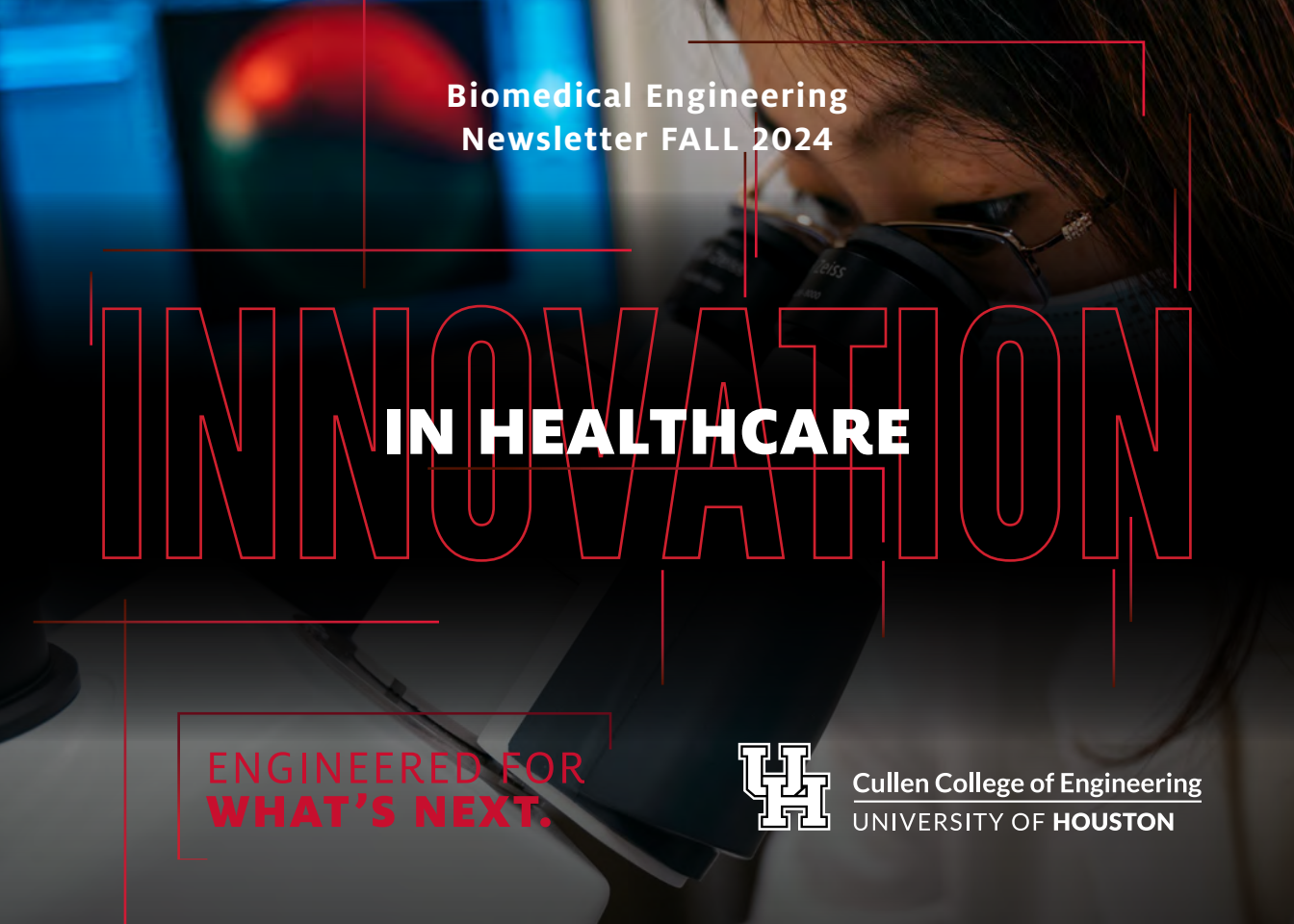


Biomedical Engineering
Newsletter FALL 2024

INNOVATION IN HEALTHCARE

ENGINEERED FOR
WHAT'S NEXT.

Cullen College of Engineering
UNIVERSITY OF **HOUSTON**

Letter from the Chair

Dear Colleagues,

I hope that you are well and that the spring semester has treated you well so far. There are many exciting things happening within our department. I am extremely proud of the work being done by our students and faculty, much of which has received national recognition, such as the NSF CAREER Award received by one of our faculty members for his work using electrolyte migration using alternating current (AC) electric fields. I am delighted to share many more highlights and accomplishments of the UH Biomedical Engineering Department's esteemed faculty and industrious students.

I hope you enjoy reading through this email sampling of our work, and if you any of these projects strike your interest, do not hesitate to reach out. We are always looking for collaborator to further our research.

Warm Regards,

Metin Akay, Ph.D.
Founding Chair, John S Dunn Endowed Chair Professor
International Academy of Medical and Biological Engineering (IAMBE
Chair-Elect IEEE BRAIN Technical Community
Department of Biomedical Engineering

UH BME **BY THE NUMBERS**

100% PH.D. POST-GRADUATE JOB PLACEMENT

**NUMBERS BASED ON FALL 2021*

DEGREES AWARDED *(FALL 2021)*

42 B.S. **22** M.S. **12** Ph.D.

ENROLLMENT *(FY 2023)*

270 UNDERGRADUATE STUDENTS

122 GRADUATE STUDENTS

FACULTY:

NAE: **1**
IEEE FELLOW: **1**
SPIE FELLOW: **1**
AIMBE FELLOWS: **3**
AAAS FELLOWS: **2**
NSF CAREER: **5**
BMES FELLOW: **1**
IOP FELLOW: **1**
IAMBE FELLOW: **1**
ACS FELLOW: **1**
TOP 1% HIGHLY CITED RESEARCHERS: **2**
HONORIS CAUSA DOCTORATE: **3**
OSA FELLOW: **1**
AICE FELLOW: **1**
AAIA FELLOW: **1**

BME'S RENITA HORNTON **EARNS NSF CAREER AWARD FOR INNOVATIVE HEART-ON-A-CHIP RESEARCH**

Renita Horton, assistant professor in the Cullen College of Engineering's Biomedical Engineering Department, has received a National Science Foundation (NSF) CAREER Award in the amount of $522,253 for research concerning congenital cardiac fibrosis and vascular cell dysfunction, with support through 2029.

Her proposal, titled "Congenital Heart on a Chip: Investigating Mechanical, Biomolecular, Cellular and Tissue-Level Mechanisms in Cardiac Fibrosis", aims to investigate "how different cells in the heart respond to chemical and mechanical signals that cause cardiac fibrosis", or the formation of scar tissue within the heart, via two- and three-dimensional chip-based models.

Horton emphasizes that understanding these key cascades that can potentially have adverse effects on the heart is a critical component of improving individual outcomes when facing complex systemic disease processes. This includes what's known as "neonatal lupus": a particular set of symptoms and effects resulting from the transfer of antibodies from a gestating parent to their fetus.

Pictured: *A research student in in the lab with Dr. Renita Horton.*

BME'S METIN AKAY HONORED WITH

IEEE ACADEMIC CAREER ACHIEVEMENT AWARD

Metin Akay, Ph.D., the founding chairman and the John S. Dunn Endowed Professor of Biomedical Engineering, has been awarded the 2024 Institute of Electrical and Electronics Engineers (IEEE) Engineering Medicine and Biology Society (EMBS) Academic Career Achievement Award in recognition of his groundbreaking work in innovative medical technologies.

Akay was recognized in Orlando earlier this summer alongside colleague John Rogers, who received the Society's Medical Technology Award. Rogers received an honorary doctorate from the University of Houston in 2021.

Akay's innovative research includes the development of drug direct-delivery systems for the treatment of brain cancer, non-invasive tools for the detection of coronary occlusion, and imaging tools to monitor neural responses to addictive substances. All three technologies have made significant impacts on modern medicine.

Pictured: *Founding chair and John S. Dunn Endowed Professor of Biomedical Engineering Metin Akay (center), with IEEE EMBS 2025 VP of Technical Activities Gert Cauwenberghs (left) and 2024 President Paul Sajda (right).*

Pictured: *ChandrLars Tebbe, an assistant professor of research in the Biomedical Engineering Department at the Cullen College of Engineering, has earned $90,000 in funding thanks to the Knights Templar Eye Foundation (KTEF) Career Starter Grant.*

UH RESEARCH PROFESSOR NABS KNIGHTS TEMPLAR GRANT

Lars Tebbe, an assistant professor of research in the Biomedical Engineering Department at the Cullen College of Engineering, has earned $90,000 in funding thanks to the Knights Templar Eye Foundation (KTEF) Career Starter Grant.

Tebbe's proposal is entitled “The clinical benefits of modulating ROM1 in switching a PRPH2-associated pattern dystrophy phenotype to retinitis pigmentosa.”The grant aims to reduce levels of ROM1 by using molecules named antisense oligonucleotides (ASOs) in a mouse model carrying an IRD-causing mutation of PRPH2. The study will test whether the administration of the ASOs in eye drops will be as effective as the injection of ASOs formulated in nanoparticles.

Tebbe joined the University of Houston in 2019. He was previously affiliated with the Department of Cell and Matrix Biology at the Johannes Gutenberg University of Mainz in Germany.

NEW

FACULTY

ALI YOUSEFI

Ali Yousefi earned his doctorate from the University of Southern California and previously served as an Assistant Professor at Worcester Polytechnic Institute. His research centers on developing methodological solutions for analyzing neuroscience data.

ANDREW NORDIN

Andrew Nordin earned his doctoral degree from the University of Nevada, Las Vegas. He completed postdoctoral research at the University of Michigan and has also served as a research scientist at the University of Florida.

AARYANI TIPIRNENI-SAJJA

Aaryani Tipirneni-Sajja completed her pre- and post-doctoral training at Stanford Medical Center and St. Jude Children's Research Hospital. During her time there, she made significant contributions to the development and validation of MRI techniques for various NIH-funded clinical trials and pilot studies.

NEW MODEL TO EXAMINE USHER SYNDROME

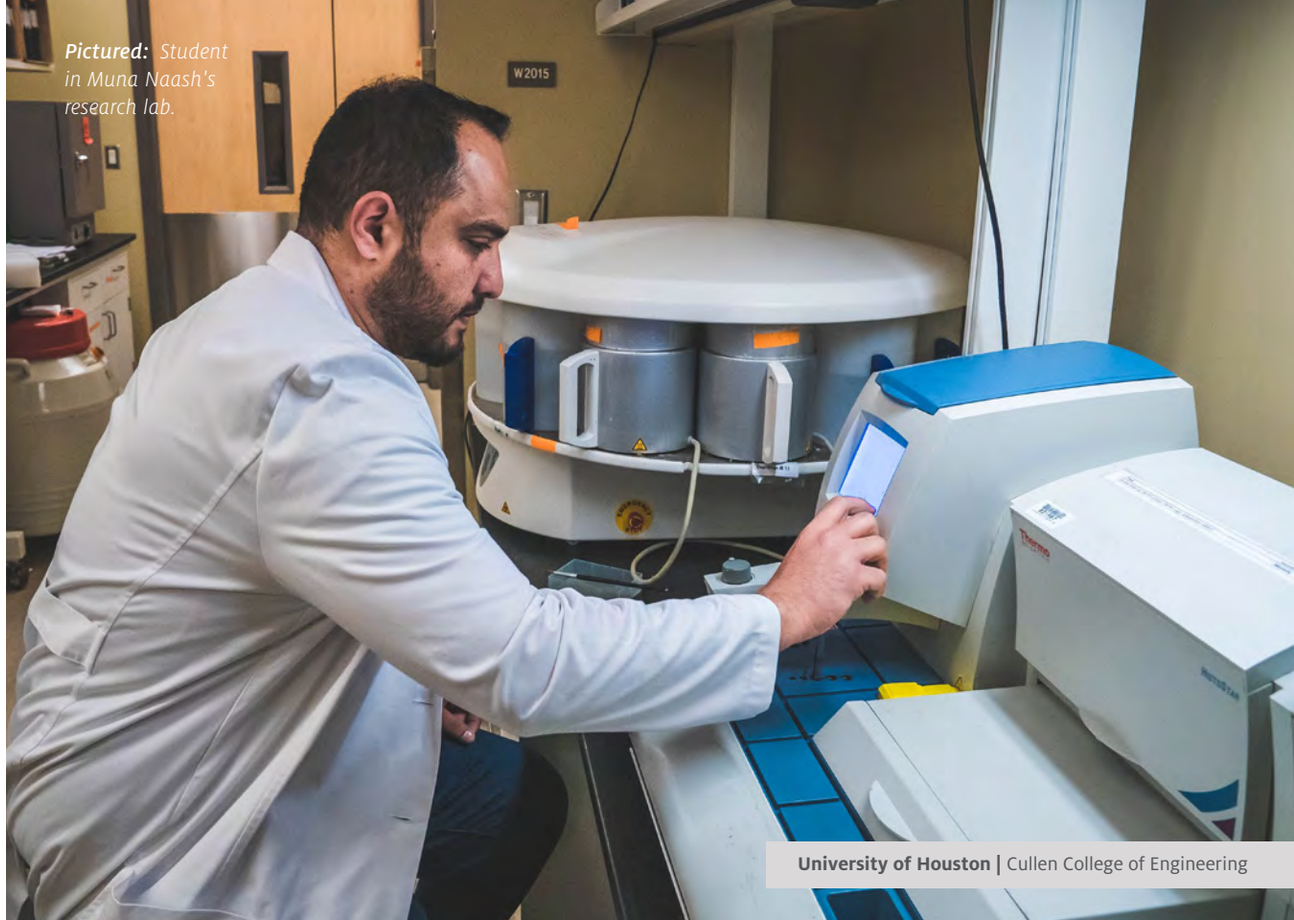
FEATURED IN NATURE COMMUNICATIONS JOURNAL

Usher syndrome, a rare inherited genetic disease, is a leading cause of combined deafness and blindness with type 2A (USH2A) being the most common form. USH2A, caused by mutations in the USH2A gene, can include hearing loss from birth and progressive loss of vision, prompting retinitis pigmentosa (RP). RP affects the retina, the eye's light-sensitive layer, leading to a breakdown of the light-sensitive cells in the retina which initially leads to night blindness followed by progressive loss of daily vision. Currently no treatment exists for USH2A.

A University of Houston biomedical engineer has reported to *Nature Communications*, her team's design and generated a model expressing c.2299delG, the most common human disease mutation in USH2A. **Muna Naash**, John S. Dunn Endowed Professor of Biomedical Engineering reported that "the model exhibits retinal degeneration and expresses a truncated, glycosylated protein which is mislocalized to the photoreceptor inner segment. The degeneration is associated with a decline in retinal function, structural abnormalities in connecting cilium and outer segment and mislocalization of the usherin interacting partners - very long G-protein receptor 1 (VLGR1) and whirlin (WHRN)."

These results prove that expression of the actual mutant protein is beneficial in reproducing USH2A retinal phenotype and offers insight into strategies for designing therapeutic interventions. An in-depth analysis of the retina in the model revealed structural anomalies in the photoreceptors ultimately leading to the death of the photoreceptor cells causing vision loss.

Naash who was recently funded by the National Eye Institute, shared that this model exhibits retinal degeneration associated with a decline in retinal function and continues to support the development of an effective gene therapy platform to treat USH2A associated visual defects.



Pictured: *Student in Muna Naash's research lab.*

UH RESEARCHERS UNVEIL

GROUNDBREAKING TECHNIQUE IN X-RAY IMAGING

Researchers at the University of Houston unveiled a groundbreaking advancement in X-ray imaging technology that could provide significant improvements in medical diagnostics, materials and industrial imaging, transportation security and other applications.

Mini Das, Moores professor at UH's College of Natural Sciences and Mathematics and Cullen College of Engineering, and Jingcheng Yuan, a physics graduate student at UH, introduce a novel light transport model for a single-mask phase imaging system that enhances non-destructive deep imaging for visibility of light-element materials, including soft tissues such as cancers and background tissues like plastics and explosives.
The design uses an X-ray mask with periodic slits, creating a compact setup that enhances edge contrast.

Das's team has already tested its model via rigorous simulations and on their in-house developed laboratory benchtop X-ray imaging system. The next goal, she says, is to integrate the technology into portable systems and retrofit existing imaging setups to test it in real-world environments, such as hospitals, industrial-ray imaging and airports.

Pictured top: *Mini Das with Physics graduate student Jingcheng Yuan*

Pictured: *Researchers at the University of Houston unveiled a groundbreaking advancement in X-ray imaging technology that could provide significant improvements in medical diagnostics, materials and industrial imaging, transportation security and other applications.*

CHANDRA MOHAN AWARDED $3 MILLION GRANT TO DEVELOP AI SYSTEM TO ANALYZE BIOPSY RESULTS

Chandra Mohan, M.D., Ph.D., Hugh Roy and Lillie Cranz Cullen Endowed Professor of biomedical engineering in the UH Cullen College of Engineering, will use a $3 million grant from the National Institute of Diabetes and Digestive and Kidney Diseases to bring AI into the diagnostic picture.

The goal of using AI to classify lupus nephritis in an automated fashion with high accuracy will translate to better treatment for lupus nephritis, according to researchers.

"By leveraging the power of computer vision and deep learning, a branch of machine learning, we will build classifiers that rival the best renal pathologists in making a diagnosis using current criteria. This could dramatically improve patient management and long-term renal and patient outcome," said Mohan.

Pictured: *Chandra Mohan.*

University of Houston | Cullen College of Engineering

WEARABLE SENSORS TO **DETECT COLORECTAL CANCER**

Through a HEALTH-RCMI Pilot Program Award, University of Houston's **Zhengwei Li** will develop a wearable biosensor that promises to detect colorectal cancer and provide real-time health monitoring through your smartphone.

Through support from HEALTH-RCMI, Li has spearheaded a new study, "Development of Ultrasensitve Smart Bioelectronic Sensors for Colorectal Cancer Prevention and Health Disparities Reducing among Black Americans." This initiative was funded $50,000 by NIMHD and HEALTH-RCMI [PI: Dr. Ezemenari Obasi].

"Colorectal cancer is the third cause of cancer related deaths in the U.S., according to the American Cancer Society," Li said. "They estimate more than 150,000 cases this year in the U.S. Black Americans and minorities are more likely to be impacted by colorectal cancer."

Li's vision about a cancer-free world is an ambitious one. He is determined to reduce cancer disparities by creating devices that can remotely sense the biophysical signals of certain cancers.

Pictured: *Zhengwei Li*

NEW RESEARCH GRANTS

RESEARCH

PORTFOLIO ADDITIONS

R01EY033978

"No-Touch High Resolution Optical Coherence Elastography of the Cornea using a Heartbeat"

Project goal: Develop new clinical technology and method capable of precise noninvasive and "no-touch" quantitative measurements of the corneal mechanical properties. This will be achieved by the development of a novel fast Optical Coherence Elastography (OCE) system utilizing a human heartbeat as the loading source.

UH Project Lead and PI: Kirill Larin, *Cullen College of Engineering Professor*

R01HD086765

"Multimodal Optical Imaging on the Effect of Maternal Polysubstance Exposure on Fetal Brain Microvessel Function"

Project goal: Understand the etiology of congenital brain growth anomalies due to prenatal alcohol/ethanol and nicotine exposure. This will be achieved by developing a new imaging platform based on multiphoton light-sheet microscopy combined with Optical Coherence Tomography.

UH Project Lead and PI: Kirill Larin, *Cullen College of Engineering Professor*

R01EY034114

"Regulation of tissue repair and scar formation by the stromal niche"

Project goal: Corneal scarring is a public health problem and a very common indication of corneal transplantation. We aim to address the innovative concept that re-establishing a unique environment or stromal niche with its unique mechanical and chemical cues is critical after injury to ameliorate scarring -- a potential target for therapeutic interventions.

UH Project Lead: Kirill Larin, *Cullen College of Engineering Professor*

PI: Espana from USF

NEW RESEARCH GRANTS

RESEARCH

PORTFOLIO ADDITIONS

R01NS125435

“Regenerative Micro-Electrode Peripheral Nerve Interface for Optimized Proprioceptive and Cutaneous specific interfacing"

Project goal: Generate a somatosensory neuroprosthesis by optimizing microstimulation within peripheral nerve conduits that use molecular guidance cues to separate cutaneous and proprioceptive sensory modalities.

UH Project Lead and PI: Joe Francis, *Professor*

R01EB032416

“Visual-search ideal observers for modeling reader variability"

Project goal: Multireader clinical imaging trials are a burdensome standard for assessing and comparing diagnostic medical imaging technology. Work will develop an adaptive computer model that can provide quantitative multireader performance estimates at clinically relevant tasks. This will improve the statistical rigor of in silico imaging trials, ultimately benefitting patient care through faster, less costly adoption of imaging advances.

UH Project Lead and PI: Howard Gifford, *Associate Professor*

UH BME STUDENT PADGETT SELECTED FOR NATIONAL SCIENCE FOUNDATION AND IEEE EMBS SPONSERED ACADEMY

Thomas Padgett, a biomedical engineering graduate from the University of Houston's Cullen College of Engineering, earned a fellowship to attend the National Science Foundation's 21st International Summer Academy BIO-X on AI, ML, Data Science in Healthcare, Medicine and Biology.

The academy was held in early June in Greece. As part of the event, Padgett presented research he is working on in the field of the collection and analysis of protein biomarkers.

Padgett will be starting medical school this fall at the UT Southwestern Medical Center in Dallas. He earned his bachelor's degree in biomedical engineering from Cullen in May 2024, graduating first in his class. He was the Outstanding Senior for the department in 2024, and the Outstanding Junior in 2023.

Padgett currently works in the lab of Chandra Mohan, Hugh Roy and Lillie Cranz Cullen Endowed Professor. He is helping to develop a platform for the collection and analysis of protein biomarkers from patient samples. They hope that this platform could one day be used by researchers to easily collect patient samples and connect a myriad of different biomarkers to associated diseases.

After completion of medical school, Padgett plans to pursue a career in neurology.

Pictured: *Thomas Padgett, a biomedical engineering graduate from the University of Houston's Cullen College of Engineering.*

University of Houston | Cullen College of Engineering

UH BME DOCTORAL STUDENT EARNS NASA SILVER ACHIEVEMENT MEDAL

Kimia Seyedmadani, a biomedical engineering student pursuing her doctorate, received NASA Silver Achievement Medal, for outstanding leadership and innovation of the biomedical and countermeasure hardware selection and flight certification processes. Her advisors are Metin Akay, Founding Chair and John S. Dunn Endowed Chair, and Yasemin Akay, Instructional Associate Professor. Together, they lead the Neural Engineering and Informatics Laboratory in the Biomedical Engineering Department.

The award caught her totally by surprise.

"I was happy and stunned," she said. "I am an Iranian immigrant with a diverse engineering background, and here I was, receiving one of the highest honor governmental medals, for impact to the field of Bioastronautics. Many people had to nominate me, from my management and above, for me to be recognized. I was very humbled by the support of my family, mentors and, most of all, my team, and I remembered them all, even those who were no longer with us."

Seyedmadani earned her B.S. followed by her M.S. in Bioengineering and Biomedical Engineering from Arizona State under the guidance of Vincent Pizziconi, an associate professor in the School of Biological and Health Systems Engineering. She also earned her M.S. in Aerospace Engineering and Bioastronautics from the University of Colorado at Boulder under the guidance of James Voss, a former NASA astronaut as well as an AIAA Fellow and Smead Aerospace scholar-in-residence.

While Seyedmadani had a diversity of knowledge prior to being hired at NASA, she wanted to continue the journey of higher education to be able to transform her work. She chose UH specifically because of Metin and Yasemin Akay's mentorship and vision.

Pictured: *Kimia Seyedmadani [center], a biomedical engineering student pursuing her doctorate, received the NASA Silver Achievement award during a ceremony in December.*

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 worldclass 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.

Cullen College of Engineering
UNIVERSITY OF HOUSTON

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Innovation in HEALTHCARE