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Welcome to our 2015 ECE newsletter. Our Department has just completed a fantastic year. The biggest news is that we have hired 10 new faculty within the last year and a half, growing from 41 to 51 tenured and tenure-track faculty, our largest number ever! Among our faculty are the Director of the National Science Foundation’s Engineering Directorate, Pramod Khargonekar, the President of the University of Florida, W. Kent Fuchs, and the Director of the UF honors Program, Mark Law.

Starting this fall, we have 5 new faculty of which 3 are focused on cybersecurity research, particularly on the hardware side. Mark Tehranipoor, who holds the Charles E. Young Leadership Chair in Cybersecurity, and Dominic Forte come from the University of Connecticut; and Swarup Bhunia comes from Case Western Reserve University. They join ECE’s Daniela Oliveira and 3 CISE faculty to form the Florida Institute for Cybersecurity, which will be officially inaugurated in Spring 2016 following a multi-million dollar building renovation that is currently underway. Also here is Damon Woodard who joins us from CISE, working in biometrics, pattern recognition, and machine learning. Finally, Roozbeh Tabrizian, formerly a post doc at the University of Michigan, joins the faculty working on resonant micro-systems, phononic devices, and mixed-domain physical sensors.

On the academic front, our revised undergraduate Computer Engineering curriculum is in full swing, allowing students to choose electives between the CISE and ECE departments. Our new undergraduate EE curriculum is also on track, providing more flexibility to students, more hands-on labs, and now offering a brand new biomedical option, which exploits the talents of our many faculty and proceeds from their research.

In this issue of our newsletter, we focus on the biomedical opportunities in ECE where we highlight the biomedical related work of our faculty—Karim Oweiss, Rizwan Bashirullah, Jose Principe, Jenshan Lin, and YK Yoon—as well as our ECE alumni—Asye Gunduz, a 2008 PhD graduate of UF ECE under the mentorship of Dr. Jose Principe, is on page 13. Finally, my own research in neuromorphic engineering builds novel computational systems inspired by the computation of the brain.

I am excited about the future of the ECE Department in this new year and on behalf of all of our faculty, I invite you to explore some of our other accomplishments highlighted in the video, “This is how we do it ECE Florida” found on our YouTube Page!

GO GATORS!
Electrical engineers are in great demand by the biomedical industry. At the cutting edge of research and development, electrical engineers have revolutionized healthcare and the medical field in fundamental ways. Studies predict a large percentage growth in biomedical related jobs with many of these jobs going to more traditional majors such as electrical engineering, mechanical engineering, or computer science.

The job outlook for majors in biology and life sciences is not as promising [2]. Recent studies show that electrical engineers’ starting salaries are higher than any other engineering majors; and electrical engineers also have more jobs available to them than any other major [1].

The following paragraphs discuss the biomedical opportunities for the eight major disciplines of electrical engineering.

1. Computer engineering is the largest division of ECE departments across the country. Embedded computers are the heart of biomedical instrumentation systems and implanted devices. Researchers are using the cloud to develop new solutions for aggregating and processing medical data. Robots are designed to assist in surgery and aid in rehabilitation. Machine learning techniques are used to collect and analyze large amounts of data related to medicine and biology, creating a new field called bioinformatics.

2. Signal Processing is a core area of electrical engineering and vital to many biomedical applications. Electrical engineers use mathematical models and statistics to record and analyze signals and images recorded from the body. Useful information can be extracted from these biological signals for diagnostic and therapeutic purposes. For example, ECG signals can be processed to determine cardiac health.

Medical images must be quickly compressed, enhanced, and stored and researchers are working on automatic methods to detect tumors and other anomalies. Hearing aids and cochlear implants rely on sophisticated signal processing to restore hearing. Brain machine interfaces are being developed to translate brain signals into motor commands that can control computer cursors, prosthetic limbs, or even the natural paralyzed limbs of a human with spinal cord injury.

3. Controls is one of the oldest disciplines in all of engineering. Nearly every device—from wheelchairs to robotic surgeons to neural prosthetics—requires sophisticated control procedures and algorithms. In order to function properly, the human body relies on control systems at various temporal and spatial scales. For instance, body temperature is maintained at a fairly constant level and our heart rate and breathing rate automatically increase when we exert ourselves in order to supply more oxygen to the body. Similarly, medical devices must rely on sophisticated control systems to operate. For instance, an implanted heart pacemaker carefully regulates a patient’s heart rate, increasing or decreasing electrical stimulation based on the difference between the current heart rate and the desired heart rate. Likewise, an implanted brain pacemaker carefully regulates pathological neural activity associated with an impending seizure in an epileptic patient, or those associated with the abnormal movements of a Parkinsonian patient.

4. Communications and networking are required for all real-world computer systems and devices. Wireless communication systems are becoming standard for wearable medical devices. For example, the field of telemedicine uses networking infrastructure to deliver health care to patients in remote regions. Modern medical evaluation, diagnosis and treatment are also delivered with the help of networked devices. (continued pg. 6)
The medical tricorder used by the medical staff of the starship Enterprise is a futuristic handheld device first popularized by the original Star Trek TV show. This science fiction device could measure vital health signs, diagnose illnesses and detect the presence of dangerous organisms. ECE professor Jenshan Lin is bringing this device closer to reality with his biomedical radio frequency (RF) circuits and systems research. Lin’s device can remotely measure vital signs, such as heart rate and breathing rate. Vital signs associated with pain and stress can be detected in real-time, such as in post-op and recovery, or during the onset of illness or when injury is about to occur. Ultimately, Lin’s device will improve the quality of patient care.

Lin’s research is being commercialized by a number of companies. Among them, Structured Marketing Products™ is marketing a baby monitor based on Lin’s technology. This monitor sounds an alarm if there are any breathing abnormalities. Lin’s research has also led to the development of TruVitals™, a company targeting the animal lovers market allowing vets, zoos and farmers to wirelessly monitor animal vital signs. The monitor will help veterinarians and zookeepers diagnose and treat animals faster as well as improve their post-operative care and inevitably quality of life.

Developing Wireless Systems Measurement for Vital Signs

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(continuation...)
The NEW Biomedical Option for the BSEE degree

- The new BSEE curriculum in Electrical Engineering now includes a biomedical option that trains students in biology, medicine, and related engineering applications. This option helps prepare students for medical school, graduate school, or for employment in the health-care industry.

- Students interested in the Biomedical option take BSC 2010 Integrated Principles of Biology I instead of Chemistry II. The first EE course in the option is EEE 4265C Bioelectrical Systems, created by ECE Professor Karim Oweiss. The course covers the theoretical and quantitative perspectives of bioelectrical signals reflecting the activity of the brain, the muscles, and the heart. Modeling and analyzing bioelectrical signals are discussed, as well as common clinical applications. At this time, the Biology 1 prerequisite is waived. After the Bioelectrical Systems course, students take at least two depth courses in the biomedical option, such as Bioinformatics, Neural Engineering and Neural Systems Modeling.

- There are many other ways for EE students to get exposure to biomedical applications. For instance, interested students are encouraged to participate in biomedical research with faculty members in ECE and in other departments. Students may sign up for course credit or get paid for their work in these research laboratories. Also, many students select biomedical topics for their final design project in the required EE Design course EEL 4924C.

- Dr. Y.K. Yoon presents hydration and concussion detection with smart mouthguard technology

- UF Undergrad shows young children how wireless devices transmit signals to computers

- The ECE Graduate Student Spring Showcase features ECE Ambassadors gator chomp

- ECE graduate student with Mike Robinson, NFL Superbowl winner, reviewing the smart mouthguard

- PhD Research student Meiyu Li works on noncontact radars for e-health
Ultra low-power devices for in-vivo or implantable applications are the wave of the future in biomedical electronics. At UF’s Department of Electrical and Computer Engineering, Dr. Rizwan Bashirullah is a pioneer in this area where he has utilized biomedical electronics in applications ranging from medication delivery systems to limb prosthetics and retinal prosthetics for the eye.

It is estimated that 125,000 people die annually because they do not follow the correct dosage of medications prescribed by their doctors and almost one tenth of hospital admissions are associated with this non-adherence at a cost of $15.2 billion dollars annually. Bashirullah has developed a miniature, low cost electronic transponder that reliably detects orally ingestible electronic pills (e-pills). The e-pill monitors dosage levels based on percent of doses taken over a period of time. The e-pill has applications for geriatric medicine, mental health and addiction treatments, and pharmaceutical clinical trials.

According to a 2015 report of the Department of Defense (DoD) over 1,645 soldiers have suffered major limb amputations during the Iraq and Afghan wars. This summer, the Defense Advanced Research Projects Agency (DARPA) an agency of the DoD awarded Bashirullah and his team a $5.4 million dollar contract to develop an implantable neural interface that can restore closed-loop coordination of motor commands. His team will use clinically established deep brain stimulation techniques to manipulate sensory nerves. More effective, real time bidirectional control of the prosthetic hand in real-time will be achieved with new state-of-the-art peripheral nerve interfaces with greater channel and electrode density, and information stability. Ultimately the DoD wants to provide military amputees with limbs that function naturally, so that they can return to a more normal life after they have suffered a catastrophic injury in combat.

Bashirullah leads the DARPA-sponsored HAPTI (Hand Proprioception & Touch Interfaces) project. In this project, Bashirullah and his team will extract voluntary motor command signals from muscles and nerves and provide tactile feedback and proprioceptive (the amputees own) feedback by patterned micro-stimulation of sensory nerves. More effective, real time bidirectional control of the prosthetic hand in real-time will be achieved with new state-of-the-art peripheral nerve interfaces with greater channel and electrode density, and information stability. Ultimately the DoD wants to provide military amputees with limbs that function naturally, so that they can return to a more normal life after they have suffered a catastrophic injury in combat.

Bashirullah first worked on biomedical electronics as a graduate student, when he contributed to the development of a retinal prosthetic device to help provide sight to subjects blinded from degenerative diseases, such as age-related macular degeneration (AMD) and retinitis pigmentosa (RP). The research eventually lead to the 2002, fi st human subject trials conducted by Second Sight, a biomedical start-up company located in Sylmar California.

**Figure 1(right):** A peripheral nervous system (PNS) electronic interface to enable bi-directional control of a mechatronic robotic hand.

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**Karim Oweiss, New Preeminence Hire in NeuroEngineering**

Karim Oweiss is a Professor of Electrical and Computer Engineering with appointments in Biomedical Engineering (BME) and Neuroscience at UF’s McKnight Brain Institute. Oweiss has developed a new course, EEE 4265C Bioelectrical Systems, the first course of the new Biomedical Option for undergraduate electrical engineers.

Over the past 15 years, Oweiss and his team have explored new techniques to advance our understanding of how the brain works and to translate this understanding to clinical applications of brain-machine interfaces (BMIs). These BMIs, which offer a direct communication path between the brain and an external device, assist and repair damaged human cognitive and sensorimotor functions.

For example, in a DARPA funded research project, Oweiss built a clinically viable BMI to help people with severe paralysis improve their quality of life. The research team focused on neural decoding—the ability to translate brain signals from people with spinal cord injury or amputation—into useful motor commands for dexterous control of artificial limbs, such as to grasp and manipulate external objects. In another project funded by the National Institute of Neurological Disorders and Stroke (NINDS), Oweiss’ team built miniaturized electronic chips fully implanted in the brain and programmed wirelessly to optimize the bidirectional communication between the patient’s brain and the machine.

More recently Oweiss and his team received another NINDS award (2015-2020) to close the BMI sensorimotor loop by making these implanted chips restore touch and proprioception—the sense that informs the brain about body movements in physical space—through artificial stimulation of brain areas associated with natural sensation and coordination of motor commands. His team will use clinically established deep brain stimulation techniques to manipulate the activity of neurons involved in these functions. Specifically, Oweiss will use optogenetics—an emerging tool that combines optics and genetics to probe neural circuits with millisecond precision—to examine specific cells involvement in these functions.

Principe has a long history of research in biosignal analysis and brain modeling, including the development of methods to quantify and predict epileptic seizures using the electroencephalogram (EEG). However, Principe has really made his mark in the development of artificial brain interfaces. He has been a pioneering leader in this field. Some of CNEL’s key milestones in the history of brain interfaces include:

History of CNEL
1990: CNEL developed and demonstrated the first brain computer interface (BCI), a cortical mouse using a NeXT computer.
2002: CNEL was part of the first large research initiative sponsored by DARPA for the development and validation of brain machine interfaces (BMIs) with implanted technology. The DARPA grant provided the opportunity to develop and compare multi-input multi-output (MIMO) linear and nonlinear models for motor BMI decoding, including low power miniaturized hardware development for real time processing of up to 100 channels of neural data.
2006: CNEL published the first book in Brain Machine Interface Engineering
2007: CNEL proposed a BMI based on reinforcement learning algorithms, which for the first time did not require the availability of a desired response to train the decoders. CNEL also envisaged and implemented the first workstation for neurophysiology data collection and close loop feedback using cloud computing, opening the neurophysiology laboratory to the world.
2012: CNEL helped develop bidirectional BMIs that not only decode motor intent but also encode sensory information in the brain via electrical stimulation. Instead of using traditional point process theory, they developed adaptive filters in functional spaces that are easier to train including the first recurrent adaptive filter in functional spaces that can be trained online.

Building on previous work, Principe and CNEL are currently involved in the HAPTIIX DARPA project with the goal of facilitating the control of bionic hands for amputees. Here, the interface is done at the peripheral nerve level, and the goal is to project the collected multichannel neuro spike trains to a subspace that spans the space of all possible movements that can be implemented by a biotic hand.

While BMIs remain a key focus, Principe and CNEL are using the knowledge gathered from the nervous system and computational neuroscience to address a wide range of research areas including information theoretic learning, neuromorphic engineering, and cognitive architectures for sensory processing.
Good news for those facing the nightly grind
Published: June 25 2015
A team of University of Florida students represent- ing the United States took a second-place prize in an international technology competition for its development of a smart mouth guard that dentists can use to diagnose and treat teeth grinding.

The team was led by Yong-Kyu “YK” Yoon, an associate professor of electrical and computer engineering, and Fong Wong, an associate professor in UF’s Restorative Dental Sciences Department and Craniofacial Center. They garnered the recognition at the International Contest of Applications in Nano/Micro Technologies in Anchorage, Alaska. The group was one of 19 finalist teams from 12 countries. More than 15,000 students from countries including China, Germany, Japan, Switzerland and New Zealand vied throughout the year for a berth in the finals.

The smart mouth guard is equipped with sensors that allow it to detect if you’re grinding your teeth, tell your dentist and even help you stop doing it. The prototype the team created does all of that and can send the information via Bluetooth to a computer or smart phone, where a dentist or orthodontist can retrieve it, make a diagnosis and suggest treatment.

An estimated 20 percent of the U.S. population – about 60 million people – suffer from teeth grinding, also known as bruxism, and most aren’t even aware they do it.

The next iteration, currently under development, could be aimed at athletes. Using different types of sensors, Yoon said, it could detect dehydration or dangerous core body temperature and alert a coach to pull a player off the field. That same information could be useful in protecting firefighters.

“We identified a niche market that’s in a very important area,” said Yoon, who also is director of the Multidisciplinary Nano and Microsystems Lab at UF.

The UF team took one of four second-place spots. The contest also awarded two first-places prizes, six third-places and four special (honorable) mentions.

Also serving as a team adviser with Yoon and Wong was electrical and computer engineering professor Huikai Xie. Student members of the UF team were Justin Correll and Tim Ajmani, electrical and computer engineering undergraduates; Troy Templin, a biomedical engineering undergraduate; and Sheng-Po Fang, a graduate student in electrical and computer engineering.

Credits
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Innovative Inventions
Biomedical Electronics/Wearable Technology

SMART GUARD

Mike Robinson (Orange Bowl winner) with Dr. Y.K. Yoon, discussing smart-guard technology for detection of dehydration and concussio.
Reliable, efficient, and cost-effective power systems are required for everything from micro-Watt implanted biomedical devices to large MegaWatt data centers. Without exaggeration, sustainable energy and power systems are fundamental for the future of the planet. With the preeminence funding from the state of Florida, ECE was able to hire two excellent faculty who will lead our power program: Shuo Wang (PhD 2005) is an expert in power electronics, electrical power, electric vehicles, and integration of renewable energy sources with smart grid. He has received over $1.6M in research funding including as NSF CAREER Award. He has published over 110 journal and conference papers with three IEEE paper awards. He holds 7 U.S. patents and he is an Associate Editor for the IEEE Transactions on Industry Applications.

Arturo Bretas (PhD 2001) is an expert in power and distribution systems protection, reliability optimization and restoration, renewable generation and distribution systems operation, power systems dynamics and control, and applications to the smart grid. He received over $20M in research funding while at Federal University of Rio Grande do Sul in Brazil. He has published over 175 journal and conference papers.

These hires will not only help us build up the power area within ECE, but collaborations will enhance every other research area of ECE including the smart grid, green computing, power system security, and power efficient electronics and devices. Furthermore, UF has existing strengths in solar energy systems, novel energy conversion cycles, and energy systems control and optimization. With these hires and other preeminent hires within the college, we hope to combine these existing strengths into integrated, multidisciplinary systems-level research, achieving true national prominence for UF in sustainable energy systems.
Students who receive a 3.9 or higher GPA are eligible for the Electric “E” and Computer “E” awards. Pictured above in left photo: (left to right) Austin Bruch, Forrest Voight, Dr. Herman Lam, Kyle, Kryazis, Nicholas Evans and Daniel Rincon. Pictured above on right: Riley Duff, Mihalo Zivkovic, Dr. Harris, Forrest Voight, Keettana Settaluri, Troy Bryant. Not in photo—Nicholas Cox, Eric Schwartz.

The UF Team above won the NSF I-Corps Top Team Award among the 2015 Winter Cohort in San Francisco. The UF team consists of Kaikai Liu (center) as the Entrepreneurial Lead, (left to right) Erik Sander as the Mentor, and Andy Li as the Principal Investigator.

Nicole Barbier

I joined the department in May 2015 as a Grants Assistant. I am a Florida native, born and raised in Ft. Lauderdale. I have a B.A. in English, a specialization in British Literature, and taught secondary English in South Florida until deciding to go back to school for a Masters degree. I later graduated from UF with a M.Ed. in Educational Leadership. While completing my Masters degree, I fell in love with not only UF and Gainesville but my future husband, making me a permanent resident. I have a background in HR, specifically compliance and international relocations, and Finance, AR, AP and general accounting. I am an avid reader, my favorite book is Pride and Prejudice, and enjoy home renovation projects.

Cherrie Hughes

Cherrie Hughes is a native Washingtonian but proud to now be a part of the Gator Nation! As project manager for a translational and economic development program, Maryland Industrial Partnerships (MIPS) at the Maryland Technology Enterprise Institute (MTECH) in the A. James Clark School of Engineering at the University of Maryland she mentored startup companies, managed technical projects, tracked and created financial and administrative operations for the Program. Prior to this she served as Associate Director of the Supply Chain Management Center for six years in the Robert H. Smith School of Business at the University of Maryland. She joined the MIST Center in November 2014. She enjoys learning about craft beers with her husband, singing and traveling with the internationally acclaimed St. Augustine Gospel Choir (Washington, DC) and managing the academic and social careers of her two kids Rory 7 and Harper 3.

Limor Herb

Limor Herb joined our department in March 2015 as a Fiscal Assistant. She is a marketing professional with 20 years of experience in the field of program development and administration. She has been a Mosaic art instructor here in Gainesville since 2005. As the Gainesville Fine Arts Association volunteer Social Media Director she is dedicated to revitalizing the downtown arts district. You could find her art work here in Gainesville’s Smokey Bear Park, and her current project “TREE OF LIFE” will be featured in the downtown area. She is a trilingual mom whose hobbies are creating and directing art festivals and surfing.
Thank You.

You help students. You make an impact.

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