UCF

Department of Electrical & Computer Engineering

AY 2019-2020

ANNUAL REPORT

MESSAGE FROM DEPARTMENT CHAIR DR. ZHIHUA QU

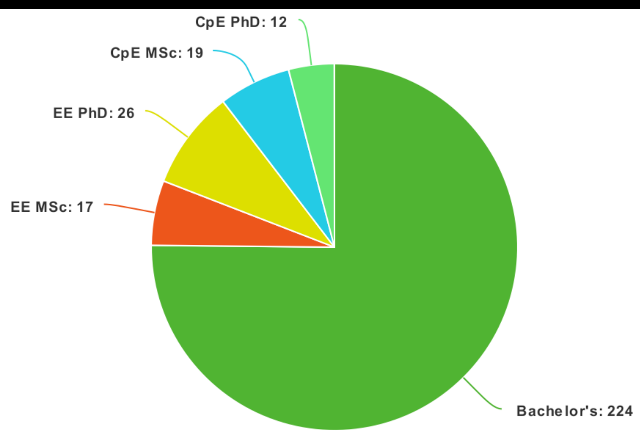
No one could have predicted the upheaval that our country and the whole world have experienced during the academic year 2019-2020. The pandemic has forced all of us to change our daily routines and adapt our work to a new normal. Despite the unprecedented challenges, our faculty and staff have united to work tirelessly in ensuring everyone's safety and health as our top priority, moving our courses and laboratory sessions online, and striving for the best quality instruction under the constraints of social distancing.

While our current situation is by no means unique, the following table reveals the story of our continuing and unparalleled efforts in meeting the increasing demands for education and innovation over the last ten years.

Metric	AY2010-2011	AY2019-2020
Full-time faculty headcount	26	41
Tenure/tenure-track faculty headcount	23	35
Student-to-faculty ratio (Fall)	44.5	41
BSc degrees awarded	141	224
MSc degrees awarded	86	36
PhD degrees awarded	19	38
Research expenditure	$2,348,434	$10,098,753
New research funding	$2,347,975	$19,144,098
EE ranking by USNWR (2011/2020)	66	53
CpE ranking by USNWR (2011/2020)	NR	52

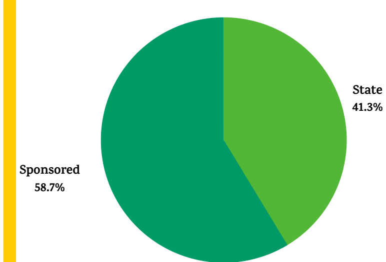
This edition of ECE annual report features our three new faculty members, contains three samples of collaborative research projects, and includes the statistics on standard metrics. With continuing support from our alumni and friends, we will continue to strive for excellence and make ECE the best it can be.

DEGREES



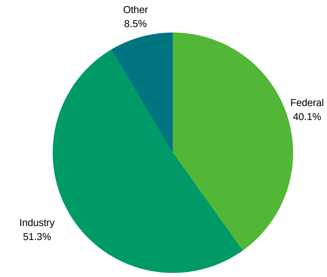
FINANCES

FY20 Expenditures



State $7,116,428
Sponsored $10,098,753
Total: $17,215,181

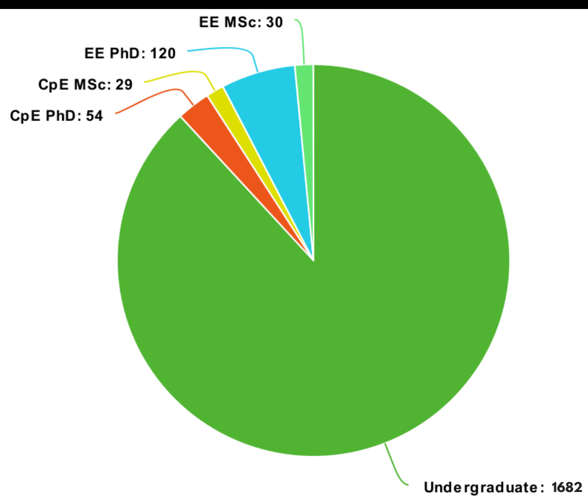
Sponsored Awards



Federal	Industry	Other
$7,684,180	$9,828,785	$1,631,132

Total $19,144,098

ENROLLMENT



RANKINGS

U.S.News & WORLD REPORT

#53 Electrical Engineering

#52 Computer Engineering

#74 2021 Best Graduate Schools Rankings Engineering

ECE WELCOMES NEW ADDITIONS

DR. ALEXANDER CARTWRIGHT
PRESIDENT, UCF

Alexander Cartwright was selected as UCF's sixth president by the UCF Board of Trustees on March 20, 2020 following a nationwide search.

Prior to joining UCF, Dr. Cartwright served as the chancellor of the University of Missouri (MU) with an appointment as a professor in the Electrical Engineering and Computer Science Department at the MU College of Engineering.

An internationally recognized researcher and scholar in the area of optical sensors, he is a fellow of the American Association for the Advancement of Science, SPIE and the National Academy of Inventors. Dr. Cartwright is a prior winner of both the National Science Foundation CAREER Award and the Office of Naval Research Young Investigator Award. In addition, he earned the 2002 SUNY Chancellor's award for excellence in teaching.

A native of the Bahamas, Dr. Cartwright holds a doctorate in electrical and computer engineering from the University of Iowa.

DR. YUXIAO YANG
ASSISTANT PROFESSOR

Yuxiao Yang is an Assistant Professor at the Department of Electrical and Computer Engineering (ECE) and the Disability, Aging and Technology (DAT) Faculty Cluster in the University of Central Florida (UCF).

Prior to joining UCF, he was a Postdoctoral Research Associate from in the Ming Hsieh Department of Electrical and Computer Engineering at the University of Southern California (USC).

He received the Ph.D. and M.S. degree in Electrical and Computer Engineering from USC in 2019 and 2018, respectively. He received the B.S. degree from Tsinghua University in 2013, majoring in Electrical and Electronics Engineering.

He has received various awards including the International Brain-Computer Interface (BCI) Award (2019), the IEEE EMBC best student paper award (2015), and the McMullen fellowship from Cornell University (2013).

DR. YEHYDA BRAIMAN
RESEARCH PROFESSOR

Dr. Yehuda Braiman is Research Professor at The College of Photonics and Optics and Department of Electrical and Computer Engineering at the University of Central Florida started January 2020. He is also an Adjunct Professor at the Department of Mechanical, Aerospace, and Biomedical Engineering at the University of Tennessee.

Prior to his appointment at UCF, Dr. Braiman held an appointment of a Distinguished R&D Scientist at Computational Sciences and Engineering Division, Oak Ridge National Laboratory and Joint Faculty Professor at Department of Mechanical, Aerospace, and Biomedical Engineering, University of Tennessee.

COLLABORATE RESEARCH HIGHLIGHTS

DRS. GEORGE ATIA, WEI SUN, ZHIHUA QU AND QUN ZHOU RECEIVE DOE'S BENEFIT FUNDING PROGRAM AWARD

Dr. Qun Zhou along with fellow ECE faculty members, Drs. George Atia, Wei Sun, and Zhihua Qu and external partners, National Renewable Energy Laboratory (NREL) and Siemens received the DOE's BENEFIT (Buildings Energy Efficiency Frontiers & Innovation Technologies) funding program in the amount of $3,750,000.

The project, entitled "Building Intelligence with Layered Defense using Security-Constrained Optimization and Security Risk Detection," works to develop a building cyber-security platform: BUILD-SOS via a probabilistic approach. BUILD-SOS protects smart buildings by effectively detecting faults and robustly operating the automation system, considering the uncertainties and probabilities in the control lifecycle. There are four objectives that are proposed to achieve the project goal:

- Probabilistic graphical models for detection and diagnosis
- Security constrained stochastic look-ahead optimization with vulnerability assessment and contingency analysis
- Probabilistic post-control performance assessment
- Validation through Building Cybersecurity Testbed (BCST) and real building demonstration

This project is well-aligned with BTO's Grid-Interactive Efficient Buildings (GEB) program area. The resulted BUILD-SOS provides a holistic solution to secure building operations and can be broadly applied to commercial buildings and campuses that are prone to cyber threats. The project will transform the way buildings are currently operated, and greatly benefit our living and work environment.

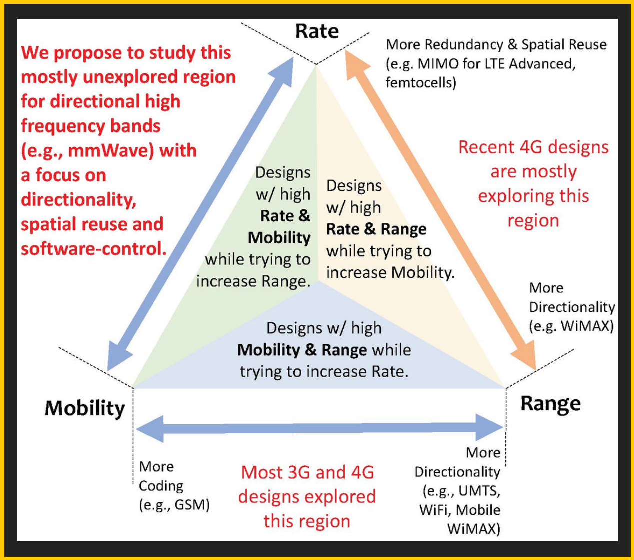
"Nothing is certain, and uncertainties come from building modeling, data sources, and even the unobservability of adversarial events," Qun said. "The BUILD-SOS platform is based on advanced data analytics and stochastic optimization. The probabilistic approach greatly increases the attacking difficulties. Hackers need to deeply understand both probabilistic detection algorithms and stochastic controls in order to execute any effective attacks. Buildings are fully armed with the BUILD-SOS."

COLLABORATE RESEARCH HIGHLIGHTS

DRS. XUN GONG, AZADEH VOSOUGHI AND MURAT YUKSEL RECEIVE NATIONAL SCIENCE FOUNDATION GRANT

Dr. Murat Yuksel, along with fellow ECE faculty members, Drs. Azadeh Vosoughi and Xun Gong, received a National Science Foundation (NSF) grant for their project entitled "Directional Software-Defined Radio." The PIs have complementary expertise on wireless communication protocols, antenna design, and signal processing. The team will also work with the COSMOS project team from NYU.

The Internet-of-things (IoT) is becoming a reality as our surroundings are getting evermore connected. The International Telecommunication Union is forecasting 100 times increase in the aggregate wireless demand by 2030 relative to 2020. The increasing density of IoT devices in civilian life imposes more stringent efficiency requirements on the use of radio frequencies, also called spectrum. The wireless community has made excellent spectrum efficiency innovations by solving interference challenges of omni-directional radios that propagate in every direction. However, it is questionable if these innovations alone will suffice as cost-effective and secure solutions for future wireless needs. As a promising solution, by transmitting and receiving in certain directions, directional radios offer high-speed wireless access, as well as wireless transmissions with lower energy consumption and probability of being intercepted by intruders. However, radio directionality has disadvantages in terms of tolerance to mobility and antenna size; and requires transmitter and receiver to be facing each other, a.k.a. line-of-sight (LOS) alignment, and larger antenna size.



This project adapts Software-Defined Radio (SDR), i.e., radio components implemented in software that enable dynamic programmability, to handle the challenges in mobility and LOS alignment of directional transceivers, and to attain practical antenna sizes. The project takes the first steps in making directionality of transceivers a programmable element of SDR platforms. In particular, the research team will design novel low-power beamsteerable mmWave antenna arrays, develop novel communication protocols to control the signal directionality, and develop novel signal processing algorithms to optimize directional communication (via rate and power control and interference management).

The technical contributions of this project will impact 5G technologies and the emerging 6G vision, and enhance the radio infrastructure needed for future smart cities and connected communities, and further the proliferation of wireless technology into civilian life.

The project will facilitate a rapid growth of next generation wireless technologies for IoT applications, via enabling gigabit-per-second indoor and megabit-per-second outdoor wireless communication. The project will also advance the theory of power control and interference management for dense networks of devices (including mobile users and fixed access points) using highly directional mmWave antennas. The project offers research opportunities to UCF undergraduate and graduate students, including under-represented minorities.

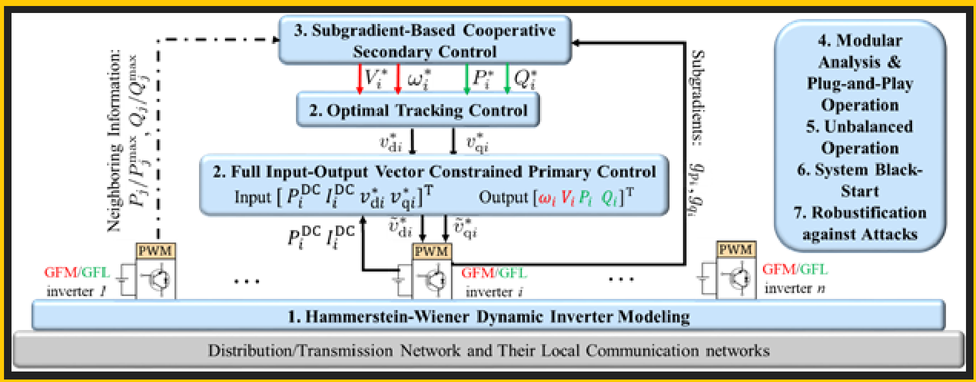
The project is "making directionality a mainstream wireless design component," says Dr. Yuksel. "More layman way of describing it could be that the project is "making radios hear from directions of their choice"."

COLLABORATE RESEARCH HIGHLIGHTS

UCF-LED TEAM TO MAKE NATION'S POWER GRID MORE RESILIENT

A UCF ECE team has been awarded a $3.75 million research award from the U.S. Department of Energy. The team, along with project partners Pacific Northwest National Laboratory, Siemens Corporate Research Center and Orlando Utilities Commission, look to keep the nation's power grid operations resilient and secure by developing and implementing innovative designs of autonomous inverter controls.

As solar, wind, and other distributed energy resources supply a significant or even predominant share of the total energy, inverter controls need to be improved to adaptively establish and support both frequency and voltage while individual DERs are of limited capacity. This project aims to provide a unified control design framework to enhance photovoltaic inverter controls and address the technical challenges of keeping the grid secure. It will coordinate grid-forming and grid-following inverters and black-start capability, which enables systems to restart independently after a power outage; ensure scalability and system stability; and protect against cyberattacks.



Dr. Zhihua Qu and Dr. Wei Sun serve as the principal investigator and co-principle investigator of the project, and, along with their research partners, will develop the following core control technologies: 1) improved modeling and simulation accuracy of inverters and PV systems by using Hammerstein-Wiener models for electromagnetic transient and circuit elements; 2) constrained vector control design to ensure that all the transient operational constraints of the inverters and grid are always satisfied; 3) stable frequency response, admissible voltage profile, and power sharing by extending decentralized and cooperative subgradient algorithms to an innovative vector control design for controlling the full input, state and output vectors; 4) incorporated nonlinear modular analysis/design to ensure transient voltage/frequency stability and scalability; 5) back start and autonomous microgrid operations; and 6) unique virtual anchor design and communication network optimization to enhance resilience against cyber/physical attacks.

Dr. Qu and his team will conduct analytical designs, software simulations, hardware-in-the-loop testing, lab prototype testing, and a field demonstration with Orlando Utilities Commission during the three-year project period. "Inverter controls, together with renewables and distributed energy resources, are what make our electricity grid autonomous, intelligent and sustainable. Our project is to design autonomous inverter controls that address the intermittent nature of renewable resources, and enhance reliability and resiliency," Dr. Qu said.

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