

Electrical and Computer Engineering
Newsletter Fall 2023

THE FUTURE IS WHAT WE DO

ENGINEERED FOR
WHAT'S NEXT.



Cullen College of Engineering
UNIVERSITY OF HOUSTON

Letter from the Chair



Dear Colleagues,

I hope that you are well. I invite you to explore this newsletter and our department's website at your leisure to see all the exciting things we are working on. We are a very future-focused department, and our faculty continue to see national recognition and we are actively producing top-quality research initiatives, such as building more reliable electrical systems, developing noninvasive brain-machine interfaces, creating the next-generation artificial intelligence system to improve medical diagnostics and more.

I hope that you enjoy reading through this sampling of our recent research, and if any of these projects strike your fancy, do not hesitate to reach out to me about collaborative opportunities. Let us continue working towards creating a better, more dynamic future!

Warm Regards,

Badri Roysam, Ph.D.

Member, ECEDHA Board of Directors
Hugh Roy and Lillie Cranz Cullen University Professor & Chair
Electrical & Computer Engineering Department
University of Houston

UH ECE BY THE NUMBERS

DEGREES AWARDED (FY2023)

 **121** B.S.

 **90** M.S.

 **24** Ph.D.

ENROLLMENT (FALL 2023)

923 UNDERGRADUATE STUDENTS

327 GRADUATE STUDENTS

 **3** NATIONAL ACADEMY OF ENGINEERING MEMBERS

 **3** NATIONAL ACADEMY OF INVENTORS FELLOWS

CPRIT **2** CANCER PREVENTION AND RESEARCH INSTITUTE OF TEXAS MEMBER

 **8** INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS FELLOWS

 **3** American Institute for Medical and Biological Engineers FELLOWS

 **2** SOCIETY FOR AUTOMOTIVE ENGINEERING FELLOWS

 **1** AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE FELLOW

 **11** NATIONAL SCIENCE FOUNDATION CAREER AWARDEES

 **1** ROYAL SOCIETY OF CHEMISTRY (UK) FELLOW

SPIE. **1** INTERNATIONAL SOCIETY FOR OPTICS AND PHOTONICS FELLOW

OSA **1** OPTICAL SOCIETY OF AMERICA FELLOW

 **1** AMERICAN PHYSICS SOCIETY FELLOW

 **1** ELECTROCHEMICAL SOCIETY FELLOW

NEW RESEARCH FUNDING



Pictured: Hien Van Nguyen in research laboratory.

ELECTRICAL AND COMPUTER ENGINEERING

\$3 MILLION GRANT AWARD TO DEVELOP AN AI SYSTEM TO ANALYZE BIOPSY RESULTS



In the ever-perilous autoimmune disease world of systemic lupus erythematosus (SLE or lupus), up to 60% of adult patients and 80% of children will develop lupus nephritis (LN), and up to half of those will move on to end-stage renal disease. LN occurs when the immune system wrongly attacks the kidneys, preventing them from doing their job, i.e., cleaning blood, balancing body fluids and controlling hormones that impact blood pressure.

Unfortunately, the most precise way to diagnose LN hasn't been all that precise. The kidney biopsy, which in itself is a painful ordeal, reaches a tipping point at the time doctors must read the biopsy report. Historically those interpretations have been imprecise and marked by significant disagreement among pathologists reading the same thing.

Enter artificial intelligence, which combines computer sci-

ence and robust datasets to enable problem-solving, and **Hien Van Nguyen**, Associate Professor of Electrical and Computer Engineering at the University of Houston's Cullen College of Engineering, has received a \$3 million grant from the National Institute of Diabetes and Digestive and Kidney Diseases to bring AI into the diagnostic picture.

This funding allows Nguyen to use artificial intelligence approaches to train a 'neural network' to learn how to read and classify lupus nephritis biopsy slides. The goal of using AI to classify lupus nephritis in an automated fashion with high accuracy will translate to better treatment for lupus nephritis. ⚙️

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Pictured: Aaron Becker in ECE drone laboratory.

\$1.7 MILLION GRANT AWARD TO DEVISE COORDINATED CONTROL OF DRONE SWARMS



As low-cost drones have proliferated worldwide, they are tasked with a variety of objectives, including remote sensing, situational awareness, material delivery and as communication relays. Heady stuff, even military in nature, prompting the deployment of not a single drone at a time, but rather, swarms of drones to complete tasks.

But as their importance and numbers have soared, their swarm mechanics have remained largely dormant. While it is now possible to fly large numbers of drones in sync, these swarms are preprogrammed by teams of animators and are refined with hours of computer simulations.

Aaron Becker, associate professor of electrical and computer engineering, who is working to refine algorithms to apply those same theories to devise coordinated control of drone

swarms to improve their fleet-like delivery of services. His work is supported by the commitment of a \$1.7 million grant from Kostas Research Institute at Northeastern University, LLC. “We want our swarms to behave optimally yet respond fluidly to changes in the environment. We aim to use computation on drones to locally make smart decisions, relay that information to the operator’s computer to make clear visualizations, and let the human operator make high-level decisions”

Two initial application scenarios will be studied. The first scenario is aerial sensing of a forest fire, where the drone swarm must both track the fire and relay communications to firefighters. The second scenario is for aerial security coverage of a commercial facility and campus. Drones must escort vehicles that enter and leave the campus, but each drone has limited battery life and must recharge when batteries are depleted. ⚙️

NEW RESEARCH FUNDING

*Pictured bottom:
Xiaonan shan*



\$700,000 RESEARCH PROJECT FOCUSING ON HOW **UNDERSERVED FARMERS CAN IMPROVE CROP, IMPACT CLIMATE CHANGE**

University of Houston researchers are developing a program to teach small-scale, underserved and limited resources (SULR) farmers how to improve their crop production by reducing greenhouse gas emissions and increasing carbon removal.

The work is supported by a nearly \$5 million grant from the US Department of Agriculture (USDA) Natural Resources Conservation Service. Researchers will partner with colleagues from Prairie View A&M University, Texas A&M University and Michigan Aerospace Corp. to study how best to implement a Climate-Smart Sustainability Certificate program for SULR farmers. UH research projects will receive almost \$700,000.

Assistant professor **Xiaonan Shan**, of Electrical and Computer Engineering Department, is one of the Co-PI's on the project that will focus on existing practices that protect the soil from erosion, pests, weeds and diseases, while increasing soil fertility and reducing greenhouse gas emissions. ⚙️

PIEREMANUELE CANEPA



Pieremanuele Canepa, joined the department this Fall as an assistant professor. Canepa earned his doctorate in chemistry from the University of Kent in the United Kingdom. Since 2018, he has been an assistant professor at the National University of Singapore. In 2022, he was named a Rising Star by the American Chemical Society.

NEW

FACULTY

NEW

FACULTY

CHU MEH CHU



Chu Meh Chu, joined the department this Fall as a senior lecturer. Chu earned his doctorate from the Georgia Institute of Technology in 2015. Chu is a machine learning expert with research, teaching and work experience in data visualization using data compression tools.

NEW

FACULTY

SEBASTIAN CSUTAK



Sebastian Csutak, joined the department this Fall as a lecturer. Csutak earned his doctorate in Electrical and Computer Engineering from the University of Texas at Austin. For the past two years, he has worked as an adjunct professor in the Department of Physics at Texas Southern University. He has a strong IP record, with 45 U.S. patents, and has worked for Baker Hughes, Aramco, Motorola and IBM.

NEW

FACULTY



Jianfeng Zheng, joined the department this Fall as an assistant professor, starting Sept. 2023. Zheng has been working at UH since 2012, first as a postdoctoral fellow and then as a research assistant professor. Along with Ji Chen, he has landed four grants for their work on electrical devices. Zheng earned his doctorate in 2009 from Tsinghua University in Beijing.

NEW DOCTOR OF PHILOSOPHY DEGREE IN COMPUTER ENGINEERING



LEARN MORE AND APPLY TODAY AT:
WWW.ECE.UH.EDU/GRADUATE

ELECTRICAL AND COMPUTER ENGINEERING



The Computer Engineering Ph.D. program will provide students with a doctoral-level education in Computer Engineering in preparation for successful academic, national laboratory, or industrial research and development careers in computer software and hardware.

Students in this program will be prepared in these vital areas: advanced software and hardware design, integrated systems, artificial intelligence, networking and cybersecurity and more.

This new Ph.D. program will be administered as a graduate research program within the Cullen College of Engineering's Department of Electrical and Computer Engineering (ECE). ⚙️

NATIONAL RECOGNITION

HARISH KRISHNAMOORTHY

WINNER OF THE



FROM THE NATIONAL SCIENCE FOUNDATION



ELECTRICAL AND COMPUTER ENGINEERING



A University of Houston professor in the Department of Electrical Engineering has earned the prestigious National Science Foundation CAREER Award.

Harish Krishnamoorthy, Assistant Professor of Electrical and Computer Engineering for his game-changing research focusing on the reliability and safety for large-scale converter applications in power electronics.

Krishnamoorthy, who is also associate director of the Power Electronics, Microgrids and Subsea Electric Systems Center (PEMSEC) at UH, has focused his career and research on high-density power conversion for grid interface of energy systems, machine learning-based methods for improving the quality and reliability of power electronics, advanced electronics and control for mission-critical applications.

His other 2023 accolades include the IEEE Power Electronics Society (PELS) Young Professional Exceptional Service Award and an Early-Career Research Fellowship (ECRF) from the U.S. National Academies (NASEM) Gulf Research Program.

In 2020, Krishnamoorthy received more than \$1.1 million from the U.S. Department of Defense to develop compact electric power systems for radar and other equipment, and in 2022 he won a \$1 million grant from the U.S. Department of Energy (ARPA-E) to build state-of-the-art power conversion systems for high-temperature applications such as downhole oil and gas.

He was also recognized as a 2022 OTC Emerging Leader and was selected to participate in the National Academy of Engineering's Grainger Foundation Frontiers of Engineering 2022 U.S.-based symposium. ⚙️

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Pictured: Portable at-home stroke rehab gear developed in the lab of Jose Luis Contreras-Vidal, director of the UH BRAIN Center. At left, the headset developed for the project controls the robotic arm, or exoskeleton, at right.

ELECTRICAL AND COMPUTER ENGINEERING

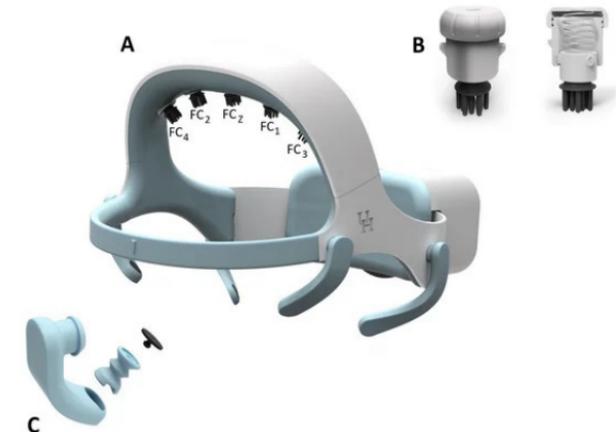
SENORS JOURNAL FEATURES PORTABLE EEG HEADSET FOR STROKE REHABILITATION

The world of at-home stroke rehabilitation is growing near, incredible news for the 795,000 people in the United States who annually suffer a stroke. A new low cost, portable brain-computer interface that connects the brain of stroke patients to powered exoskeletons for rehabilitation purposes has been validated and tested at the University of Houston.

Jose Luis Contreras-Vidal, Hugh Roy and Lillie Cranz Cullen Distinguished Professor of electrical and computer engineering, reports in the journal *Sensors*, “ We designed and validated a wireless, easy-to-use, mobile, dry-electrode headset for scalp electroencephalography (EEG) recordings for closed-loop brain-computer (BCI) interface and internet-of-things (IoT) applications.” Contreras-Vidal is an international pioneer in noninvasive brain-machine interfaces and robotic device inventions.

An EEG-based brain-computer interface (BCI) is a system that provides a pathway between the brain and external devices by interpreting EEG. In other words, the device reads your mind, interpreting the brain’s activity to initiate robotic movement. Brain-machine interfaces based on scalp EEG also have the potential to promote cortical plasticity following stroke, which has been shown to improve motor recovery

outcomes. “We used a multi-pronged approach that balanced interoperability, cost, portability, usability, form factor, reliability and closed-loop operation,” said Contreras-Vidal. A portable and wireless BCI system is highly preferred so it can be used outside lab in clinical and non-clinical mobile applications at home, work, or play.” ⚙️



Pictured: Fully assembled one-size-fit-all (patent pending) headset design.



AI-FOCUSED STRUCTURED RESEARCH

FEATURED IN THE JOURNAL ADVANCED ENGINEERING INFORMATICS

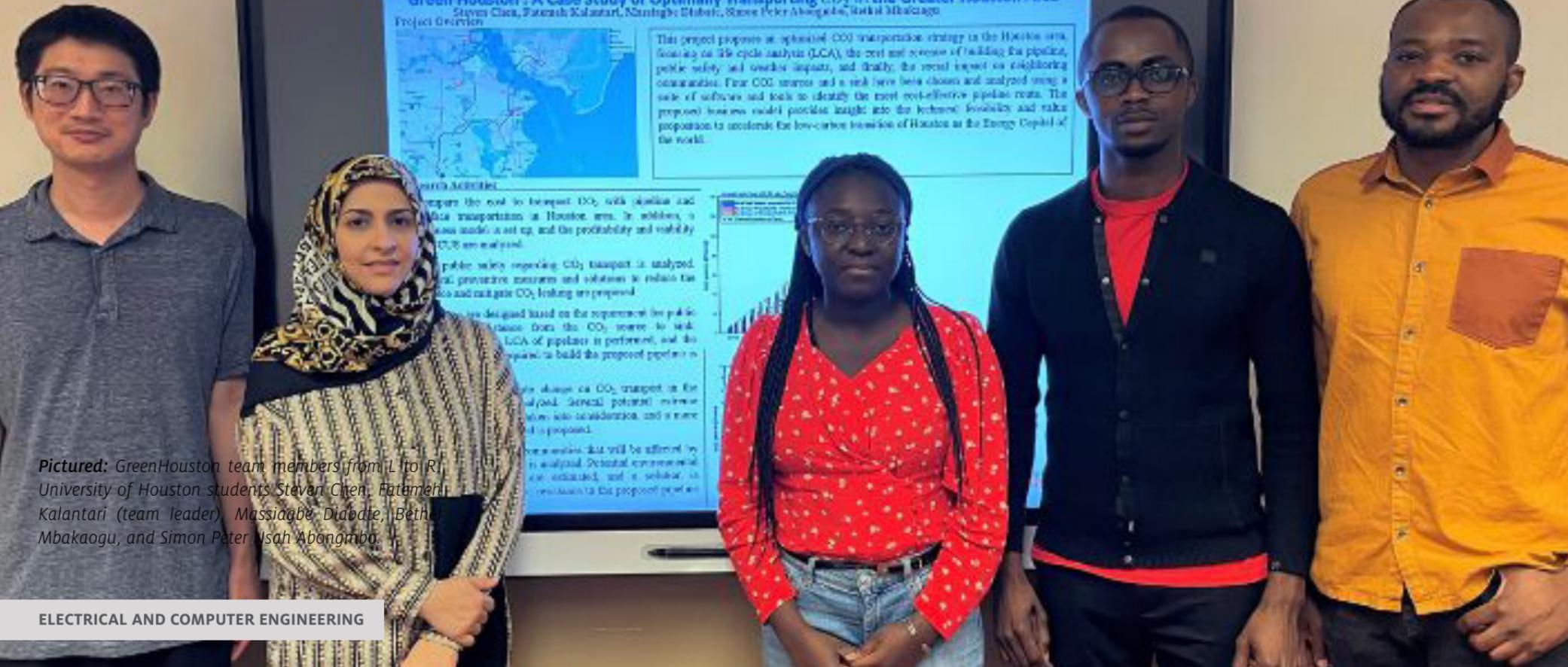
After natural disasters, many people are understandably worried about the potential for structural damage to their homes. The research work of a Cullen College of Engineering Ph.D. student and his advising professor aims to provide them with another tool for identifying that damage.

Subin R. Varghese, an Electrical and Computer Engineering Department student, is an author of “Unpaired image-to-image translation of structural damage.” The paper was published in *Advanced Engineering Informatics* in April 2023. Varghese is advised by Vedhus Hoskere, assistant professor in the Civil and Environmental Engineering Department.

Varghese notes that by using AI, potential damage following natural disasters and other weather-related events could be detected. This is especially important because of the strain on inspectors and emergency personnel after these events. ⚙️

Pictured: Subin R. Varghese

STUDENT SUCCESS



Pictured: GreenHouston team members from L to R: University of Houston students Steven Chen, Fatemeh Kalantari (team leader), Massagbe Diabate, Bethel Mbakaogu, and Simon Peter Usah Abongimbo.

ELECTRICAL AND COMPUTER ENGINEERING

UH ECE STUDENTS SHINE IN **DOE'S AMERICAN-MADE CARBON MANAGEMENT COMPETITION**

GreenHouston, a team of University of Houston students mentored by Assistant Professor **Jian Shi** from the UH Cullen College of Engineering, created a winning proposal for an optimized carbon dioxide transportation pipeline specifically tailored for the Houston area.

The team's strategy, which factored in cost analysis, revenue potential, safety considerations, weather hazards and social impact on neighboring communities, addressed complex challenges surrounding carbon management and won third place in the first American-Made Carbon Management Collegiate Competition.

The team plans to use the cash award to grow their project through additional research, refining existing technologies, addressing remaining challenges and raising awareness of CCUS and its project. ⚙️

STUDENT SUCCESS



ELECTRICAL AND COMPUTER ENGINEERING

UH ECE DEPARTMENT HOSTS IEEE-HKN STUDENT LEADERSHIP CONFERENCE

More than 250 people flocked to the Cullen College of Engineering at the University of Houston in early November, as the Electrical and Computer Engineering Department hosted the 2003 IEEE-HKN (Eta Kappa Nu) Student Leadership Conference.

The overarching mission and vision of the IEEE-HKN is to recognize excellence in scholarship, attitude and character. The leadership conference serves as the hallmark event for these goals.

The event focuses on training for Chapter leaders, individual and professional development, technical sessions, and networking to bring together members from around the world and encourage inter-chapter activity and cooperation.

This year's event featured sessions on community service, planning a career path for future job opportunities, and alumni talking about the things overlooked during undergrad and the next steps in grad school.

For more information about IEEE-HKN, visit its website.

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CULLEN

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The University of Houston

Cullen College of Engineering

The University of Houston Cullen College of Engineering addresses key challenges in energy, healthcare, infrastructure, and the environment by conducting cutting-edge research and graduating hundreds of world-class engineers each year. With research expenditures topping \$40 million and increasing each year, we continue to follow our tradition of excellence in spearheading research that has a real, direct impact in the Houston region and beyond.

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The Future 
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