

Electrical and Computer Engineering
Newsletter Spring 2024

**THE FUTURE
IS WHAT WE DO**

**ENGINEERED FOR
WHAT'S NEXT.**



Cullen College of Engineering
UNIVERSITY OF HOUSTON

Letter from the Chair



Dear Colleagues,

Salutations from Houston!

Please join me in congratulating Professor Ji Chen on becoming our newest IEEE Fellow, Professor Zhu Han on becoming our first ACM Fellow, and Professor Xingpeng Li on becoming our newest NSF CAREER Awardee. The past year has been impactful, as our research expenditures exceeded \$10M, our citations approached 25,000, enrollments continued to grow across all three of our campuses (UH main, UH at Katy, and Dalian (China).

Our faculty continued to excel in research and teaching innovation across the board in diverse areas including advanced battery technology, brain-machine interfaces, subsea robotics, AI systems for biomedicine, implanted device engineering, and cancer detection, to name a few. I hope that you enjoy reading through this sampling of our recent research, and if any of these projects spark interest, do not hesitate to reach out to me about collaborative opportunities.

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.

 **180** M.S.

 **24** Ph.D.

ENROLLMENT (FALL 2023)

923 UNDERGRADUATE STUDENTS

327 GRADUATE STUDENTS



3 NATIONAL ACADEMY OF ENGINEERING MEMBERS



2 SOCIETY FOR AUTOMOTIVE ENGINEERING FELLOWS

OSA **1** OPTICAL SOCIETY OF AMERICA FELLOW



3 NATIONAL ACADEMY OF INVENTORS FELLOWS



1 AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE FELLOW



1 AMERICAN PHYSICS SOCIETY FELLOW



2 CANCER PREVENTION AND RESEARCH INSTITUTE OF TEXAS MEMBER



13 NATIONAL SCIENCE FOUNDATION CAREER AWARDEES



9 INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS FELLOWS



1 ROYAL SOCIETY OF CHEMISTRY (UK) FELLOW



1 ELECTROCHEMICAL SOCIETY FELLOW

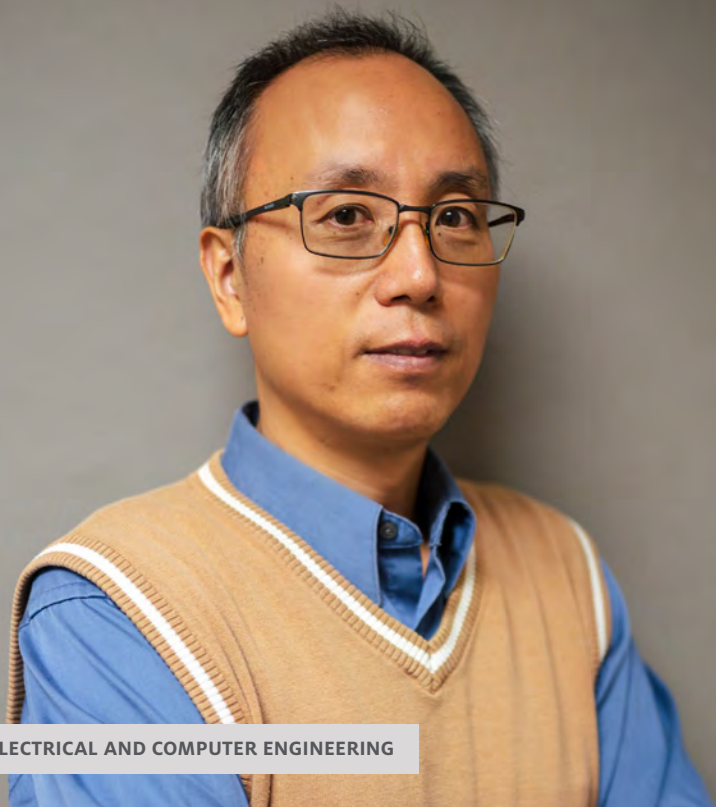


3 American Institute for Medical and Biological Engineers FELLOWS



1 INTERNATIONAL SOCIETY FOR OPTICS AND PHOTONICS FELLOW

*Pictured left to right:
Jiming Bao and Zhu Han*



ELECTRICAL AND COMPUTER ENGINEERING



REPEAT! UH ECE PROFESSORS NAMED MOST CITED IN THE WORLD

For the second straight year, UH ECE Professors **Jiming Bao** and **Zhu Han**, are among the world's elite researchers for their significant and broad influence of their scientific work. The annual Clarivate list of Highly Cited Researchers includes global research and social scientists whose published academic papers rank in the top 1% of citations for field and publication year. Jiming Bao has been cited 18,510 times and has an H-Index of 58. His work covers nanomaterials, biomedical sensing and therapeutics, energy harvesting and storage, optoelectronics and photonics. Zhu Han has been cited 40,000 times and has an H-Index of 83. He researches wireless resource allocation and management, wireless communications and networking, game theory, big data analysis, machine learning, security, quantum computing, carbon neutralization and smart grid technology. ⚙️

NATIONAL RECOGNITION

JIAN SHI

WINNER OF THE

2024
FACULTY EARLY CAREER
DEVELOPMENT (CAREER)
AWARD

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.

Jian Shi, Assistant Professor with a dual appointment to the Engineering Technology and Electrical and Computer Engineering departments for his game-changing research focusing on facilitating the transition to renewable energy, by reducing the short-term and long-term social costs of decarbonization.

Shi is the director and founder of SOAR, the Smart and Zero-Carbon Energy Analytics and Research Lab at UH, has focused his career and research developing new carbon-driven mechanisms, methodologies and algorithms into the existing power grid operation conventions to accommodate and accelerate the process of decarbonization, while maintaining its desired operational characteristics and societal responsibilities.

Besides research, another key aspect of my CAREER proposal is to train the next-generation energy workforce and prepare them to understand, engage in and ultimately lead the energy transition in the decades to come. As a Hispanic-serving institution with a diverse student body, UH has provided excellent opportunities for me to engage and train students from all backgrounds, especially Hispanic and Asian American students, to foster a more diversified and vibrant workforce in the future energy industry.

The award runs through February 2029, with \$500,861 in funding. ⚙️

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NATIONAL RECOGNITION

XINGPENG LI

WINNER OF THE



2024
FACULTY EARLY CAREER
DEVELOPMENT (CAREER)
AWARD



FROM THE NATIONAL SCIENCE FOUNDATION



ELECTRICAL AND COMPUTER ENGINEERING



In the race to achieve a net-zero future based on clean energy, renewable energy sources like solar and wind power have emerged as potential champions in the battle against climate change. However, as traditional synchronous generators are replaced by inverter-based renewable energy resources, the transition creates a low-inertia challenge within the existing power grids leading to stability and reliability concerns.

Xingpeng Li, assistant professor of electrical and computer engineering at the University of Houston, is working on a solution that will allow seamless integration of renewable energy sources with the rest of the power grid without causing any problems. He received a National Science Foundation CAREER Award for his proposal "Frequency-Constrained Energy Scheduling for Renewable-Dominated Low-Inertia Power Systems." The goal of the project is to ensure that evolving power systems can continue to operate efficiently and stably while supporting fast-growing wind and solar generation.

Li and his research team will use machine learning to create more efficient and less complicated dynamic performance models and then integrate these models into the day-ahead scheduling application used by grid operators to schedule all the generating resources for the next operating day.

Li's research interests include planning and operations of various power energy systems including bulk power grids and microgrids. He leads the Renewable Power Grid (RPG) Lab at UH. He is also the Associate Director of the Power Electronics, Microgrids & Subsea Electrical Systems Center (PEMSEC) at UH. ⚙️

NATIONAL RECOGNITION



Pictured: Jinghong Chen

ELECTRICAL AND COMPUTER ENGINEERING

JINGHONG CHEN HAS BEEN NAMED SENIOR MEMBER OF THE NATIONAL ASSOCIATION OF INVENTORS

Jinghong Chen, an associate professor in the University of Houston's Cullen College of Engineering, has been named a Senior Member of the National Academy of Inventors (NAI) from the U.S. Department of Energy (DOE) to explore ways to prolong the life of such assets by repurposing them for clean energy projects like wind power, hydrogen generation, and carbon sequestration.

Chen is a world-renowned expert in high-speed and radio-frequency integrated circuit technologies. He holds 10 U.S. patents and several of his inventions have been commercially licensed.

"I deeply appreciate my colleagues for their great support and inspiration on technology innovation," Chen said. "This recognition motivates me to keep working hard on the disclosure of intellectual property, mentoring innovative students and translating our inventions to benefit society."

NAI Senior Members are active faculty, scientists, and administrators from NAI member institutions who have demonstrated remarkable innovation producing technologies that have brought, or aspire to bring, real impact on the welfare of society. They also have growing success in patents, licensing, and commercialization, while educating and mentoring the next generation of inventors.

"We proudly celebrate the well-deserved induction of our esteemed colleague, Jinghong Chen, as a Senior Member of the National Academy of Inventors," said Ramanan Krishnamoorti, vice president of energy and innovation at UH. "This honor not only recognizes Professor Chen's achievements but also reflects the University of Houston's commitment to groundbreaking research and innovation. Together, we are shaping a future where innovation knows no bounds." ⚙️



JI CHEN
EARNS IEEE FELLOW
DISTINCTION

Ji Chen, a professor in the Electrical & Computer Engineering Department and the Houston site director of the NSF I/UCRC Center for EMC Research, was elevated to Fellow elected as a Fellow of the Institute of Electrical and Electronics Engineers, one of the highest honors of distinction provided by the organization.

Chen was recognized as being one of the top researchers in the area of EM modeling and measurements for MRI device safety. Less than 0.1 percent of IEEE voting members are selected annually for the Fellow distinction. He is the only member of the faculty to earn this distinction this year.

He has been a long-time member of the IEEE, and he has served the organization with distinction. He earned Senior Member status in 2008, which was followed by the APMC 2008 Best Paper Award, EMC Society Distinguished Lecturer for 2009-10, and the EMC Society Technical Achievement Award in 2011. Since 2017, he has also served as an associate editor for IEEE Transactions on Electromagnetic Compatibility. ⚙️



ZHU HAN
EARNS ACM
FELLOW DISTINCTION

A professor from the Cullen College of Engineering's Department of Electrical and Computer Engineering is part of one of 20 teams or individuals chosen for the 2022 Accelerator for Cancer Therapeutics annual cohort.

According to Texas Medical Center Innovation (TMCi), the effort is comprised of Texas-based startups working to address the world's most significant cancer challenges with novel technologies and treatments. As the innovation hub of the Texas Medical Center, TMCi spearheads the Accelerator for Cancer Therapeutics, funded by the Cancer Prevention and Research Institute of Texas (CPRIT) in association with the Gulf Coast Consortia (GCC) and the University of Texas Medical Branch (UTMB).

Wei-Chuan Shih, Ph.D., along with Dr. Steven Lin of M.D. Anderson Cancer Center, are part of the 2022 cohort. Shih is a Cullen College of Engineering Professor in the Electrical and Computer Engineering Department. They were chosen to further develop Scenexo as part of the nine months of clinical and business development education and advisement they will receive from the accelerator program. ⚙️



Pictured: Hien Van Nguyen in research laboratory.

\$750K GRANT AWARD DEVELOP A COMPREHENSIVE ROADMAP FOR REPURPOSING OFFSHORE INFRASTRUCTURE FOR CLEAN ENERGY



The Gulf of Mexico is home to more than 1,500 platforms, 14,000 wells and 10,000 miles of pipelines. Once these assets reach the end of their fossil energy use, they are decommissioned – usually meaning plugged and abandoned wells, as well as pipeline and

equipment that are taken apart and brought back to shore or sunk to the ocean floor.

The U.S. Department of Energy (DOE) recently announced \$17.4 million funding for 19 early-stage research projects focused on expanding clean energy technologies at colleges and universities across America. These projects will establish visiting scholars' programs, create new academic curricula related to geosciences, and provide interdisciplinary training in humanities-driven science, technology, engineering, and mathematics fields.

Harish Krishnamoorthy, associate professor of electrical and computer engineering, at The University of Houston Cullen College of Engineering has received \$749,992 in funding from the U.S. Department of Energy (DOE) to explore ways to prolong the life of such assets by repurposing them for clean energy projects like wind power, hydrogen generation, and carbon sequestration.

The study will create a detailed plan covering technical, social, and regulatory aspects, as well as available resources. It will also identify community resources, government incentives, legal requirements, and industry concerns. The aim is to help communities, investors, and industry to engage in such projects. ⚙️



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. ⚙️

Pictured: Cell phones and TV signals have jammed the wireless spectrum to the point that there's really no spectrum left. Photo courtesy: Baylor University

UH JOINS NEW SMART HUB, A \$5M DEPARTMENT OF DEFENSE CONSORTIUM **SOLVING TOMORROW'S WIRELESS SPECTRUM ISSUES TODAY**


To tackle the challenges of a shrinking wireless spectrum, the University of Houston has joined the Spectrum Management with Adaptive and Reconfigurable Technology (SMART) Hub – a Department of Defense Spectrum Innovation Center to conduct multifaceted spectrum research to meet national defense needs.

The center, led by Baylor University, is a collection of researchers, engineers and economic and policy experts looking to enact a paradigm shift in the use and management of the wireless spectrum. At the University of Houston, David Jackson, professor of electrical and computer engineering; Zhu Han, Moores Professor of electrical engineering are joining forces to serve on the SMART Hub. The trio will produce strategies for enhanced communication in complex environments, like forests, inner city environments, mountainous terrains or regions having electromagnetic interference. ⚙️

Pictured: Zhu Han



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). ⚙️



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

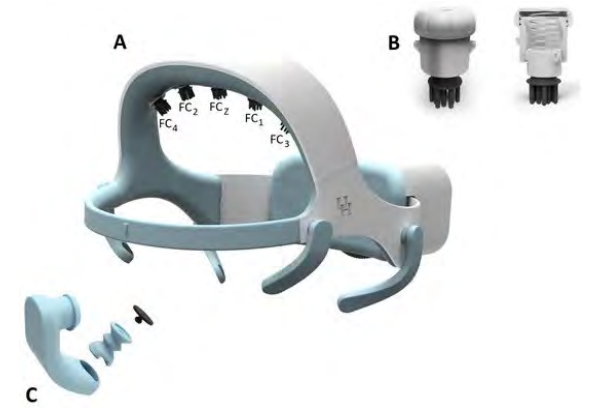
SENSORS JOURNAL FEATURES PORTABLE EEG HEADSET FOR AT-HOME STROKE REHABILITATION

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:** Yuan Zi is studying in the Electrical and Computer Engineering Department at the Cullen College of Engineering. He was chosen for a 2023 summer internship, and completed it with the industrial AI team at the ABB Corporate Research Center in Germany, under the mentorship of Ralf Gitzel, Ph.D.*

ELECTRICAL AND COMPUTER ENGINEERING

CULLEN COLLEGE

UH ECE PH.D. STUDENT ZI THRIVES DURING RISE INTERNSHIP

An engineering student completing his doctorate at the University of Houston was honored by being selected for a Research Internships in Science and Engineering (RISE) Professional summer research internship in Germany.

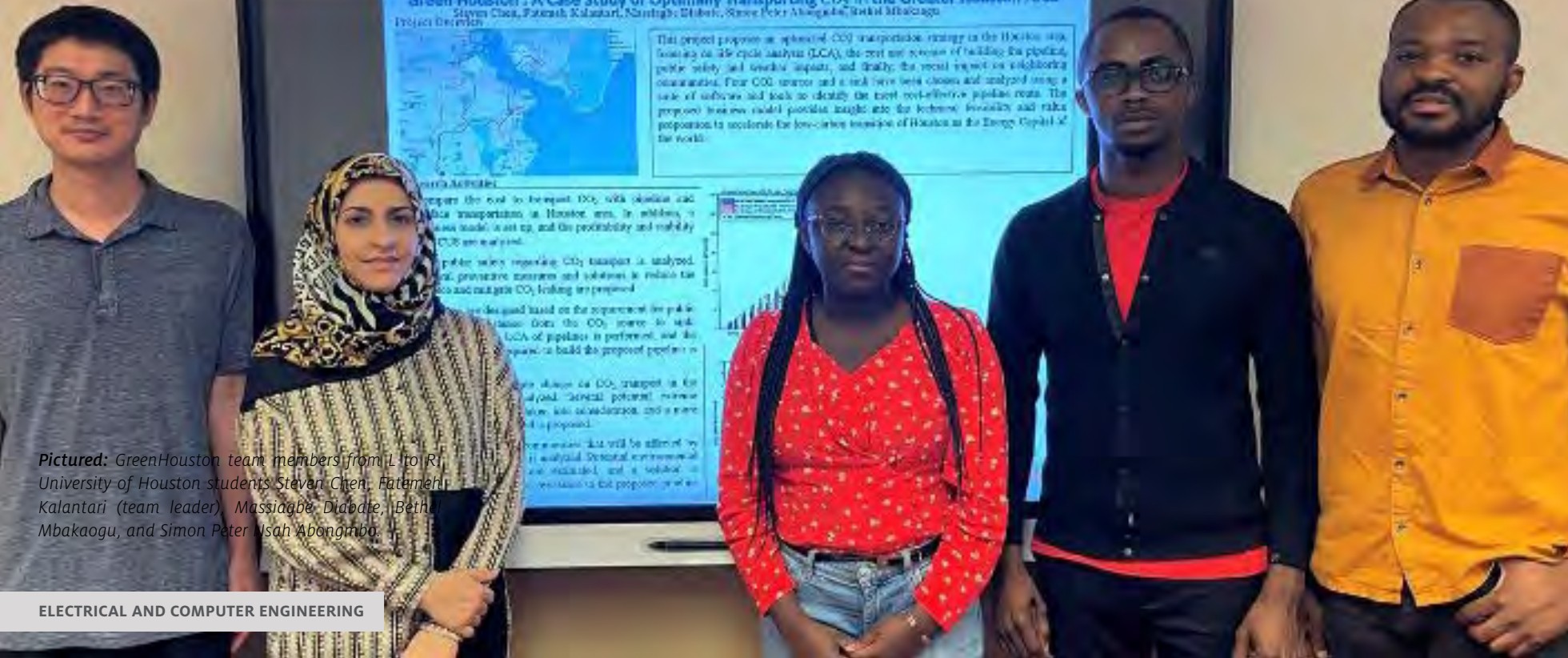
Yuan Zi is studying in the Electrical and Computer Engineering Department at the Cullen College of Engineering. He was chosen for a 2023 summer internship, and completed it with the industrial AI team at the ABB Corporate Research Center in Germany, under the mentorship of Ralf Gitzel, Ph.D.

“It was an incredible experience, working alongside domain experts and data scientists who had dedicated years to solving complex problems,” he said. “This internship provided me with a multitude of positive experiences that I hold close to my heart.”

Zi is scheduled to graduate in 2024. He is looking for work that will allow him to apply his diverse skill set and knowledge base. He also encouraged both graduate and undergraduate students to apply for RISE internship opportunities. It has led to networking opportunities, as well as professional and personal development for him. ⚙️

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STUDENT SUCCESS



Pictured: GreenHouston team members from L to R: University of Houston students Steven Chen, Fatemeh Kalantari (team leader), Massiagbe 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 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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