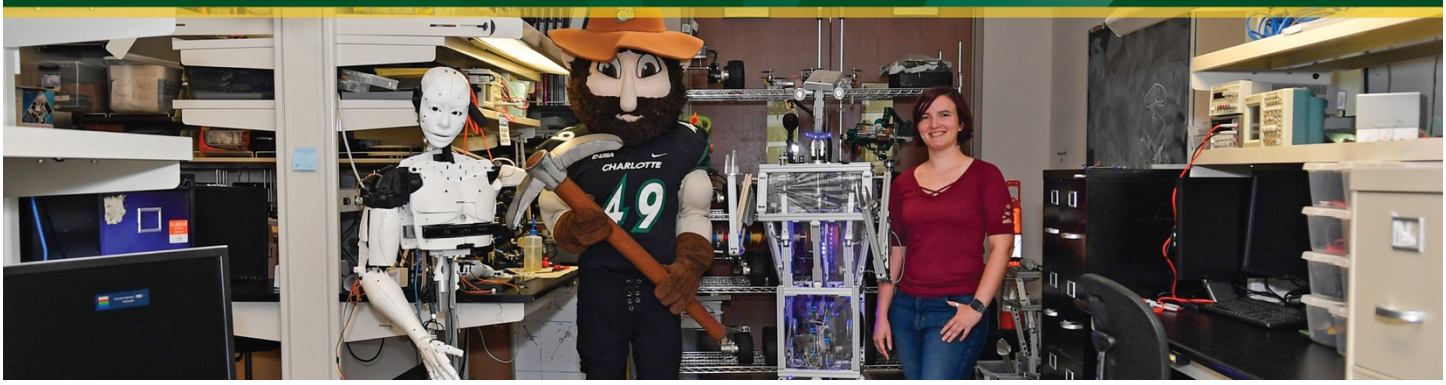
UNC CHARLOTTE

Electrical And Computer Engineering

The William States Lee College of Engineering

Newsletter Fall 2018



Asis Nasipuri, Chair

Dear Friends:

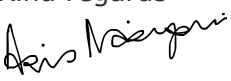
As we approach the Holidays, I am pleased to share with you the annual Newsletter from ECE at UNC Charlotte.

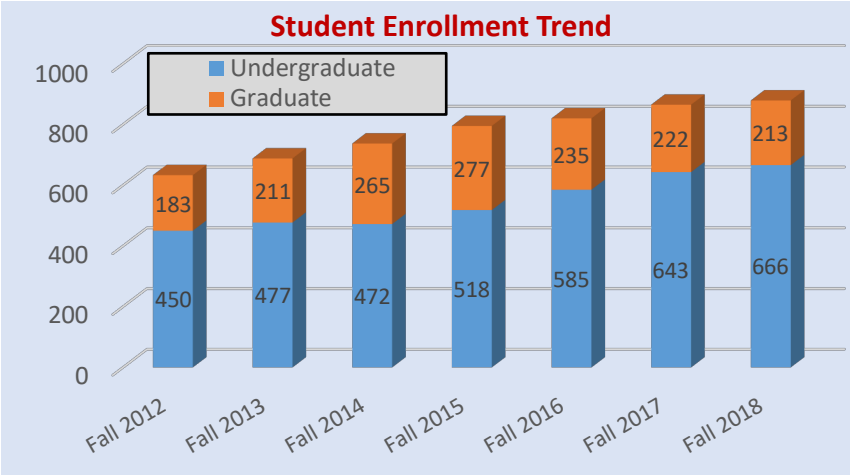
ECE's undergraduate student enrollment continued to grow this year, primarily in the computer engineering program. The PhD program continued to attract an increasing number of high-quality students and a total of 20 PhD students graduated from ECE in 2018.

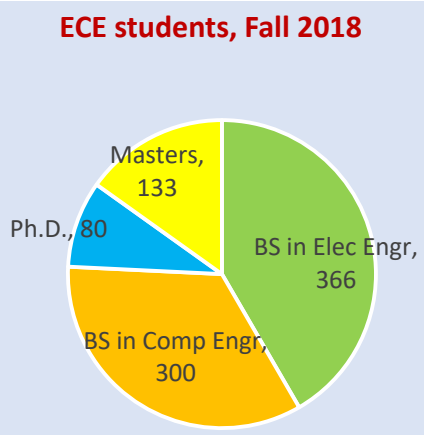
ECE is pleased to welcome two new faculty members in 2018: Dr. Chen in computer vision and machine learning, and Dr. Smith in electromagnetics. Our faculty achieved admirable success in sponsored research, scholarship, and professional service activities this year. Specifically, ECE faculty already secured over $4M of new research awards in the current fiscal year. This includes a $1.9M grant from the *NSF Smart and Connected Communities* program by Drs. Tabkhi, Ravindran, and his collaborators, and a $1M grant from *DOE's Vehicular Technology Program* by Drs. Mazzola, Cox, Manjrekar, and others from the Energy Production and Infrastructure Center (EPIC). Dr. James Conrad was elected *IEEE-USA President*. Dr. Andrew Willis won the College of Engineering *Graduate Teaching Excellence Award*. Some of these highlights and more are included in this Newsletter.

Thank you for your interest in the ECE Department at UNC Charlotte. I wish you all Happy Holidays and a prosperous 2019!

Kind regards







Faculty Highlights

Dr. James Conrad Elected IEEE-USA President

Dr. James Conrad, Professor of Electrical and Computer Engineering, was elected as the 2019 IEEE-USA President. James Conrad has spent an equal amount of time working in industry and academia. He received his bachelor's degree in Computer Science from the University of Illinois, Urbana, and his master's and doctorate degrees in computer engineering from North Carolina State University. He is currently a professor at the UNC Charlotte and Associate Department Chair. He has served as an assistant professor at the University of Arkansas and as an instructor at North Carolina State University. He has worked for IBM, Ericsson/Sony Ericsson, and two start-up companies. He teaches and conducts research in the areas of embedded systems, robotics, parallel processing, artificial intelligence, and engineering education. He has published eight books in the field of embedded systems and robotics.

Dr. Conrad also serves IEEE as an ABET Program Evaluator, and serves the community on the Board of Directors for FIRST North Carolina, the state organization supporting the FIRST Robotics program.

Dr. Andrew Willis wins College of Engineering Graduate Teaching Excellence Award

Dr. Andrew Willis, Associate Professor of ECE, won the 2018 College of Engineering's Graduate Teaching Excellence Award. Dr. Willis teaches undergraduate and graduate courses in the general area of signal and image processing, computer vision, and pattern recognition. His teaching philosophy is based on providing "lasting intellectual value", which can be theory, implementation, or both. He believes in providing a rationale for how, what, and why to elevate the learning context. His students regard him as a teacher who likes to challenge his students and serves as their guide to overcome them. They find his classes to be challenging and interesting at the same time. His devotion to teaching is highlighted in his statement "Ultimately, I take from teaching at least as much as I give." Dr. Willis has recently accepted the role of ECE's Associate Chair of the Electrical Engineering Program, starting January 2019.

ECE Professor's AI Semiconductor Startup Draws Strong Support

In 2017, ECE Associate Professor Jeremy Holleman joined semiconductor veterans Kurt Busch, Pieter Vorenkamp, and Stephen Bailey, to form Syntiant, a startup company focused on ultra-low-power chips for machine learning. This October, Syntiant raised $25M in a Series B funding round led by M12, Microsoft's venture fund.

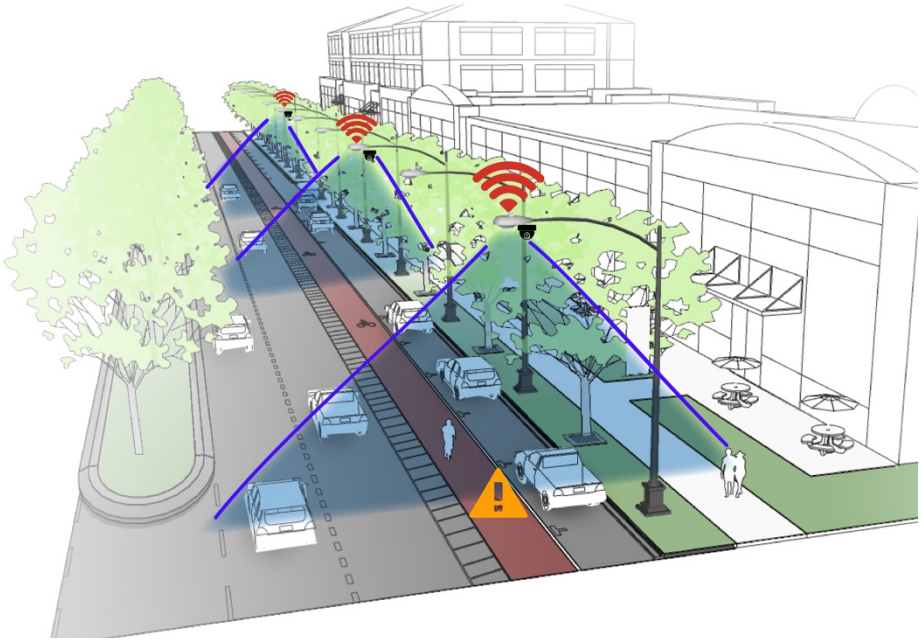
Syntiant is developing semiconductor solutions designed from the ground up for deep learning inference. Without the constraints of legacy processor architectures, Syntiant's neural decision processors (NDPs) use an analog neural network that can offer orders of magnitude lower power by extreme memory efficiency along with massively parallel computation with modest precision. Ideally suited for applications as small as hearing aids and IoT, or as large as smart speakers and mobile phones, Syntiant enables always-on deep learning inference in battery-powered devices.

Earlier this month at Infineon's OktoberTech 2018, Syntiant demonstrated a prototype NDP that can simultaneously support dozens of application-defined audio and keyword classifications, enabling developers to create custom, always-on speech user interfaces. Optimized for audio data rates, the processor is capable of speaker identification, audio event detection, environment classification, and sensor analytics.

Dr. Jeremy Holleman is currently on leave from UNC Charlotte.

Research Highlights

UNC Charlotte receives $1.9M NSF funding for community co-development of artificial intelligence systems designed to improve public safety



Researchers at the University of North Carolina at Charlotte have been awarded funding from 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 will develop an optical sensing platform that uses artificial intelligence to detect and prevent street crime without the use of profiling. The technology will be developed with the cooperation of the Charlotte communities in which it will be deployed, a participatory strategy that will improve safety while respecting the needs of neighborhoods, and improve the likelihood of widespread adoption.

The project, entitled "Building Safe and Secure Communities through Real-Time Edge Video Analytics," is led by UNC Charlotte Assistant Professor of Electrical and Computer Engineering Hamed Tabkhi. Co-principal investigators are Shannon Reid from the Department of Criminal Justice and Criminology; Arun Ravindran from the Department of Electrical and Computer Engineering; Srinivas Pulugurtha from the IDEAS Center and the Department of Civil and Environmental Engineering; and Douglas A Shoemaker from the Center for Applied Geographic Information Science.

The UNC Charlotte team's project was selected from over 300 submitted proposals to the NSF's Smart and Connected Communities program. The NSF has long been a leader in supporting fundamental research to equip U.S. cities and communities with more responsive and adaptive technologies and services. Smart and connected communities successfully integrate people with information and communication technologies to improve economic opportunity and growth, safety and security, health and wellness, and overall quality of life.

In 2017 the UNC Charlotte group began their research with an NSF planning grant that allowed them to engage with community leaders in Charlotte's North End Smart District and ask them what types of security concerns they had, and what were the special requirement of their neighborhoods. Using surveys, they found broad support for technology leading to safer streets, with valuable feedback regarding how best to go about it.
"So often the community is not actively engaged in the topics that immediately involve them. We thought we could do it better, and actually learned from residents how best our technology could support them," said Tabkhi. "From their responses we realized that by working closely with residents, we could make our platform better and improve public safety and build trust at the same time."

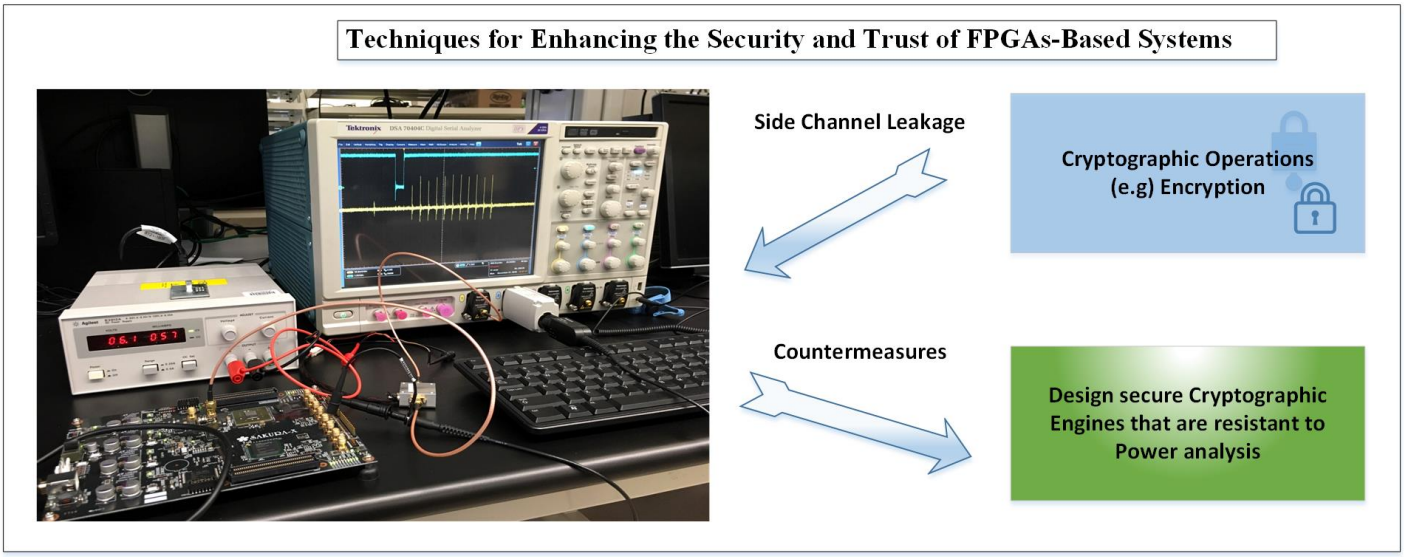
Smart Cities is a movement where technology and analysis of "big data" are leveraged to make cities more efficient and responsive. Smart technologies can be complex as 5G wireless networks and self-driving cars, and as simple as walkable neighborhoods. However, crime and the perception of risk can be obstacles to the deployment and adoption of digital solutions. Tabkhi and his team hope to enable smart city applications to be more effective by placing residents "in the loop" of information, and warning them of public safety risks through automated monitoring and reporting.
As the grant proposal describes: "The proposed research makes fundamental advances in multiple areas from computer vision, computer architecture, and real-time edge computing, as well as criminology and community-technology interaction. It paves a path for bringing the recent advances in deep learning and data analytics to enhance the safety and security of communities without jeopardizing the privacy of residents."

"Our AI platform can make residents aware of safety issues, such as street crime, without the use of identities or profiling. Instead we focus on detecting behaviors associated with crime, something we call "intelligent" policing."

The group intends to take what they are learning from residents and use that to begin training intelligent policing algorithms in an on-campus testbed before deploying limited, experimental engagements at invited locations in Charlotte, Concord and Gastonia.
The project has numerous community partners, including the City of Charlotte, and continues to recruit others. Community presentations on the project were held last spring as part of the planning grant, and the researchers intend to hold numerous others in the future.

Collaborative Research on Hardware Security and Trust

Dr. Fareena Saqib, Assistant Professor of Electrical and Comuter Engineering at UNC Charlotte, received funding from the National Science Foundation (NSF) for a collaborative research in hardware security of embedded systems. The 3-year $500,000 project entitled "Techniques for Enhancing the Security and Trust of FPGAs-Based Systems" will develop techniques for enhancing the security and trust of FPGA based systems. The project investigates countermeasures to side-channel-based attack mechanisms; and focuses on developing methods that makes hardware designs resilient to differential and correlation power analysis. Several strategies will be investigated in collaboration with the University of New Mexico (UNM) and University of Maryland Baltimore County (UMBC).



The project was selected for funding by NSF's CORE Secure and Trustworthy Cyberspace Program under the Directorate for Computer and Information Science & Engineering, Division of Computer and Network Systems. This project addresses the need for stronger, hardware-based security and emerging trust concerns in modern microelectronic systems. Techniques that leverage dynamic partial reconfiguration (DPR) as countermeasures to differential power analysis (DPA) will play a central role in this research but other techniques including noise injection countermeasures and true random number generators (TRNGs) will also be investigated. Resource-constrained system architectures represent the target hardware platform of this research. The methods will also be evaluated on system-on-chip (SoC) FPGAs that are increasingly used in larger, high-security systems found in aerospace and defense, industrial control systems (SCADA) and automotive and autonomous vehicles.

Dr. Saqib also received funding from Duke Energy on a project entitled "Hardware Secure Communications for Power Converters interfacing Renewable Energy Resources". This one-year (07/01/2018 – 06/30/2019) $160,622 grant involves Dr. Madhav Manjrekar, Associate Professor as Principal Investigator with Dr. Saqib and Dr. Somasundaram Essakiappan, EPIC Teaching Professor and Duke Energy Suite Power Labs Manager as Co-Principal Investigators.

This project addresses a major gap in the commercially off-the-shelf distributed energy resource (DER) inverters and grid devices; and aims at consideration of a hardware-based security capability and trust component to ensure secure communications between the device interactions in the Open Field Message Bus (OpenFMB) network. Duke Energy has been actively working on an open interoperability framework called the Open Field Message Bus (OpenFMB) that enables the inverters to quickly communicate in a secure manner with other devices on the power grid. Objective of this project is to design secure cryptographic hardware accelerates on reconfigurable fabric that enable the ability for Duke Energy to securely access, store, and trust data from either utility-owned or third-party grid-tied inverters.

This project has been initiated in the backdrop of the collaborative engagement of the Duke Energy/Emerging Technology Office (ETO) and the University of North Carolina at Charlotte (UNCC)/Energy Production & Infrastructure

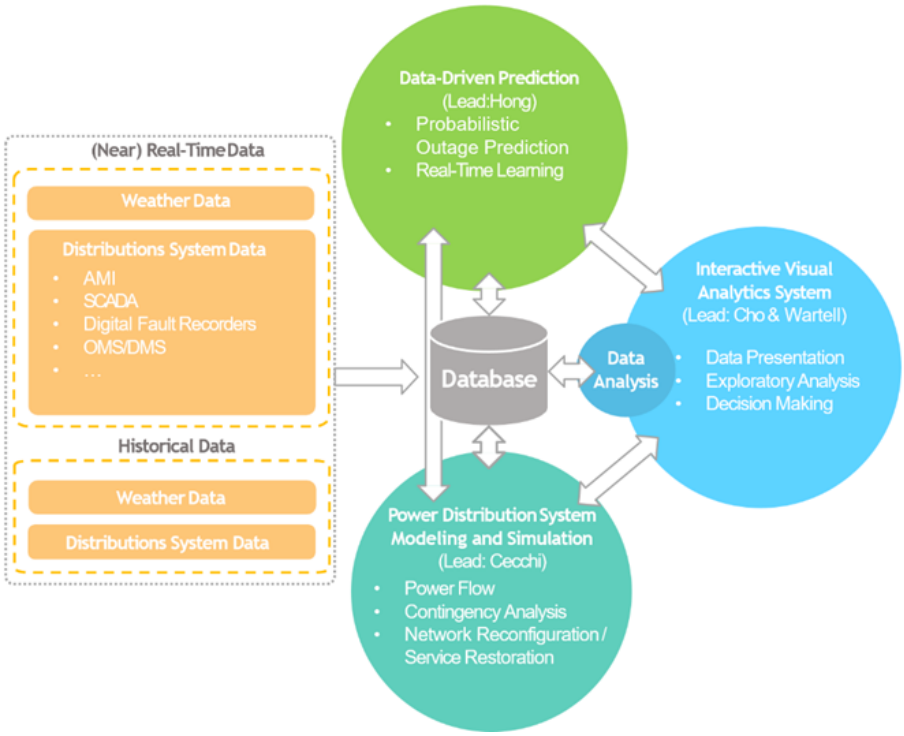
Center (EPIC) in research and development activities related to technologies of interest to the energy industry. This collaboration is expected to help facilitate the development of ideas and enhance testing capabilities while supporting activities to further energy education opportunities, advance efforts in the applied research clusters, and promote economic development in the region.

Solution for Curbside-Charging Electric Vehicles for Planned Urban Growth

Drs. Mike Mazzola, Robert Cox, Madhav Manjrekar, David Young, and Jean-Claude Thill received a $942,000 grant from the U.S. Department of Energy, to develop an innovative solution related to curbside charging of electric vehicles. The federal grant awarded is part of an $80 million investment in advanced vehicle technologies research to enable more affordable mobility, strengthen domestic energy security, reduce the nation's dependence on foreign sources of critical materials, and enhance U.S. economic growth. This work supports the U.S. Department of Energy's (DOE) goal to invest in early-stage research of transportation technologies that can give families and businesses greater choice in how they meet their mobility needs.

EPIC, with Dr. Robert Cox as the lead PI, will be responsible for the project management of the design of unique structural and electrical upgrades to the utility light poles selected to receive the curbside EV charging infrastructure made by Eaton Corporation. Testing will be performed and validation of the communications, electric, and structural subsystems will be conducted before delivery to Duke Energy's Mount Holly research facility for full system testing and qualification. Centralina Council of Governments will manage the process of selecting the Charlotte area government to host the demonstration and assisting in community relations during the planning and execution of the demo.

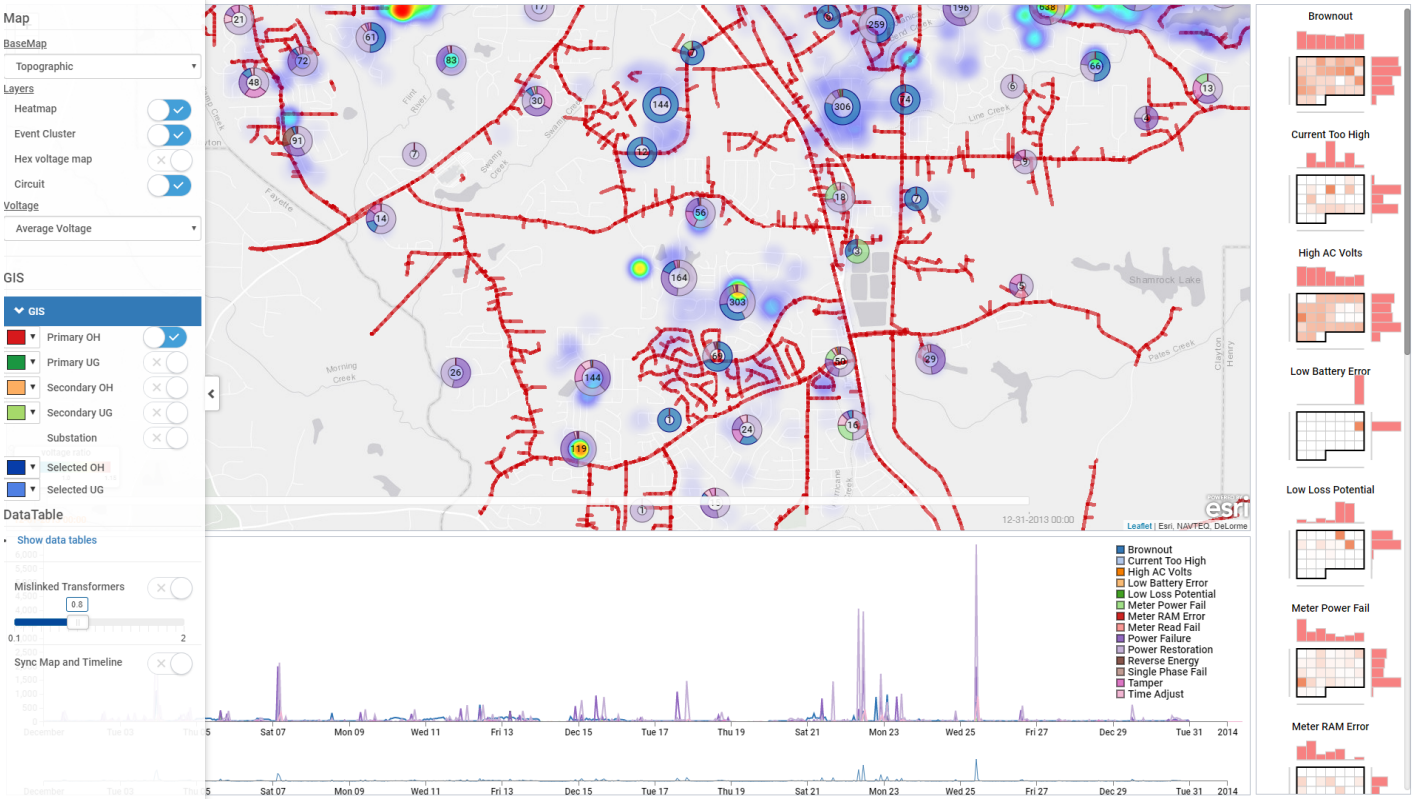
Researchers receive NSF EAGER to enhance decision making in electric power distribution systems



A team of UNC Charlotte researchers has been awarded a National Science Foundation (NSF) EArly-Concept Grants for Exploratory Research (EAGER) as part of the Real-Time Learning and Decision-Making in Engineered Systems (Real-D) program. Led by Associate Professor of ECE Valentina Cecchi, the 2-year $300k project is entitled "Visual Analytics for Enhanced Decision-Making and Situational Awareness in Modern Distribution Systems, with a Focus on Outage Prediction and Management". Co-Principal Investigators are Tao Hong from the Systems Engineering and Engineering Management Department, and Zach Wartell and Isaac Cho from the Department of Computer Science in the College of Computing and Informatics.

The project focuses on the integration of three main components: (1) Data-driven real-time probabilistic outage prediction with weather data, (2) Situationally-aware modeling and simulation of the electric

power distribution system, and (3) An interactive visual analytics system, to provide visual, prescriptive analytics. The focus will be on real-time probabilistic outage prediction and subsequent outage management strategies. The developed approach will enable and enhance fast and confident decision-making, thus supporting overall efficiency and reliability improvements in distribution systems, reducing outage times and improving reliability indices. The project will also lead to a new approach to handling big data in the electric grid, and to new directions in associated engineering and computing disciplines applied together to the power industry.



Visual analytics user interface prototype for power distribution systems decision-making and situational awareness

Advance EV charging

EPIC is pleased to announce research partnership with ZapGo, Inc. Founded in Oxford, England, ZapGo has recently located its US office to Charlotte, NC, joining hundreds of other energy-related companies in the Charlotte region. ZapGo leads the way in ultra-fast sub-five-minute charging with its Carbon-Ion (C-Ion) cells that can replace slow-charging lithium-ion batteries.

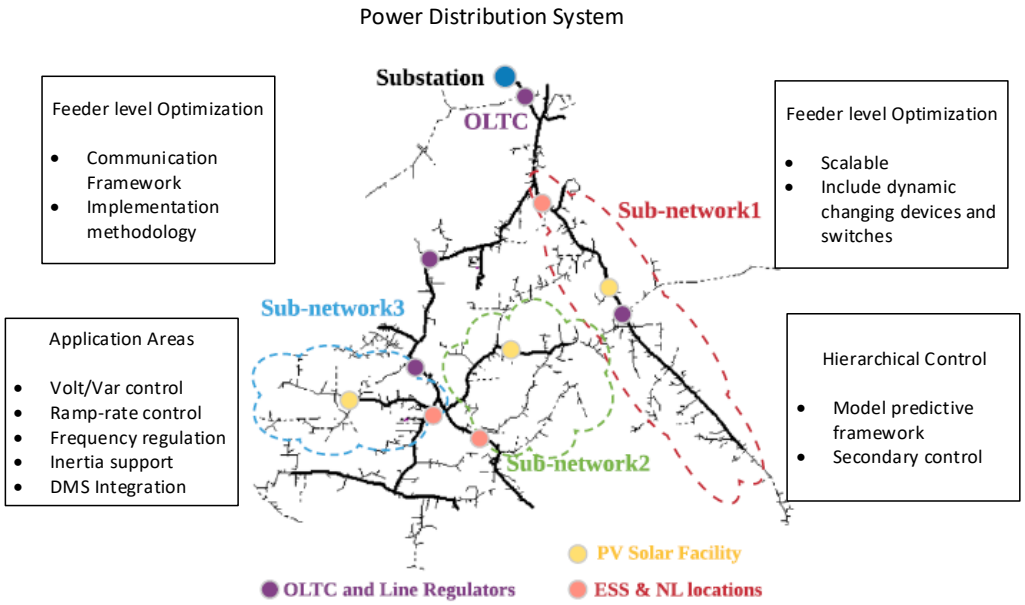
UNC Charlotte is providing engineering expertise leading to the first large-format grid-tied energy storage system based exclusively on C-Ion cells with Parker Hannifin's Energy Grid Tie Division as the system integrator. Parker Hannifin brings their field-proven power conversion technology to the project. EPIC will also work closely with Duke Energy to test the system at their Mount Holly Microgrid Research Center to confirm its easy integration into a utility distribution network. This work is led by Dr. Mike Mazzola and Dr. Madhav Manjrekar.

Operation and control of active power distribution system with high penetration of DERs and energy storage

Researchers at UNC Charlotte have been awarded funding from the National Science Foundation (NSF)'s Energy Power and Control and Networks (EPCN) program, to develop new methods for operation and control of power distribution system. The $360,000, the 3-year grant will develop a new framework for power distribution system operation and control with high penetration of renewable energy resources. The technology will be useful for power utilities to include a higher percentage of renewable energy based energy resources into their energy source mix without compromising the quality and reliability of the existing power grid operation. The technology will be developed with the cooperation of utility and the outcome will be tested based on real-life data sets.

The project, entitled "Data-Driven Operation and Control of Active Power Distribution Systems with High Penetration of Distributed Energy Resources and Energy Storage," is led by UNC Charlotte Professor of Electrical and Computer Engineering, Sukumar Kamalasdan. Co-principal investigator is Tao Han from the Department of Electrical and Computer Engineering.

The UNC Charlotte team's project was selected from over 400 submitted proposals to the NSF's EPCN program. The NSF has long been a leader in supporting fundamental research to equip U.S. cities and communities with more responsive and adaptive technologies and services. Smart and connected communities successfully integrate people with information and communication technologies to improve economic opportunity and growth, safety and security, health and wellness, and overall quality of life.



New ECE Faculty in 2018

Dr. Chen Chen
Assistant Professor
Ph.D., UT Dallas, 2016

Research Interests: Image and video processing, computer vision, hyperspectral image analysis, machine learning.

Dr. Kathryn Smith
Assistant Professor
Ph.D., UNC Charlotte, 2018

Research Interests:
Electromagnetics, antennas, fractal metamaterials.