Department of Electrical and Computer Engineering
Cullen College of Engineering

THE FUTURE IS WHAT WE DO

ELECTRICAL & COMPUTER ENGINEERING

ECE'S YAO AND ZHAO RECHARGE BATTERY POTENTIAL

New Discovery Could Extend Battery Life, Change EV Landscape

Low-battery anxiety may soon be a little less stressful thanks to a recent discovery by researchers at the University of Houston.

For decades, scientists have struggled to understand what, exactly, is happening inside a solid-state battery in real time, which has made extending its life difficult. Now, a UH research team, in collaboration with researchers from Brown University, worked around that problem using operando scanning electron microscopy, a powerful high-resolution imaging technique. The technique helped them understand why solid-state batteries break down and what could be done to slow the process.

"This research solves a long-standing mystery about why solid-state batteries sometimes fail," said **Yan Yao**, the Hugh Roy and Lillie Cranz Cullen Distinguished Professor of Electrical and Computer Engineering at UH and the corresponding author of this study published in the journal Nature Communications. "This discovery allows solid-state batteries to operate under lower pressure, which can reduce the need for bulky external casing and improve overall safety."

Prior to this revelation, scientists knew adding small amounts of other metals, such as magnesium, to lithium negative electrodes helped improve battery performance, but they didn't understand why, said Yao, who is also the principal investigator at the Texas Center for Superconductivity at UH.

What Yao's team learned is that over time, tiny empty spaces, or voids, form within the battery and merge into a large gap, ultimately causing the battery to fail.

After a series of experiments, the team found that adding small amounts of alloying elements like magnesium can close these voids and help the battery continue to function.

Yan Yao
Professor

Lihong Zhao
Assistant Professor

ECE'S RAJASHEKARA, HUANG LAND $2.8M GRANT TO POWER NEXT-GEN MILITARY DRONES

A major grant will position the University of Houston at the forefront of redefining how military drones operate.

The grant, totaling $2.8 million, will fund a new induction machine-based electrical power generation system designed to replace the older, less efficient synchronous generator systems currently used in Unmanned Aircraft Systems. The goal is to create a power source that is lighter, more efficient and more cost-effective.

UH worked with GE Aerospace and Northrop Grumman to develop the technology. By improving power generation, the system could help drones consume less fuel and produce fewer emissions. The project is led by UH Electrical and Computer Engineering Professors **Kaushik Rajashekara**, who served as PI, and Hao Huang, co-PI

"This project allows us to reduce the weight and cost of the overall system, while increasing its efficiency," Rajashekara said. "That means cleaner, more capable drones."

For UH, the project is an opportunity to build its reputation in aerospace research. The work is being carried out in collaboration with the Air Force Research Laboratory, making the university a key player in advancing drone technology.

The project is being executed in three phases, the first being a seven-month process in which UH worked with GE Aerospace to develop initial concepts and planning. That piece was completed in 2024.

The university is currently in the middle of the second phase, which will focus on design and analysis. Rajashekara expects this phase to take nine months. The final phase, which is the actual construction of the concept, will take about two years.

C-VISER SEES THE FUTURE OF AI IN STRUCTURAL ENGINEERING CAN ARTIFICIAL INTELLIGENCE TRANSFORM THE PRACTICE OF STRUCTURAL ENGINEERING?

Aaron Becker has always been interested in robots. It's just that, up until he decided to pursue postgraduate studies, he could never quite get his hands on one.

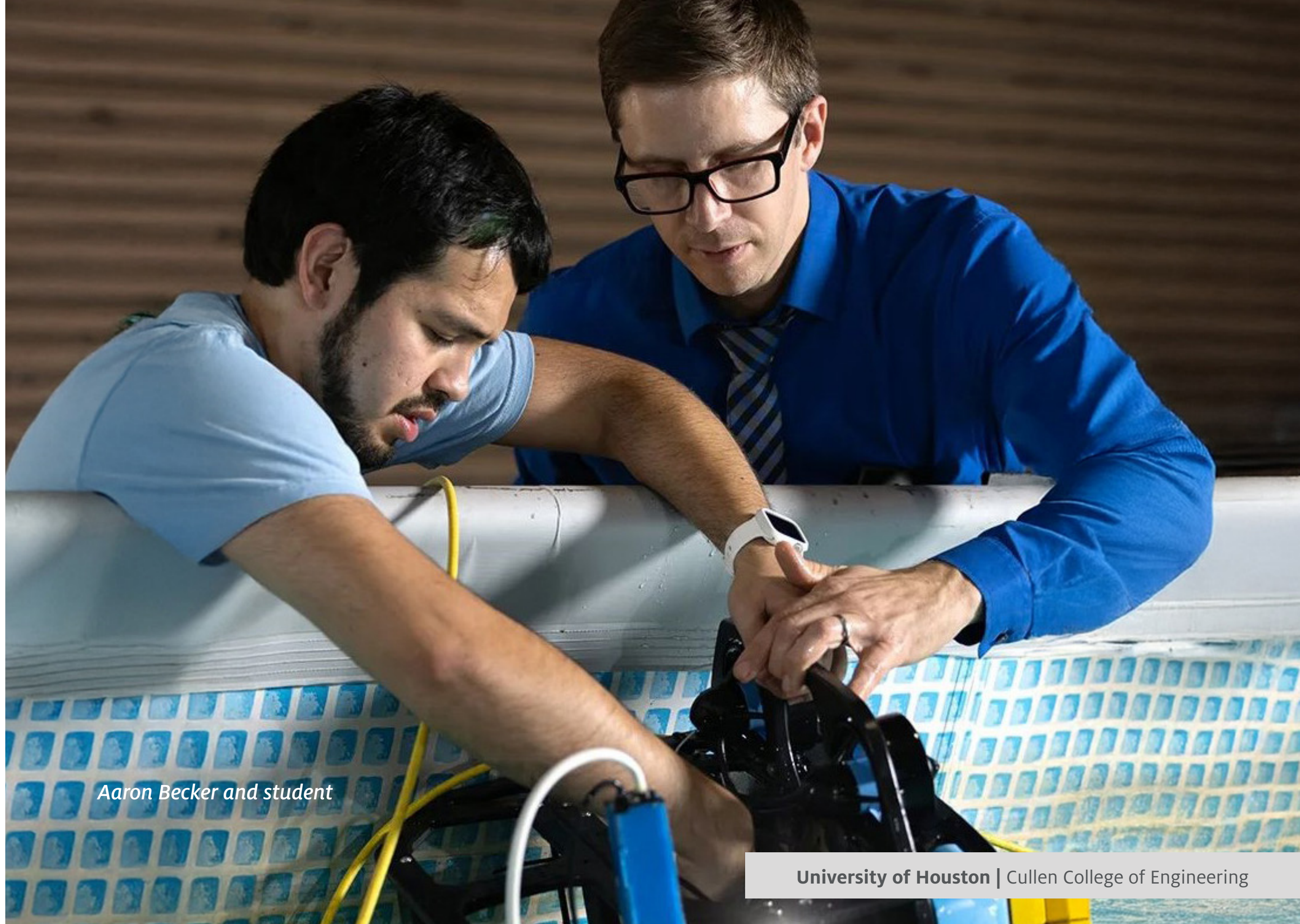
He asked Santa Claus for a robot when he was 6, but it never came. As an undergrad at Iowa State University, he figured a degree in computer science might be the ticket. No such luck.

"I said, 'Man, I've got to go back to grad school. I want to make sure this time,'" Becker says. "I want to understand [robotics] and figure out how to make things move and change their environment."

A program in control systems at the University of Illinois Urbana-Champaign finally introduced him to the world of robotics. Since earning a Ph.D. in electrical and computer engineering in 2012, Becker hasn't looked back.

He joined the faculty at the University of Houston in 2014, where he runs a swarm robotics lab and works as an associate professor in the Electrical and Computer Engineering Department at the Cullen College of Engineering. He also manages a YouTube channel (youtube.com/@AaronBecker), where his videos have garnered tens of thousands of views.

Solving problems within the energy industry has become a major area of focus. Becker has spent the last decade researching and developing processes that keep workers safer, improve productivity and optimize systems within the industry. The trick, he says, is to get your hands dirty, identify a pain point and use robotics to solve the issue.



Aaron Becker and student

AI DRIVES DEVELOPMENT OF CANCER FIGHTING SOFTWARE $2.5 MILLION FAST-TRACK GRANT TO DEVELOP ANALYSIS OF SINGLE CELLS

Each year, billions of tons of carbon dioxide and other greenhouse gases are released into the atmosphere by the burning of fossil fuels, certain industrial processes, construction and other human activities. This has contributed to a significant increase in the Earth's temperature which is leading to a rise in natural disasters, elevated health risks and damage to our planet's biodiversity. There is an urgent need to find better solutions to reduce the levels of atmospheric carbon dioxide.

A team of scientists led by **Xiaonan Shan**, associate professor of electrical and computer engineering at the University of Houston's Cullen College of Engineering, and Haotian Wang, associate professor of chemical and biomolecular engineering at Rice University's George R. Brown School of Engineering and Computing, have discovered simple yet elegant solutions to address a fundamental issue in carbon capture and utilization technology: carbon dioxide reduction reaction (CO 2RR). The study was published recently in Nature Energy.

"This advancement paves the way for longer-lasting and more reliable (CO 2RR) systems, making the technology more practical for large-scale chemical manufacturing," Shan said. "The improvements we developed are crucial for transitioning CO 2 electrolysis from laboratory setups to commercial applications for producing sustainable fuels and chemicals."

Xianonan Shan
Associatet Professor, Department of Electrical and Computer Engineering

UNIVERSITY OF HOUSTON JOINS DOE'S NEW ENERGY INNOVATION HUB TO ADVANCE BATTERY TECHNOLOGY

Associate professor of electrical and computer engineering and IEEE senior member **Xingpeng Li**, Ph.D., has received a Grainger Foundation Frontiers of Engineering Grant for the Advancement of Interdisciplinary Research by the National Academy of Engineering (NAE).

This grant, available only to attendees of the 2024 Grainer Foundation Frontiers of Engineering Symposium, provides seed funding for Li's collaborative project titled "Electrical Grid Congestion: Analysis, Implications and Enhancement," which he undertakes alongside Satyajith Amaran of Dow.

Frontiers of Engineering is an NAE program that brings together highly accomplished early-career engineers from industry, academia, and government to discuss pioneering technical work and leading-edge research in various engineering fields and industry sectors.

Li has had a particular focus on power engineering and power systems since he was a bachelor's student. He also completed both his master's degree and Ph.D. in power systems and automation, with a Ph.D. focus on real-time power system operations.

After joining the University of Houston in 2018, his research expanded to include power system control, reliability, and resilience, as well as small-scale power systems known as micro-grid systems, such as those that serve a single community or a university or business campus.

Now, Li and Amaran's project "aims to analyze electrical network congestion and its implications for industry entities and grid operators through three tasks: assessing network congestion and electricity price contours under different scenarios, developing a novel hierarchical machine learning (ML) model for predicting congestion and electricity prices, and simulating the impact of demand response from large consumers."

"For this particular project, we want to analyze electrical network congestion so that we can figure out the impacts of congestion and how it affects wholesale electricity prices, and how that affects the larger industry consumers who want to avoid high or peak pricing," said Li.

Xingpeng Li
Aossicate Professor, Department of Electrical and Computer Engineering

UH BRAIN, TIRR MEMORIAL HERMANN DEVELOP FIRST WEARABLE PEDIATRIC SOFT EXOSKELETON MADE OF SMART MATERIALS

Just one look at the next-generation lightweight, soft exoskeleton for children with cerebral palsy reveals the powerful role technology can play in solving global challenges and improving lives.

Built to help children walk, the MyoStep addresses motor impairments that severely restrict children's participation in physical activities, self-care and academic pursuits, leading to developmental delays, social isolation and reduced self-esteem. It is lightweight, discreet, made of smart materials and wearable technology, and tailored to fit seamlessly into the lives of children and their families.

The MyoStep soft exoskeleton is being introduced in Electron Devices Magazine by a team from the NSF UH Building Reliable Advances and Innovation in Neurotechnology (BRAIN) Center, an Industry–University Cooperative Research Center (IUCRC) and TIRR Memorial Hermann.

"The MyoStep project represents a significant advancement in the field of pediatric mobility aids, particularly for children with cerebral palsy," said Jose Luis Contreras-Vidal, director of the NSF BRAIN Center and Hugh Roy and Lillie Cranz Cullen Distinguished Professor of Electrical and Computer Engineering.

"By integrating cutting edge technologies such as artificial muscles, smart fabrics, and a comprehensive sensor network, MyoStep offers a promising solution to the challenges faced by existing exoskeletons," he said.

Elham Morshedzadeh and Jose Luis Contreras-Vida

ECE'S HIEN VAN NGUYEN LEADS TEAM LAUNCHING NEW ERA IN RADIOLOGY TRAINING

New AI System Predicts a Radiologist's Next Glance — Before the Doctor Makes It

On a daily basis, a radiologist in the U.S. (the physician who specializes in reading and interpreting medical images) pores over 150 to 200 X-rays. Their specialty is so important that researchers are now trying to get in front of where they will look next — what area of the image they will next scrutinize — to open a powerful window into how they think and to discover the origins of diagnostic errors.

Understanding this gaze behavior is not just about their next move; it's about replicating their expert attention to train the next generation of specialists.

"We're not just trying to guess what a radiologist will do next; we're helping teach machines and future radiologists how to think more like experts by seeing the world as they do," reports **Hien Van Nguyen**, associate professor of electrical and computer engineering, in Nature Scientific Reports.

Nguyen's newly developed AI system, MedGaze, is designed to emulate how radiologists visually interpret chest X-rays. By replicating radiologists' expert attention, MedGaze is useful for increasing the efficiency of hospitals through understanding which cases take more time and mental effort, helping manage workflow. It also improves the accuracy of AI-powered diagnostic systems focusing on image areas that human experts would prioritize.

"MedGaze is a non-invasive, non-interfering software system trained to mimic how expert doctors visually examine chest X-rays, including where they look, how long they look there and what sequence they follow," Nguyen explained. "We call this a 'Digital Gaze Twin,' and it works by analyzing both the images and the radiology reports doctors write."

MedGaze learns patterns from thousands of previous eye-tracking sessions where radiologists' gaze paths were recorded while interpreting X-rays. It then uses this knowledge to predict where a radiologist is likely to look next when reading a new X-ray.

Hien Van Nyguen
Associate Professor

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