THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

COLLEGE OF ENGINEERING

Department of ELECTRICAL & COMPUTER ENGINEERING

FALL 2019

THE UNIVERSITY OF
ALABAMA IN HUNTSVILLE

COLLEGE OF ENGINEERING

A MESSAGE FROM
DRS. GORUR AND GAEDE

INSIDE

This past academic year has been eventful one for the ECE Department. Our newly launched B.S. in Cybersecurity is off to a great start. Over 100 students have enrolled in the program during the 2019 Fall semester. The enrollment in computer engineering has increased, while electrical engineering showed a small decline. This is consistent with what is happening nationwide. The demand for engineers with hardware and software skills is high, and this is attracting students who would have otherwise joined electrical engineering.

Upgrading of undergraduate laboratories has been a high priority for the Department. Last Fall, we upgraded the laboratory used for teaching embedded systems. This Spring, we upgraded the laboratory that is used for signal processing, and design and modeling of electric circuits and systems. We were able to increase the number of work stations and enhance safety for our students using the latest computers and systems.

Dr. Rhonda Gaede was appointed as the Associate Chair of the Department. Dr. Gaede's background is Computer Engineering and Cybersecurity. Dr. Gaede has an established record in conducting summer camps such as Tech Trek, GenCyber and BEST for high school students.

We hired Dr. Aubrey Beal as a tenure-track Assistant Professor. Dr. Beal obtained the Ph.D. degree from Auburn University and comes to us from the U.S. Army Research, Development, and Engineering Command (now Army Futures Command (AFC) CCDC) at the Charles M. Bowden Laboratory, Huntsville. He works in the broad area of signal processing.

Our faculty continue to win research grants from government and industry. Our undergraduate students are excited to participate in innovative projects and our graduate students are presenting papers in international conferences. You can read about all of these in this newsletter.

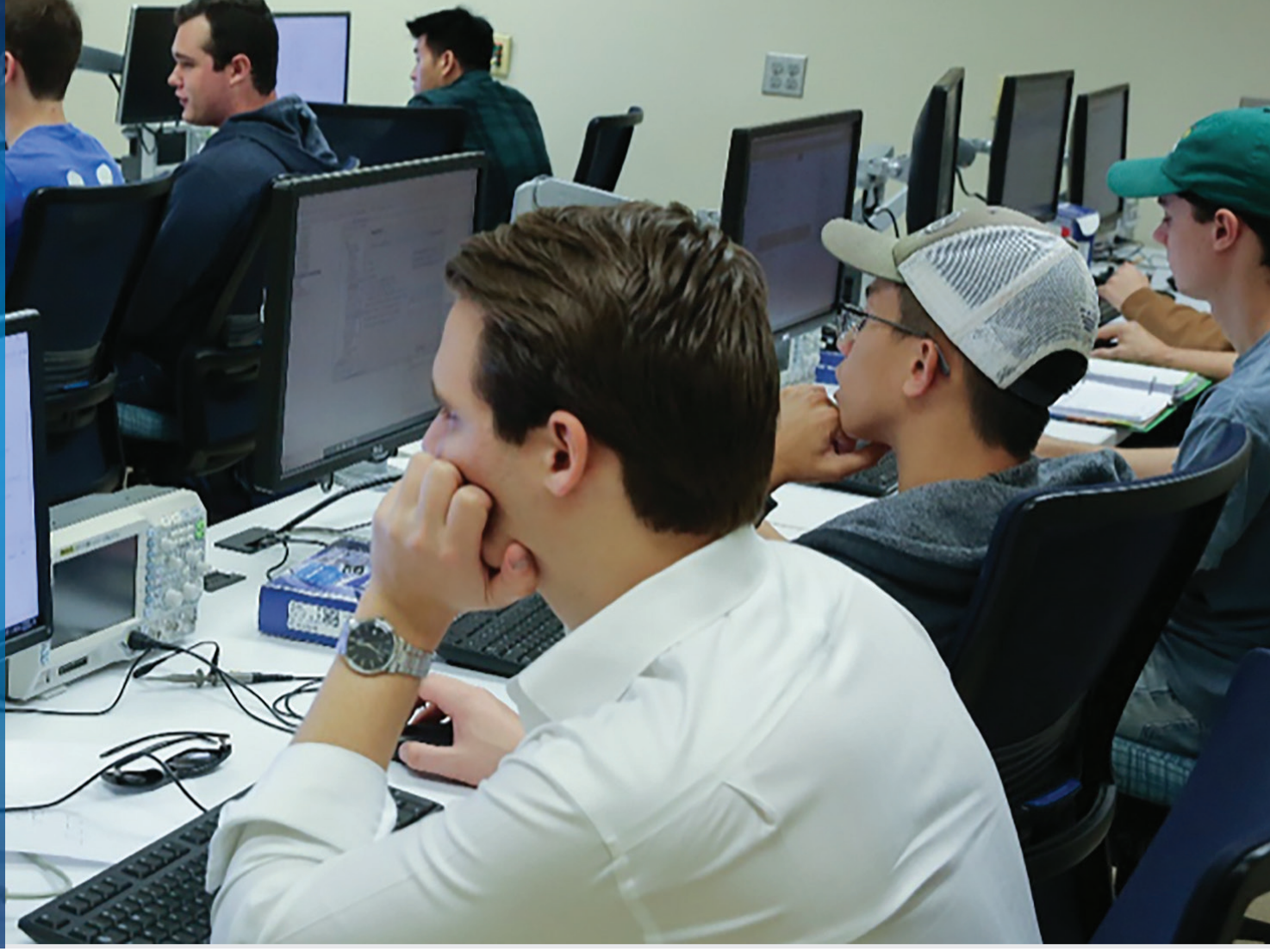
Dr. Yuri Shtessel and Ms. Linda Grubbs, both of whom have been associated with the ECE Department for 28 years, have decided to retire from UAH effective January 1, 2020. We wish them a very happy retirement.

Sincerely,

Dr. Ravi Gorur

Rhonda Kay Gaede

Dr. Rhonda Gaede



UPGRADING UNDERGRADUATE LABORATORIES

Engineering Building 109, which is used as the laboratory for multiple undergraduate courses, underwent an extensive renovation and upgrade (left bottom picture shows before upgrade). The laboratory can now handle 28 students (up from 20). New furniture with built-in electrical outlets, improved cable management systems, and integrated computer systems has made the laboratory more safe and aesthetically pleasing (middle bottom picture). This also allowed more space for adding equipment like digital oscilloscopes and spectrum analyzers. The upgrading and renovation was largely funded by the Department's annual lab equipment budget. Gleason Research Associates, Inc. donated the new spectrum analyzers, and the Department is grateful for the donation.

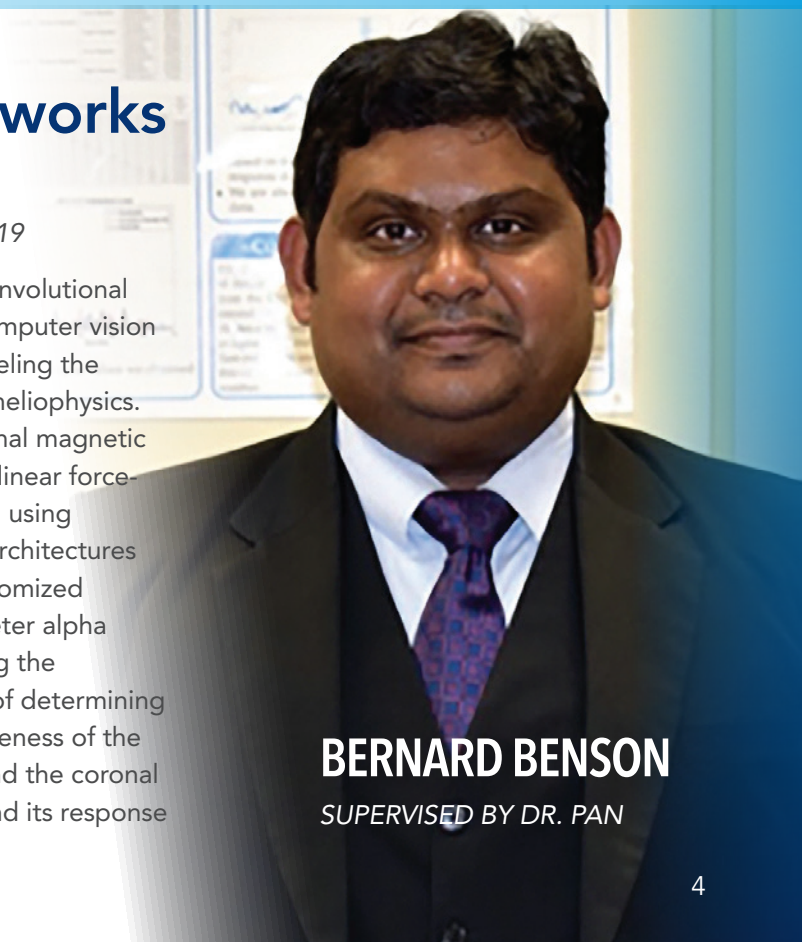
OUR STUDENTS AT INTERNATIONAL CONFERENCES

2018 - 2019

Application of Neural Networks For Image Processing

Machine Learning in Heliophysics, Amsterdam, September 2019

Recent advances in the field of neural networks have made convolutional neural networks (CNNs) a conventional algorithm for many computer vision tasks, including image recognition and object detection. Modeling the coronal magnetic field of the sun is an important objective in heliophysics. This study extends the use of CNNs to the application of coronal magnetic field modeling. We employ a simple one-parameter model of linear force-free magnetic fields (LFFFs) to model active regions of the sun using multiple dipolar configurations. We then use state-of-the-art architectures such as ResNet and Inception networks, and develop our customized network "SolarNet" to determine the associated LFFF parameter alpha from a set of synthetic loop images, which are generated using the modeled active regions. Our results show very high accuracy of determining the LFFF parameter alpha, thereby demonstrating the effectiveness of the generic and customized deep CNN architectures to understand the coronal magnetic field. The usefulness of the LFFF parameter alpha and its response to observed images is also studied.



BERNARD BENSON

SUPERVISED BY DR. PAN

Cyber Attack Reconstruction of Nonlinear Systems Via Higher-Order Sliding-Mode Observer

Control and Decision Conference, Miami Beach, December 2018

Cyber-Physical Systems (CPS) are the integration of computing and communications with the physical world. CPS has been playing a crucial role in many critical infrastructures including power grids, water networks, integrated biological systems, advanced automotive and industrial automation systems, and economic systems. Exchanging data among sensors, actuators, and other networked components makes it possible for attackers to gain access to computing platforms and manipulate systems to severely compromise system performance, with disastrous consequences.

There is a significant amount of publications which have focused on keeping the system safe from attacks; however, ensuring CPS control systems can continue functioning properly if a cyber attack has happened is a serious problem that should be investigated.

In the work presented at the conference, a sliding mode observer and a sparse recovery algorithm are used to reconstruct the state and sparse sensor attacks of a nonlinear CPS, respectively. The sensors and states, corrupted by the attacks are then cleaned on-line in order to stop the attacks propagation to the CPS through output feedback control. After a finite time transient needed for the attack reconstruction, the CPS closed-loop performance of the system corrupted by the attack matched the performance of an attack-free system.

SHAMILA NATEGHIBOROUJENI

SUPERVISED BY DR. SHTESSEL

Accuracy Improvement of Dynamic Sensors Using Higher Order Sliding Mode Observers

American Control Conference, Philadelphia, July 2019

Sensors are becoming increasingly important in many applications. Selecting a sensor with a particular accuracy and maintaining it over time is one of the biggest challenges in sensor technology. In many situations, users will be unaware of the sensor settings and it may go out of tolerance. In the present research, the accuracy and performance of the sensors has been improved by reconstructing the true input of sensors from distorted measurement by using the technique of Higher Order Sliding Mode Observer (HOSMO). The proposed technique estimates the actual/true input of sensors thereby improving the sensor response and driving the error to zero in a finite time. A case study was performed on a planar metal-polymer composite sensor model and the simulation results illustrate the efficiency of the technique in improving sensor accuracy, performance and precision of the sensor.

RAJESH R. JAYASHEELAREDDY

SUPERVISED BY DR. SHTESSEL

Evaluation of Insulators Used on Power Lines

IEEE Conference on Electrical Insulation and Dielectric Phenomena, Richland, Washington, October 2019

Power outages can greatly impact the nation's economy. They influence the consumers of electricity in several ways, such as causing interruptions in business, affecting the functioning of key life-saving equipment in hospitals, and property loss, to name a few. According to a report by Electric Power Research Institute (EPRI), the estimated cost of power interruptions was $150 billion in 2012. It was reported that the short-term, momentary interruptions, which lasted five minutes or less, had a stronger impact (around 67%) on the total cost of interruptions than the less frequent sustained interruptions. One of the principal causes of momentary interruptions is flashover of outdoor insulators. In our research, we developed a model to calculate the flashover voltage of polluted outdoor insulators in the presence of multiple dry band discharges. The proposed model was used to calculate the flashover voltage of standard insulators. Case studies were presented to compare the flashover voltage in the presence of multiple small dry band arcs with a single predominant dry band discharge.

MEGHANA RAMESH

SUPERVISED BY DR. GORUR

ZABED IQBAL

SUPERVISED BY DR. POUR

A Modified-Binomial Linear Array with Reduced Grating Lobes and One-Wavelength Element Spacing

IEEE International Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting, Atlanta, July 2019

Phased array antennas are widely used in a variety of applications, such as satellite communications and radar, because of their high gain, high tracing accuracy, swift switching capability, and most importantly unique electronic beam scanning characteristic. However, scanning phased array antennas with element spacing greater than half wavelength usually generate grating lobes in the visible region, which worsen for wide scan angles. In this study, a novel method is proposed to reduce grating lobes of a linear phased array antenna, consisting of a dual-mode circular microstrip patch antenna, with one-wavelength element spacing for scanned beams up to ±40°. The dual-mode circular microstrip patch antenna operates at the fundamental TM21 mode with a conical radiation pattern. A seven-seven element linear phased array, whose array elements are excited by a modified binomial expansion and distributed along the x-axis is investigated. By simultaneously exciting these two modes with a proper mode content factor, a self-scanning and adaptive nulling radiation profile can be realized which can effectively be utilized to nullify the unwanted grating lobes. The reduced grating lobes achieved through this method are significant.

Multi-Camera Topography Module

A team of four ECE students, Andrew Little, Amanda Suiter, Christopher Layne, and William Watson took up the task of designing a multi-camera module instead of the conventional single camera mounted on drones. The goal was to capture a wider field of view for drone-based image capture, as a single downward-facing camera found on drones offers a narrow field of view. As the drones can carry only a limited amount of weight, the primary design constraint was to not exceed a 1.3 kg weight limit.

The multi-camera topography module takes pictures from four different cameras using two Raspberry Pi 3B+ units at five frames per second for a duration of 10 minutes. The Pi units and the camera modules are mounted on a 3D printed baseplate. The cameras are mounted at an angle to avoid extensive overlap. The captured images at each timeframe are removed off of the module and stitched together and rendered into a video format using MATLAB. This can be used to obtain an image of a specific geographical area chosen by the user as long as they follow the FAA guidelines for drones.

Amanda Suiter, Andrew Little, Christopher Layne & William Watson

There are various functions that can be implemented with this module, such as getting a bird's-eye view of farmland, surveying land for new infrastructure and local development, and conducting inspections from an additional vantage point. The student team, under the supervision of Dr. Reardon and Professor Dennis Hite, completed the design and made successful test runs. They were sponsored by IERUS Technologies and also had the support of their employees, namely Dane Phillips, Stephen Henning, John Reinhardt, and Alex Clark.

Intelligent Radar

In Spring 2019, a group of four, consisting of Raymond Lee, Logan Shelton, Judson Smith, and Anne Wolf, designed an image processing system for Dynetics' GroundAware® Radar. The implementation of a computerized image processing algorithm for target detection helps reduce human operator dependency. Computers overcome the limitations of human vision and poor response time and can respond much faster as they can process the data much faster.

The GroundAware system uses a digital beamforming radar in conjunction with an electro-optical infrared camera to monitor potential threats within a given area. The radar reports multiple targets, and the camera is programmed to adjust its line of sight based on the highest priority target. The radar also does some data processing to provide position and velocity, and predicts some target classification (person, car, truck, tank, etc.) based on image classification techniques. The camera's main goal is to keep the highest priority object in the frame. An image processing technique called foreground detection can be used to separate the targets within an image from the surrounding terrain. Computers store image information as a three-dimensional array of arbitrary values of red, green and blue pixels. This can be simplified by using an IR camera which instead of RGB uses only one color element. IR cameras also produce better results in the dark because they depend on thermal energy to produce images.

Jud Smith, Logan Sheldon, Anne Wolf & Raymond Lee

The goal of the project was to begin the early stages of image processing and provide potential ideas to the GroundAware team that would benefit future projects. Currently, only stored data is being processed. With more advancements, this could be implemented as a real-time system.

Solar Panel Efficiency and Power Controller

The team of electrical engineering students, Cannon Bearden, Dana Overton, Joseph Morris, and Elizabeth Bekken, supervised by Dr. Ray, took on the challenge of designing a device which automatically calculates and stores the maximum power and efficiency of a solar panel. While solar panels are a means of clean energy, they can be an unsteady source of energy due to variations in the amount of sunlight they receive and are also affected by cloud, dust, etc. The project aims to detect such factors by analyzing the performance of the panel and alerting the user when the panel is underperforming.

The efficiency depends on the amount of sunlight the panel is exposed to and the size of the load the panel is powering. Since the sunlight that the panel is exposed to cannot be controlled, the load has to be controlled. By changing the load in accordance with the panel's output, maximum efficiency can be achieved. This would require a method of sweeping through a range of load voltages and then capturing and storing the voltage that produces a maximum amount of output power.

The hardware setup consists of an Arduino Uno to produce the voltage sweep and retrieve the corresponding voltage and power, an LCD screen to display the results, and a memory card to store the result. A MOSFET is used as a voltage-controlled resistor to measure the current. MATLAB was used to set up the input and output pins for the Arduino to run the tests and retrieve values. The open-circuit voltage of the panel was obtained by exposing it to sunlight for a period of five hours. The corresponding data shows how the setting sun affects the voltage. The LCD displays all the data.

Joseph Morris, Dana Overton, Cannon Bearden & Elizabeth Bekken

ECE THANKS

Gleason Research Associates, Inc. for Supporting Senior Design Projects!

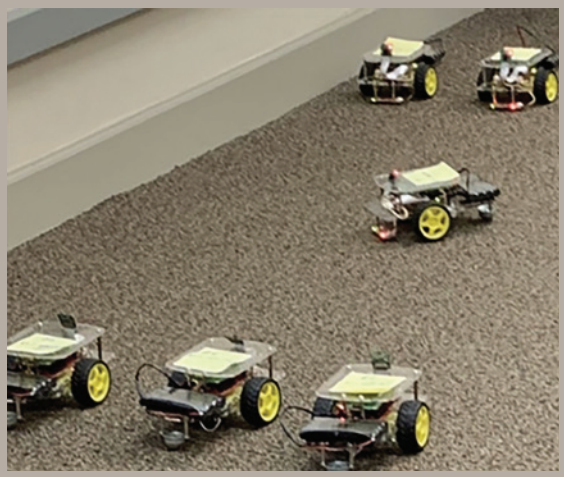
Gleason Research Associates, Inc. is an outstanding example of how industry can provide support and enrich the student experience here at UAH. Their $10,000 new equipment donation will support the Design and Modeling of Electric Circuits and Systems course. This course introduces students to design, complex problem solving, and prototyping while developing techniques and proficiency in using common test equipment and programming; the basic skill set needed by all future engineers. Gleason Research Associates, Inc. also supports and mentors electrical engineering senior design projects.

Miles Foshee & Dennis Hite during sign dedication aknowledging GRA's support

GENCYBER CAMP AT UAH

The ECE Department held "CyberCharged" GenCyber camps for rising 6th, 7th, and 8th graders in July 2019, directed by Dr. Rhonda Gaede with lead instructor Dr. Jennifer English. The event was a one-week, non-residential camp designed for participants to explore cybersecurity concepts using Plugged, Raspberry Pi, and Unplugged activities. Using multiple modes reinforced these concepts by presenting different facets of the concepts. Key activities included: touring the FBI Regional Computer Forensics Lab and the UAH data center, interacting with a panel of cybersecurity professionals, implementing Caesar cipher cracking on a Raspberry Pi, learning about parity through Card Flip Magic, debating the use of facial recognition, and synthesizing various concepts to complete a Raspberry Pi scavenger hunt.

COE LAUNCHES MENTORING PROGRAM FOR UNDERGRADUATE STUDENTS



A college-wide effort has been initiated in Fall 2019 to support our engineering accreditation and to provide important mentoring, advising, and career development to our students. Each program has two new required courses numbered 299 and 399, which are zero-credit hour classes and require no fees or tuition. The classes are participatory in nature. The grade basis is S for satisfactory or U for unsatisfactory, and students must earn an S in both classes to graduate.

The purpose of these courses is to provide students with:
(1) general curriculum advising
(2) techniques and habits for academic success
(3) mentoring from department faculty
(4) career development
(5) industry interactions via presentations and panel discussions

DR. LAURIE JOINER
University Distinguished Teaching Award

Dr. Joiner received the University Distinguished Teaching Award at the Spring 2019 University Awards Ceremony. She is an Associate Professor in the ECE Department and has been at UAH since 1998. Dr. Joiner enjoys teaching the signals and systems classes and teaches several graduate level classes in communications. She has been the advisor for 13 Ph.D. students, and 25 M.S. thesis students.

DR. BISWAJIT RAY
Joseph Dowdle Award

Dr. Biswajit Ray wins the Joseph Dowdle Award. "Teaching students is one of the rewarding experiences I am enjoying since joining UAH from my previous industry job. I enjoy greatly the student-teacher interactions inside or outside the classroom. One key component of my teaching method is to engage the students with the subject matter by illustrating the real-life applications. Currently, I teach two undergraduate courses (EE 310: Solid State Fundamentals and EE 410: Photovoltaics) and one graduate course (EE 610: Reliability of Electronic Devices) at UAH. I often incorporate my research findings in some of these courses. In addition, I offer senior design projects where I involve undergraduate students with research experience. I hope my recent NSF award (NSF-UKRI #1935676) will help me further to engage students in the research activity."

DR. DAVID COE
COE Outstanding Service Award

Dr. David Coe wins the COE Outstanding Service Award. He takes great pride in attending recruitment events like Discovery Day, Charger Preview days and open houses. He presents exciting information on computer engineering and cybersecurity programs.

MR. CHRIS HARDY
ECE Linda Mauldin Hooper Outstanding Service Award

Mr. Chris Hardy (Lab Manager) wins the ECE Linda Mauldin Hooper Outstanding Service Award. "Hands-on learning is increasingly important in a time when online learning is becoming more popular. Seeing and doing are two totally different experiences, and I think our labs offer the critical transformation of theory into action. It's one thing to watch a video of someone doing an experiment, but being in a lab, turning knobs, switching wires, and seeing the effects of those changes in real-time, turns an experiment into an experience. My goal as the lab manager is to keep students excited about engineering by providing them with a great lab experience. That translates into practice having properly functioning equipment, clean and useful work-spaces, and safe environments."

NEW FACULTY

Dr. Aubrey Beal
ASSISTANT PROFESSOR

Aubrey Beal received B.E.E. (2010), M.S. (2012), and Ph.D. (2015) degrees in Electrical Engineering from Auburn University in Auburn, AL. His work in graduate school used concepts in nonlinear dynamics to innovate techniques for communication systems, compressive noise ranging systems, and true random number generation in integrated circuits. During a postdoctoral appointment with the U.S. Department of Energy's Oakridge Institute for Science and Education for the U.S. Army AMRDEC from 2015-2017, he applied these concepts to give unique advantages to physical systems. He has industry experience in bulk power systems with Southern Company in Birmingham, AL, power electronics for high performance computers with IBM in Poughkeepsie, NY, as well as metal detection for biomedical and industrial applications with Enventys Partners in Charlotte, NC.

Since 2017, Dr. Beal has served as a researcher and electronics engineer with the U.S. Army RDECOM (now Army Futures Command CCDC) in Charles M. Bowden Laboratory at Redstone Arsenal, Alabama. This work supports basic and applied research for the U.S. Army. He is currently an Assistant Professor at The University of Alabama in Huntsville and is interested in enhancement and security of cyber-physical systems though advances in nonlinear dynamics, machine learning, and signal processing.

WELCOME OUR NEWEST CHARGERS!

Dr. Emil Jovanov
NAMED IEEE FELLOW

Dr. Emil Jovanov was elected to IEEE FELLOW Grade for contributions to "wearable health monitoring". Dr. Jovanov is recognized as the originator of the concept of wireless body area networks for health monitoring, and this recognition demonstrates that he is one of the leaders in the field of wearable health monitoring. The IEEE Fellow "is a distinction reserved for select IEEE members whose extraordinary accomplishments in any of the IEEE fields of interest are deemed fitting of this prestigious grade elevation." The ECE Department is home to three IEEE Fellows (the others being Dr. Tim Boykin and Dr. Ravi Gorur), and one Fellow of the SPIE (Dr. Junpeng Guo).

PH.D. GRADUATES
THE **ECE DEPARTMENT** 2019

FATHI MUHAMMAD ALDUKALI
Field: Electrical Engineering
Dissertation: Hybrid Impulsive Higher Order Sliding Mode Control
Advisor: Dr. Yuri Shtessel

CAROLINE SANGEETHA JOHN
Field: Electrical Engineering
Dissertation: "Characterization and Modeling of Ferroelectric Ultracapacitors for Energy Storage"
Advisor: Dr. Fat Ho

SHAMILA NATEGHIBOROUJENI
Field: Electrical Engineering
Dissertation: "Attack Reconstruction and Secure State Estimation in Cyber-Physical Systems using Sliding Mode Observers"
Advisor: Dr. Yuri Shtessel

MATTHEW A. NICELY
Field: Computer Engineering
Dissertation: "Parallel Implementation of Resampling Methods for Particle Filtering on Graphics Processing Units"
Advisor: Dr. Earl Wells

MOUNIKA PONUGOTI
Field: Computer Engineering
Dissertation: "Hardware Data Value Tracing in Multicores"
Advisor: Dr. Aleksandar Milenkovic

JASON MATHEW RENEAU
Field: Electrical Engineering
Dissertation: "Short-Range Phase Coded Linear Frequency Modulation Waveform Radar Design and Analysis"
Advisor: Dr. Laurie Joiner

THIAGO RODRIGUES
Field: Computer Engineering
Dissertation: "Open PLC: Towards A Fully Open and Secure Programmable Logic Controller"
Advisor: Dr. Thomas Morris

SCOTT COREY WOLFSON
Field: Electrical Engineering
Dissertation: "Physically Derived Two-Dimensional Predictive Model for Dual-Gate Devices using Quintic Splines"
Advisor: Dr. Fat Ho

CONGRATULATIONS
TO ALL!

Dr. Yuri Shtessel

DISTINGUISHED PROFESSOR

Yuri B. Shtessel received the M.S. and Ph.D. degrees in Electrical Engineering from South Ural State University, Chelyabinsk, Russia in 1971 and 1978, respectively. In 1979-1991 he was with the Department of Applied Mathematics, the South Ural State University, Chelyabinsk, Russia. He joined UAH in 1993 and became a Distinguished Professor. Dr. Shtessel graduated 12 Ph.D. students and 35 M.S.E. students with thesis. His research interests include sliding mode control and observation with applications to aerospace vehicles and electric power systems.

He co-authored the book "Sliding Mode Control and Observation," Springer, 2014. Since 1995, Dr. Shtessel published 98 journal papers, more than 250 conference papers, 19 chapters in scholarly books, and received a patent. He also received more than $1.2 million support as a PI/Co-PI of research projects funded by NASA, AFOSR, U.S. Army, and industry. He was invited as a Visiting Scholar/Professor to conduct research in major universities of UK, France, Italy, Spain, Israel, Mexico, and China.

Dr. Shtessel is a member of the IEEE Variable Structure Systems Technical Committee and serves as a subject editor of the Journal of the Franklin Institute, a technical editor of the IEEE Transactions on Mechatronics, and an associate editor of the IEEE Transaction on Aerospace and Electronic Systems. He is a recipient of the IEEE Third Millennium Medal for outstanding contributions to control systems engineering (2000), the Visiting Lady Davis Fellowship, Technion, Israel (2003), the UAH Research and Creative Achievement Award (2004), the Distinguished Visiting Fellowship of the Royal Academy of Engineering, UK (2008), and the UAH College of Engineering Outstanding Senior Professor Award (2013). Dr. Shtessel holds the ranks of IEEE Senior Member and AIAA Associate Fellow.

He's been married to Nina Shtessel for 45 years, has two daughters (Alena and Ludmila), and four grandsons (Jason, Charles, Ari, and Idris).

Ms. Linda Grubbs

SENIOR STAFF ASSISTANT

Linda Grubbs, Senior Staff Assistant, will retire on January 1st, 2020 after 28 years of accredited service in the ECE Department. A native of New Orleans, she moved here due to her husband's job and decided to apply at UAH. Linda said, "I love working with the great faculty and staff in the ECE Department here at UAH. They are the best you could wish for. I will miss them." She plans to remain a resident of Huntsville and continue volunteer work for the non-profit organization she has supported for years. Linda loves to travel with her husband, work crossword puzzles, read, surf the web, and binge watch Netflix or DVD favorites.

UAH's Department of Electrical and Computer Engineering offers a full range of accredited degree programs through the Ph.D. level, in addition to separate interdisciplinary master's degrees in software engineering and cybersecurity. Our programs are designed to not simply train students to be users of current technology, but also to educate them so that they actually understand how this technology works. As a result, our graduates can be found throughout the world, actively impacting industry, government, and academia.

For more information about our department or to learn more about our degree programs, please visit **www.uah.edu/eng/departments/ece**

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ARMDEC

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