Master of Science in Computer Engineering program was approved by the UNC System recently, and ECE is looking forward to welcoming new students to the program from fall 2021.

Research and development continued in full swing with abundant safety measures in the laboratories. ECE faculty continued to achieve outstanding successes in advancing research on current and emerging topics such as wireless systems with edge computing, real-time AI, power systems resiliency, intelligent power electronics, and new educational initiatives for workforce development in cybersecurity and power engineering. New research funding secured by ECE faculty, including those associated with the Energy Production and Infrastructure Center (EPIC), exceeded $5M again this year. Despite social distancing, several multidisciplinary collaborations emerged successfully. Drs. Sukumar Kamalasadan and Tao Han secured a four-year $4.6M multidisciplinary project from DoE's Advanced Systems Integration for Solar Technologies (ASSIST) program. Their collaborators include researchers from Argonne National Lab, Idaho National Lab, OPAL RT Technologies, Duke Energy, and three other universities. Dr. Fareena Saqib was part of a consortium led by the College of Technology at Purdue University Northwest (PNW) that won a $6M collaborative award from the National Security Agency (NSA) on Cyber Security workforce development. Dr. Hamed Tabkhi's multidisciplinary project sponsored by NSF's Smart and Connected Communities program, completed its second year. This $1.9M project includes other faculty from ECE and Department of Criminal Justice and Criminology.

Dr. Jim Conrad, who is serving as the President of IEEE-USA this year, has been elected as the IEEE Eta Kappa Nu President-elect for the coming year. Dr. Cutitaru was awarded the 2020 Undergraduate Teaching Excellence Award from The Williams States Lee College of Engineering. ECE recognized outstanding student achievements from the 2019-2020 academic year remotely this year. Some of these stories are included in this Newsletter.

I wish you all a peaceful Holiday Season and a glorious New Year!
Kind regards

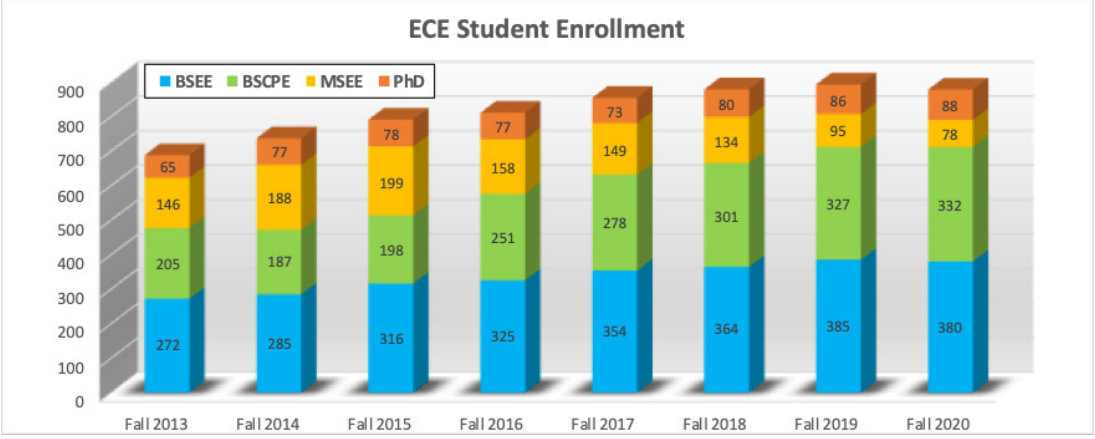
Asis Nasipuri
Professor and ECE Department Chair

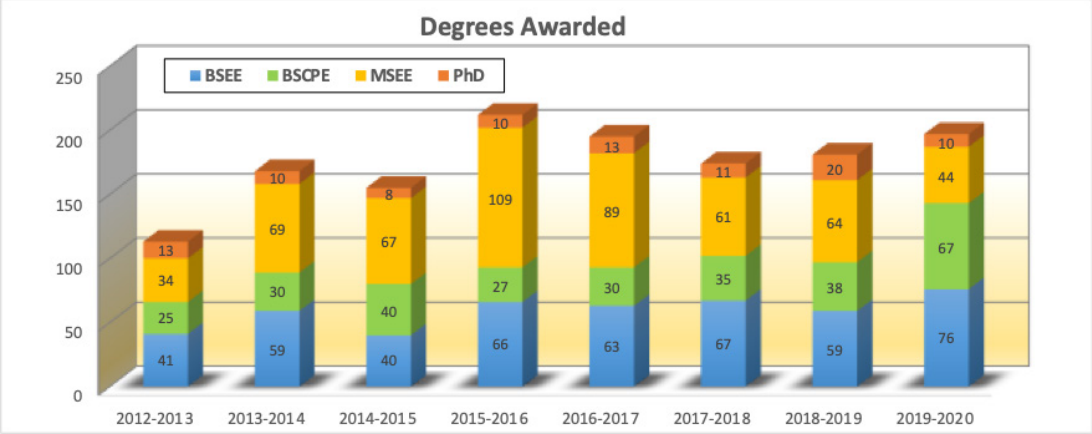
ECE AT A GLANCE

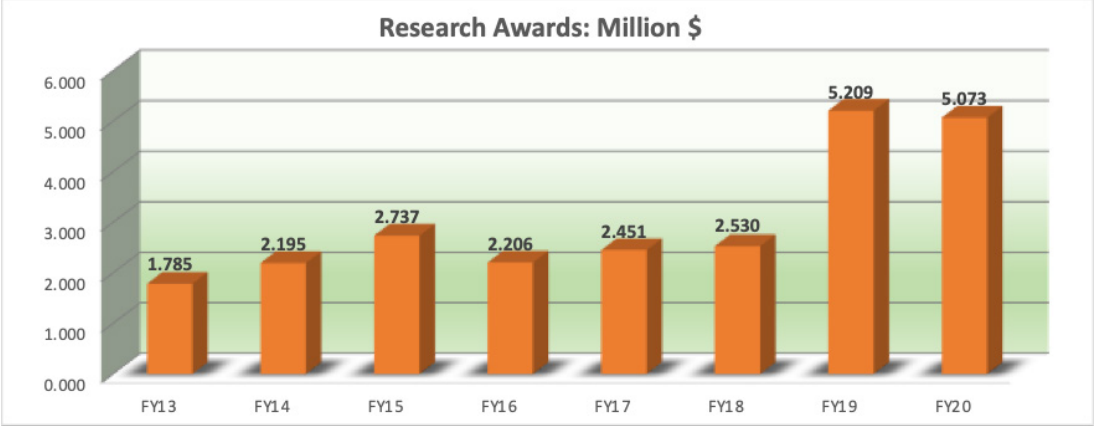
UG students	Master's students	PhD students	Total Faculty
730	78	88	37

FY20 New Research $$	Journal Publications	Conference Publications
$5.1M	48	119

STATISTICS







Wireless for Edge Computing

Dr. Tao Han is working on several projects that integrate wireless networking with advance processing that are implemented on edge servers. In his UbiVision project, he collaborates with Dr. Chen Chen on an interdisciplinary research project for designing a platform to enable people from all over the world to share their smart cameras, which can be Uber, Airbnb, or Mobike in the context of smart cameras. For example, a person in New York City can "see" what is happening in Los Angeles via a wearable camera shared by another person located in Los Angeles. UbiVision is designed with novel network protocols and machine learning algorithms to dynamically manage highly coupled resources and functions across multiple technology domains: 1) camera functions such as image preprocessing and embedded machine vision; 2) network resources in the radio access network; 3) computation resources and machine vision on the edge servers. Drs. Han and Chen were awarded a $403,800 grant from NSF's Computer and Information Science and Engineering (CISE) to support this research. [Read more]

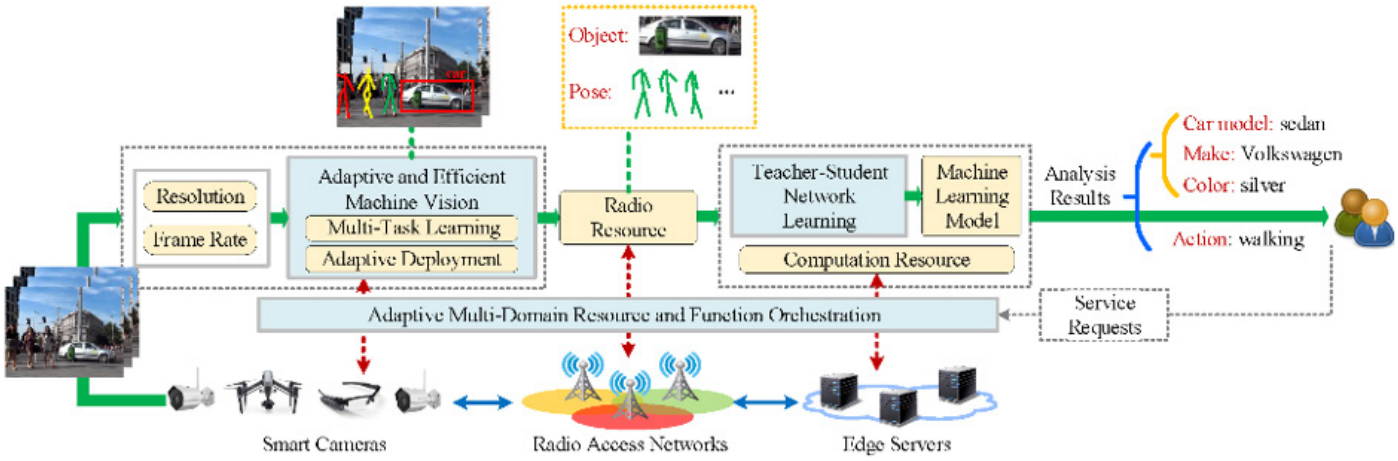


Figure 1: UbiVision system overview

Dr. Han, in collaboration with Drs. Yu Wang (Temple University) and Pu Wang (UNC-Charlotte), is also working on a project to develop an innovative robust 3D airborne computing and networking system, AirEdge, that exploits a swarm of aerial mobile radio access points and edge servers carried or deployed by unmanned aerial vehicles (UAVs). The unique feature of AirEdge is to enable fast-deployable highly-efficient on-demand edge computing and networking services through (1) the communication-motion co-design principles for 3D UAV networking, and (2) the communication-computation co-design to enable reliable and energy-efficient airborne edge computing. AirEdge has great potentials to promise fast-deployable on-demand durable edge computing services beyond traditional networking services and will enable a series of transformative applications in the areas of disaster rescue, public safety, anti-terrorism, battlefield assistance, and mobile entertainment. This project is supported by a $333,440 grant from the NSF.

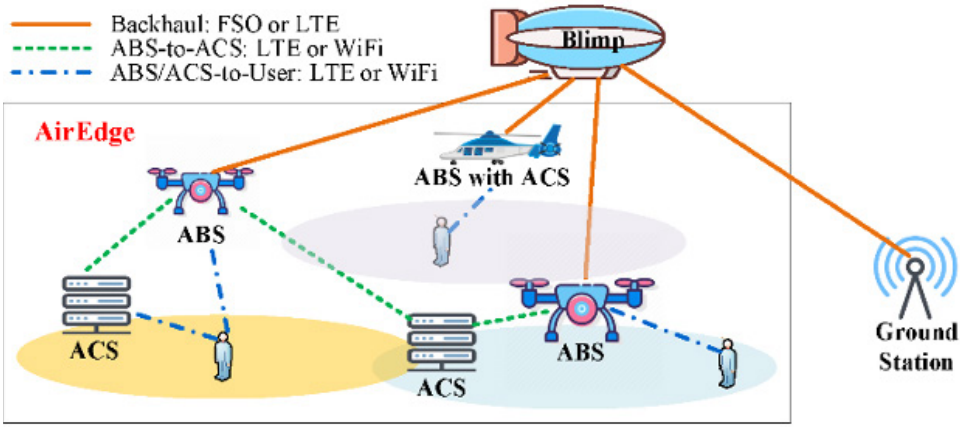
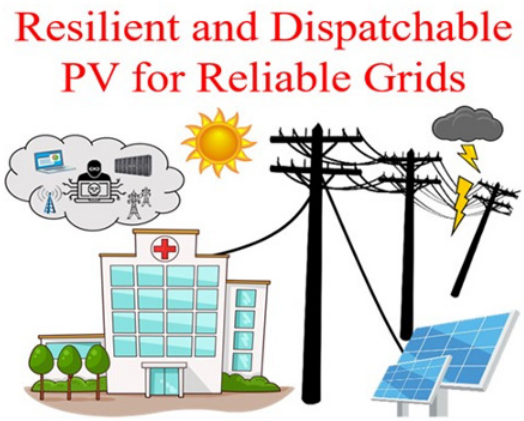


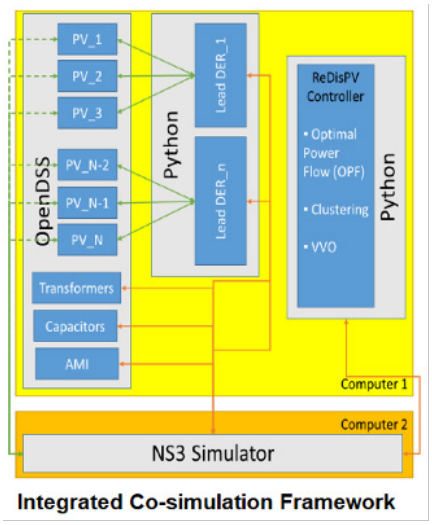
Figure 2: AirEdge system overview. (ABS: Aerial base stations; ACS: Aerial computing stations; FSO Free Space Optical)

Developing Resilient Control for Real-time PV Dispatch



In January 2020, The U.S. Department of Energy Solar Energy Technologies Office (SETO) awarded $4.6 million to ECE Professors Dr. Sukumar Kamalasadan and Dr. Tao Han for the project "Optimal Reconfiguration and Resilient Control Framework for Real-Time Photovoltaic Dispatch to Manage Critical Infrastructure." The project will develop an integrated tool that works in conjunction with the legacy and inverter-based controllers, existing communication system, meters, and DMS to monitor the 'health' of distribution grid with high penetration of photovoltaics and other distributed energy resources (DERs). The integrated tool will include a management mechanism to utilize PVs, Energy Storage and flexible loads, to support critical infrastructure during emergency and improve reliability during normal operation. It will be modular and able to seamlessly integrate with the existing infrastructure (a non-proprietary vendor agnostic solution). The project will develop a unique situational awareness tool that can be used by the operator for organizing the DERs in terms of availability, usability, and improved dispatch-ability.

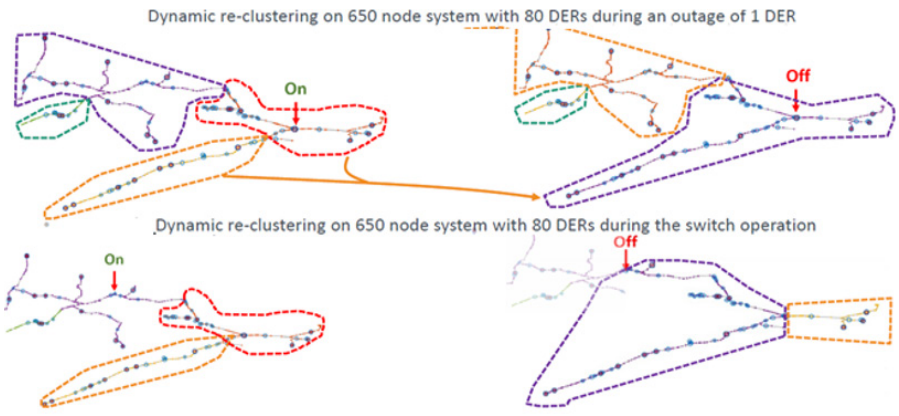
The project team includes UNC Charlotte (lead institution), Clemson University, Florida International University, New Mexico State University, Argonne National Lab, Idaho National Lab, OPAL RT Technologies, and Duke Energy. The project scope is for three years with a total grant amount of $4.6M that includes the DoE share of $3.7M. The project is one of the 10 awarded by the DoE to advance solar energy's role in strengthening the nation's electricity grid. The projects represent $36-million in research that is part of the Advanced Systems Integration for Solar Technologies (ASSIST): Situational Awareness and Resilient Solutions for Critical Infrastructure funding program to improve situational awareness of solar energy systems.



Integrated Co-simulation Framework

The team has already achieved some exciting results. A combined transmission and distribution co-simulation power grid model along with a communication system model has been developed and demonstrated. This achievement will allow the power grid community to study the impact of Distributed Energy Resources (DERs) in transmission and distribution power grid networks using a single simulator along with communication challenges. A new clustering architecture with cluster control has been designed and tested that allows the collective control and management of DERs with energy storage to support the critical infrastructure of the power grid. A resilient control architecture that allows detection of the health of DERs in the cluster and automatically characterizes the operational capability has been developed. This method allows the utility to manage the DERs considering the cyber and physical threats. Also, a novel protection and reconfiguration architecture for power distribution system is developed considering DERs operating in zones that automatically balances the power in each zone as well as identify zones with required generation during failure.

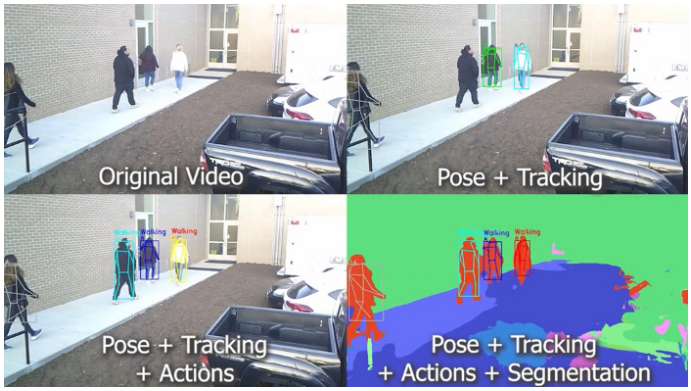
Current work includes the development of optimal power flow management architecture and area-control framework, the development of risk and vulnerability assessment framework for the power grid, development of a situational awareness module, and development of threat aware communication infrastructure. In year 2, the plan is to show the scalability and integration of the Redis-PV modules will be demonstrated using a real-time hardware-software framework. [Read more]



Cybersecurity Workforce Development

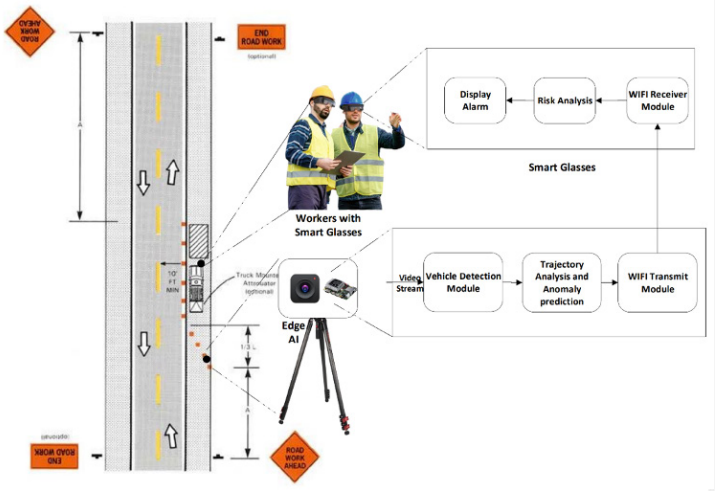
The National Security Agency (NSA), Department of Defense (DoD), has recently awarded a nearly $6 million Cyber Security Workforce Development grant to a consortium of universities including UNC Charlotte. The participating institutions in the consortium include College of Technology at Purdue University Northwest (PNW), Ivy Tech Community College of Indiana, University of Tennessee at Chattanooga, and University of North Carolina at Charlotte. UNC Charlotte was awarded $500K towards this project, to be led by Dr. Fareena Saqib, Assistant Professor of Electrical & Computer Engineering and Member of Cyber DNA Centre. The two-year grant commencing from September 2020 will allow the consortium to develop an artificial intelligence and cybersecurity certification-based national training program for more than 425 transitioning military, first responders, and other adult trainees. The training program will be offered online and free of charge to the trainees. During first year of the grant, the coalition will develop an artificial intelligence-cybersecurity curriculum. This will allow pathways to be created for trainees to pursue degree programs at the partaking institutions. During the second year of the grant, the trainees are expected to take certification exams and to earn industry and government recognized certifications. [Read more]

Real-time AI

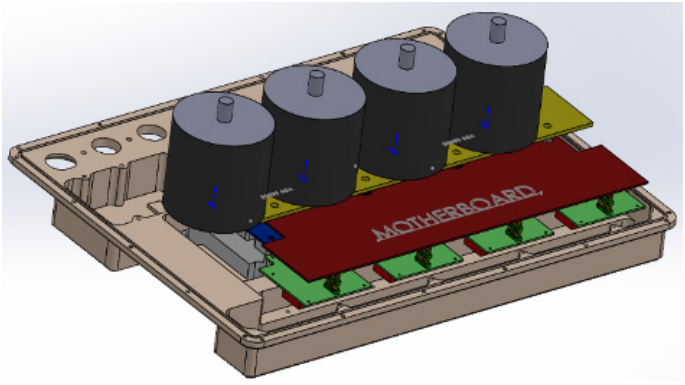


Dr. Hamed Tabkhi leads multiple projects that involve development of solutions for applying Artificial Intelligence (AI) in real time for improving public safety. His project entitled "Building Safe and Secure Communities through Real-Time Edge Video Analytics" is supported by the National Science Foundation (NSF)'s Smart and Connected Communities program to co-develop technology to support public safety. The $1.9 million, 4-year grant supports the development of an optical sensing platform that uses artificial intelligence to detect and prevent street crime without the use of profiling. Dr. Tabkhi and his team have extensively engaged and partnered with Central Piedmont Community College (CPCC) to create the first community-based real-time Artificial Intelligence (AI) testbed at the CPCC campus. The testbed has been used as a real-world demonstrator of real-time AI for privacy-first intelligent processing and services. The students both at UNCC and CPCC play an active role in developing the technology, installing the testbed, and evaluating which includes creating the labeled dataset for the training of AI algorithms. In collaboration with the CPCC Criminal Justice program, the team is set to expand the testbed to a campus-wide coverage across many cameras to explore and validate the practicality of developed algorithms in real-world scenarios with a privacy-first design mindset. [Read more]

Dr. Tabkhi is also leading a project on the development of a AI-based safety system that enables real-time prediction for safety risks near highway work zones. The goal of this research is to provide real-time notification to highway workers through smart glasses when a work zone intrusion is about to happen. This project focuses on short-duration highway work zones which cause higher safety risks due to lack of proper safety mechanisms. 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. 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. 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. [Read more]



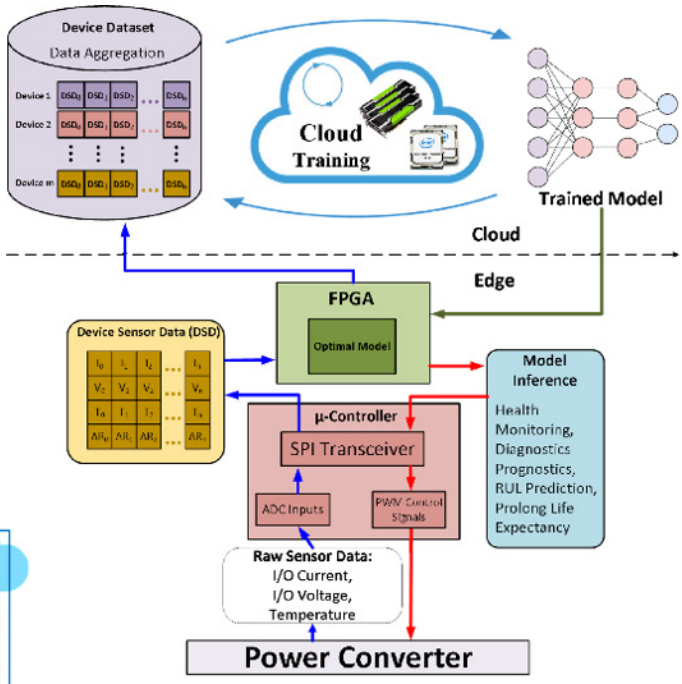
Intelligent Power Electronics

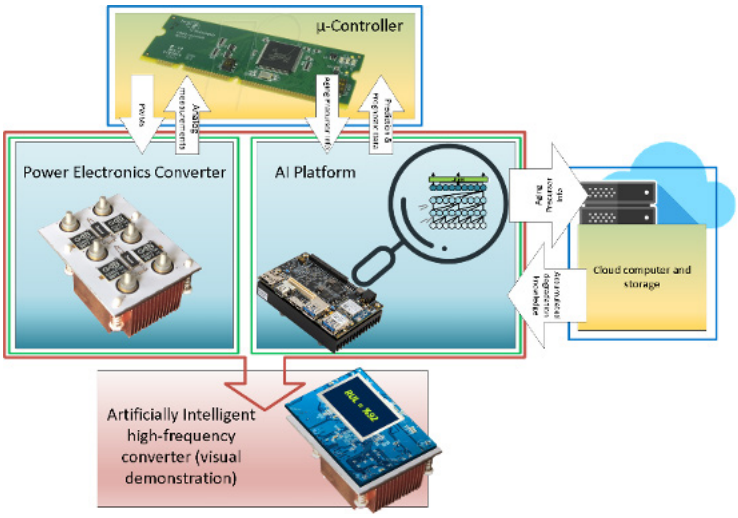


ECE faculty are developing specialized intelligent DC-AC and DC-DC power converters using embedded and edge computing. Dr. Babak Parkhideh, Associate Professor of ECE and Faculty Associate of the Energy Production and Infrastructure Center (EPIC) at UNC-Charlotte, recently launched a project that focuses on developing and validating a DC-AC power electronic inverter as an essential subsystem of a new grid management architecture noted as Intelligent Power Stages (IPS). The IPS includes features such as subsystem interoperability, embedded intelligence, advanced EMI mitigation, as well as embedded and supervisory controls supporting multiple applications. The IPS can be divided into major subsystems which include a SUPER system controller, system protection, a DC-AC three-phase inverter with embedded localized control, isolated DC-DC power conditioner, and robust communications supporting subsystems interoperability and system level communication interface. Dr. Parkhideh has received a $250K grant from the DOE Oak Ridge National Laboratories to support his research.

Dr. Parkhideh, in collaboration with Dr. Tabkhi, is also developing a transformative solution called Deep learning Reliability Awareness of Converters at the Edge (Deep RACE) for real-time modeling and assessment of GaN power modules embedded into a wide range of smart power electronics systems. Deep RACE makes departures from classical learning and statistical modeling to deep learning-based data analytics, combined with full system integration for scalable real-time reliability modeling and assessment. The proposed research will create a real-time model of proposed deep learning algorithms. The proposed method leverages the Long Short-Term Memory (LSTM) networks as a branch of Recurrent Neural Networks (RNN) to aggregate reliability across many power converters with similar underlying physics. Equally important, to monitor the system behavior, for the first time, we propose to conduct necessary research to develop a non-invasive sensing scheme that 1) can be integrated into power modules and 2) measures the current mismatch among parallel devices. If the latter is successfully demonstrated, the number of required sensors is reduced significantly to assess the gradual degradation of the power module. This research is sponsored by a grant from the DOD DA Army Research Laboratory (ARL).

EPIC at UNC-Charlotte has demonstrated capabilities in the development and evaluation of advanced power systems. This experience includes the development of advanced power electronics, such as high-power density grid-tied three-phase inverters. The development team is led by professional engineering faculty and research staff. Detailed technical design execution is conducted by a multi-disciplinary team of experienced research engineers and graduate research assistants. [Read more]

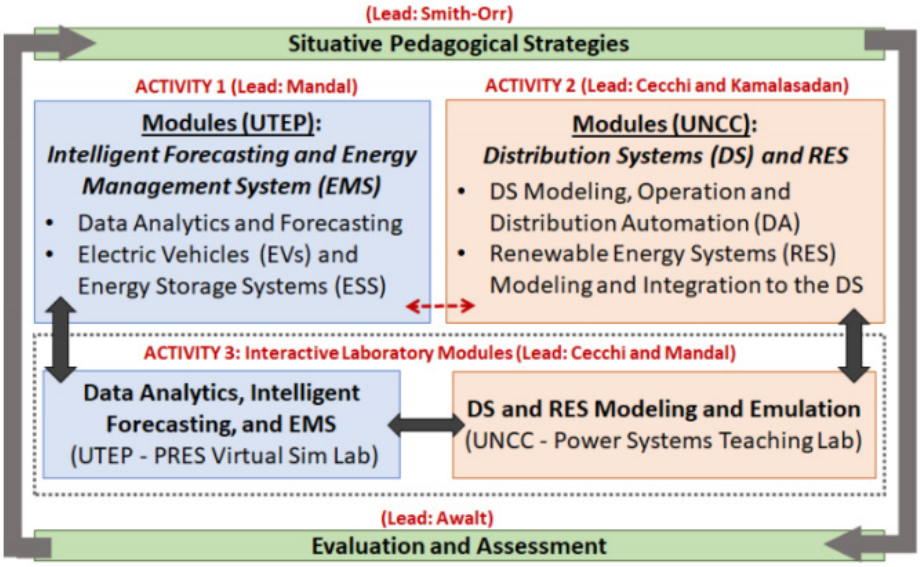




Method	Kalman Filter	Particle Filter	Deep RACE
Miss-prediction Error	17.75%	15.85%	8.93%

Innovative Framework for Electric Power Engineering Curriculum Based on Situative Pedagogy and Data-Driven Analytical Approaches

Drs. Valentina Cecchi (Associate Professor, ECE), Sukumar Kamalasadan (Professor, ECE), and Courtney Smith-Orr (Teaching Assistant Professor, ECE) received funding from the NSF under the Improving Undergraduate STEM Education (IUSE) program. They are collaborating with researchers at the University of Texas El Paso to enhance power engineering undergraduate curriculum.



The grid of the future is envisioned as an intelligent system that can be monitored, supervised, and controlled in real-time, consisting of millions of smart devices and interconnected decision-makers. Thus, today's power engineers require multi-disciplinary engineering knowledge to manage the modern power grid consisting of a larger amount of renewable energy resources, digital devices, information technology tools, and sensors. There is a great need for energy professionals that can deal not only with current, but also with future challenges, and are knowledgeable not only in classic power systems topics, but also in areas such as renewable energy and data analytics. Therefore, a change in the educational paradigm is called for in power engineering. This project will develop an integrated research-oriented curriculum for active and situated learning with an emphasis to engage and improve students' skillset in the area of renewable energy (RE) integrated power distribution system analysis with data analytics, viz: Smart Energy Management Systems. This overall goal will be achieved by introducing enhanced lecture modules and an interactive hybrid emulator-simulator laboratory. [Read more]

NEW ECE FACULTY AND STAFF IN 2020

Dr. Dipankar Maity

Assistant Professor
Ph.D., University of Maryland, College Park, 2018

Research Interests:
Controls and systems theory, motion planning for autonomous robots, information theoretic control, game theory.

Frederica V. Higgs

Undergraduate Advisor
M.S., Higher Education Administration and Leadership, Kaplan University/Purdue Global University, 2014

Interests:
Higher education, advising, public relations, creative writing.

OTHER NEWS

Dr. Conrad elected IEEE Eta Kappa Nu President for 2022

Dr. James Conrad, currently serving as the IEEE-USA President, has been recently elected to serve as the President-elect of IEEE Eta Kappa Nu (IEEE-HKN), the honor society of IEEE. IEEE-HKN promotes excellence in the profession and in education with ideals of Scholarship, Character and Attitude.

Dr. Cutitaru wins Engineering Teaching Excellence Award

Dr. Mihail (Misha) Cutitaru, Teaching Assistant Professor of ECE, was awarded the Williams States Lee College of Engineering's 2020 Undergraduate Teaching Excellence Award. Misha teaches large enrollment foundational classes in Computer Engineering including Introduction to Engineering, Logic System Design, and Computer Organization. Additionally, Misha has served as an advisor to the local IEEE Student chapter, and mentor on several senior design projects. He uses inspiring projects to foster critical thinking by enabling students to apply the concepts learned in class. Of particular relevance to modern pedagogical methods, is Misha's effective use of technology to provide videos of classroom lectures, promote interactive classes, and interactive annotation of lecture slides. Misha's expertise in online learning proved especially helpful to other ECE faculty when all classes had to be transitioned online during the Covid-19 pandemic.

ECE Doctoral Student named in Charlotte's "Top 25 under 25"

Pedro Regalado, Ph.D. student in ECE and a 2019 graduate from ECE's BSEE program was named in Charlotte's "Top 25 under 25" in 2020 by the Charlotte Inno journal. The journal compiles a list of the Queen City's most promising and notable entrepreneurs and technologists who are under the age of 25. Pedro received this recognition on account of his research related to wearable technology with a focus on mixed reality using the device Teleview. His device determines use cases for connecting, interacting, and sharing content in real-time with others from any location.

Duke University Research Poster Competition

Mr. Akintonde Abbas, a PhD student working under the supervision of Professor Badrul Chowdhury of ECE won first prize at the Energy Research Poster Presentation (RPP) competition held in November 2020. The competition is one of the main events of the annual Duke University Energy Week. This competition, which is open to both academic researchers and industry professionals, features original, energy-related research, including scientific findings, engineering breakthroughs, new business models, policy analysis, and much more. Due to the current limitations in in-person gatherings, this year's competition took a virtual format with the top five entries presented during a live session sponsored by the Duke University Energy Initiative. Mr. Abbas' work focuses on comparing the usage of grid-scale batteries and the control of flexible loads for combined value-added services.

Outstanding Master's Thesis Award

Karim Erian was awarded the UNC Charlotte Graduate School's 2021 Outstanding Master's Thesis Award in the Mathematics, Physical Sciences, and Engineering category for his thesis entitled "System Integration over a CAN bus for a self-driven low-cost autonomous All-Terrain Vehicle". His supervisor was Dr. James Conrad. Karim received a $500 cash award and plaque in recognition of this award. In addition, Karim's thesis will be submitted to the Conference of Southern Graduate School's regional competition held in the spring. For more information about the competition, please see their website at http://www.csgs.org/awards/.

UNCC 2020 3MT Competition

Mr. Akintonde Abbas, a PhD student working under the supervision of Professor Badrul Chowdhury of ECE won top honor at the recently concluded UNCC 2020 3MT Competition. Originating at the University of Queensland, Australia, the Three Minute Thesis (3MT®) is a professional international research communication competition, that celebrates the discoveries made by graduate student researchers while helping students develop important academic, presentation, and research communication skills. Finalists describe their research to a lay audience in only three minutes with just one static slide. Mr. Abbas won first prize for his presentation titled "What if your HVAC unit could prevent a major power outage?" which is based on his work exploring the use of customer-side resources for services supporting both transmission and distribution grids.

Prize Conference Paper Award

ECE Ph.D student Yafeng Wang, supervised by Dr. Tiefu Zhao, won the Prize Conference Paper Award from IEEE IAS Renewable and Sustainable Energy Conversion Committee at 2020 IEEE Energy Conversion Congress and Exposition (ECCE), Detroit, MI, USA, 2020, for their paper entitled "A Hybrid Voltage Regulator with Arcless Tap Change and Stepless Voltage Regulation Functions."

Best Paper Award

ECE Ph.D. student Anjus George, supervised by Dr. Arun Ravindran, won the Best Paper award for their paper "Scalable Approximate Computing Techniques for Latency and Bandwidth Constrained IoT Edge", from the EAI International Conference on Intelligent Edge Processing in the IoT Era (EAI Edge-IoT 2020), December 2-4, 2020

ECE Student Achievement Awards

The Annual Student Achievement Award Ceremony was not held in person this year, due to safety considerations. The list of awardees for the 2019-2020 academic year are listed here.