Biomedical Engineering
Newsletter Fall 2022

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 fall semester has treated you well so far. There are many exciting things happening within our department, including advancements in the medical field. 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 stroke rehabilitation research earlier this year. Our Ph.D. students routinely find job placement after their time with us — in fact, our post-graduate job placement rate was 100% in Fall 2021.

I invite you to come visit our department to learn more about opportunities for collaboration and more. You have my best wishes for a productive fall.

Warm Regards,

Metin Akay, Ph.D.
Founding Chair, John S Dunn Endowed Chair Professor
Department of Biomedical Engineering
Cullen College of Engineering
Univeristy of Houston

UH BME **BY THE NUMBERS**

100% PH.D. POST-GRADUATE JOB PLACEMENT

**NUMBERS BASED ON FALL 2021*

DEGREES AWARDED *(FALL 2021)*

53 B.S. **19** M.S. **9** Ph.D.

ENROLLMENT *(FALL 2021)*

284 UNDERGRADUATE STUDENTS

122 GRADUATE STUDENTS

FACULTY:

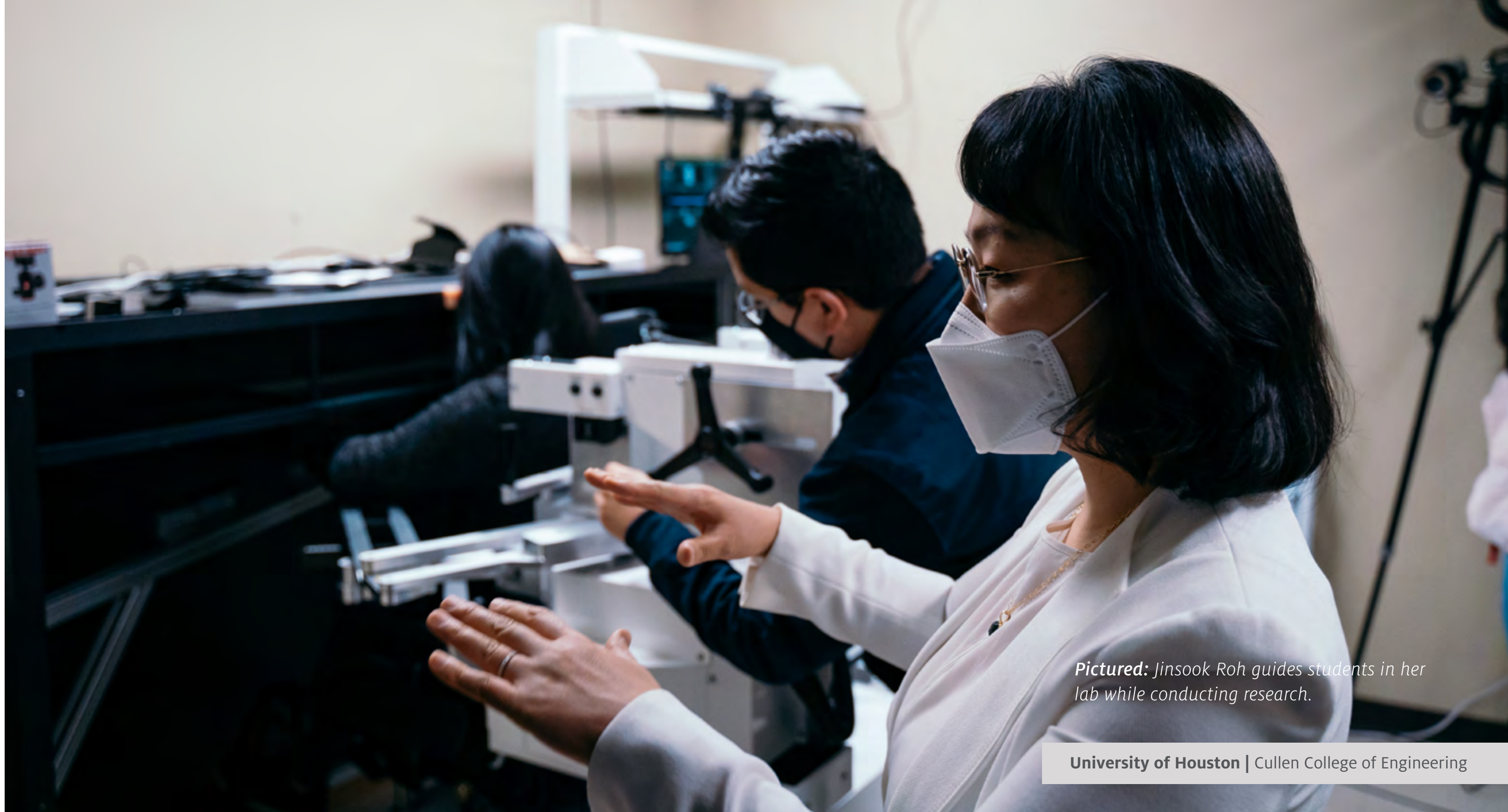
NAE: **1**
IEEE FELLOW: **1**
SPIE FELLOW: **1**
AIMBE FELLOWS: **3**
AAAS FELLOWS: **2**
NSF CAREER: **2**
BMES FELLOW: **1**
IOP FELLOW: **1**
IAMBE FELLOW: **1**
ACS FELLOW: **1**
TOP 1% HIGHLY CITED RESEARCHERS: **2**
HONORIS CAUSA DOCTORATE: **1**
OSA FELLOW: **1**
AICE FELLOW: **1**

JINSOOK ROH INVESTIGATES A NOVEL APPROACH FOR STROKE REHABILITATION USING **HARMONY UPPER BODY EXOSKELETON**

Harmonic Bionics, the robotics company for augmenting human movement, announced on July 12 that the University of Houston has purchased and received a Harmony SHR™ exoskeleton to be used in research being conducted by **Dr. Jinsook Roh**, Assistant Professor of Biomedical Engineering at the Cullen College of Engineering, and her team at the Rehabilitation Engineering for Improving Neuromotor control (REIGN) Lab.

Roh is a 2022 National Science Foundation CAREER award recipient, and her research focuses on the neural mechanisms of motor coordination in able-bodied and neurologically impaired individuals.

With an anatomically matched shoulder and bilateral design, Harmony SHR can facilitate a more natural range of motion with multi-plane movements. The system's actuation and control allow for differentially adjusting assistance/resistance at each joint with precise motion and effort sensing for objective assessment of joint angle and force generation.



Pictured: *Jinsook Roh guides students in her lab while conducting research.*

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

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

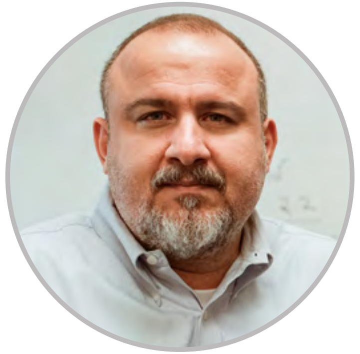
“Visual-search ideal observers for modeling reader variability"

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*

RESEARCH

PORTFOLIO ADDITIONS



R01NS12465

Electrophysiological footprints of PD motor phenotypes

Project goal: Deep brain stimulation (DBS) of subthalamic nucleus (STN) and globus pallidus internus (GPi) has largely replaced ablative techniques in the surgical treatment of Parkinson Disease (PD) but very limited data exists regarding the electrophysiological abnormalities within these structures for subtypes of PD. The project will show initial evidence of electrophysiological footprints of PD motor phenotypes within the territories of STN. Based on these key preliminary observations, together with clinical experts from BCM, the prroject will investigate dynamics of oscillatory neural activity recorded from the territories of STN and GPi with high resolution electrodes during wake DBS surgery for the personalization and optimization of DBS in PD.

UH Project Lead and PI: Nuri Ince, *Cullen College of Engineering Professor*

R01DK133800

“High-Density Surface Electromyography Guided Precision Botulinum Neurotoxin Injections to Manage Chronic Pelvic Floor Pain"

Project goal: Develop a personalized approach for botulinum neurotoxin injection into pelvic floor muscles guided by intra-vaginal high-density surface EMG to optimize the treatment outcome in treating Interstitial cystitis/ bladder pain syndrome, which negatively impacts the quality of life and sexual activities in 2.7% to 6.5% of women in the U.S.

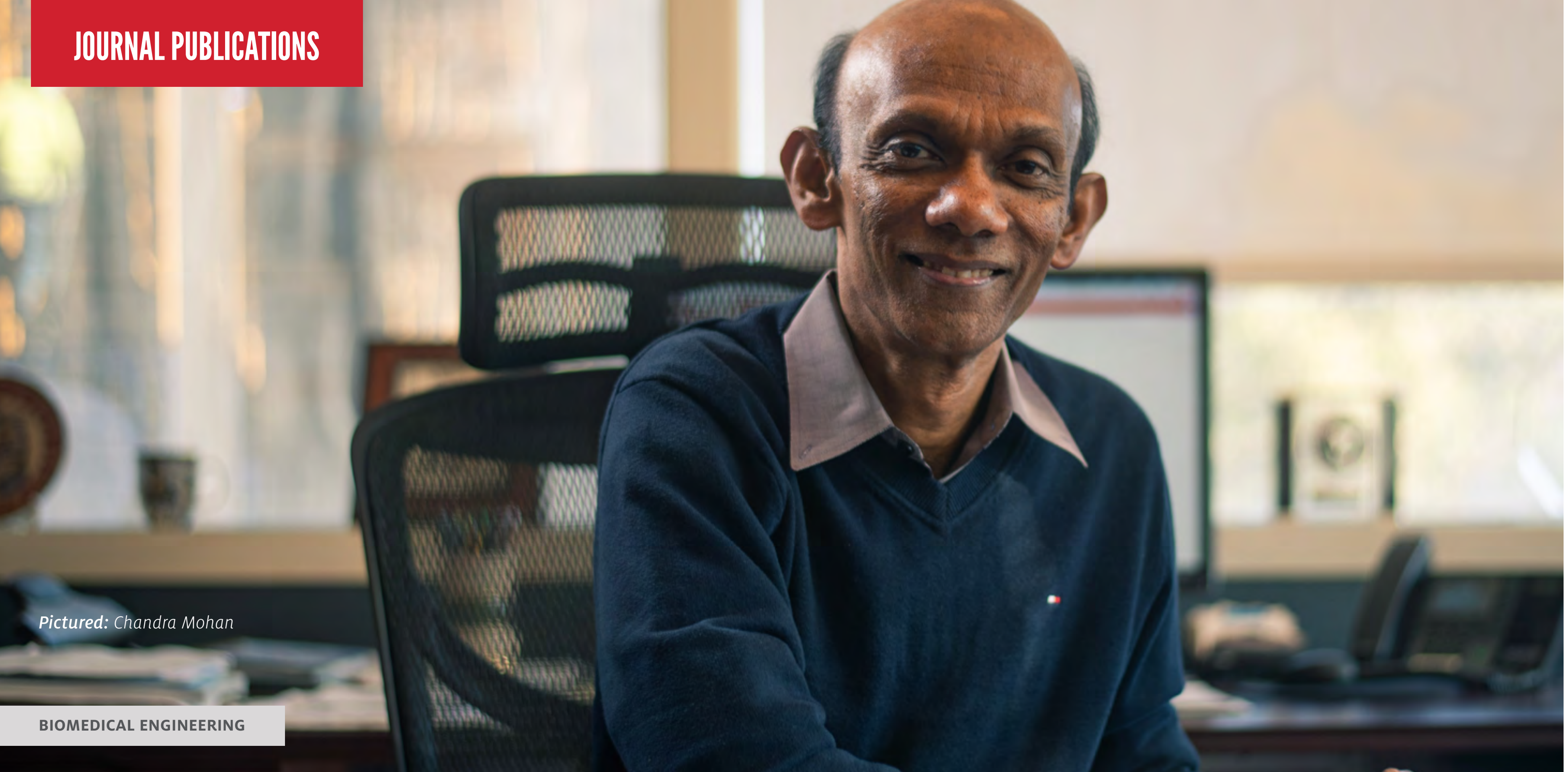
UH Project Lead and PI: Yingchun Zhang, *Associate Professor*

R21NR020379

“Assessing multifactorial etiology of IC/ BPS using a novel PFM-Hip-Trunk muscle network analysis"

Project goal: Distinguish pelvic floor muscle (PFM) phenotypic subtypes in Interstitial cystitis/ bladder pain syndrome for personalized and precision treatment by comprehensively assessing the PFM overactivity, hip/trunk muscle activity alteration, PFM-to-Hip/Trunk inter-muscular connectivity.

UH Project Lead and PI: Yingchun Zhang, *Associate Professor*



Pictured: Chandra Mohan

IDENTIFYING BIOMARKERS FOR HEART DISEASE AND FOR CHILDREN WITH LUPUS NEPHRITIS

Two separate findings by a University of Houston nationally recognized expert in systemic lupus erythematosus (SLE or lupus), a chronic autoimmune disease that affects multiple organs including the kidneys, skin, joints and heart, are being reported in scientific and medical journals.

Chandra Mohan, M.D., Ph.D., Hugh Roy and Lillie Cranz Cullen Endowed Professor of biomedical engineering in the UH Cullen College of Engineering, has identified blood biomarkers that predict which lupus patients will develop heart disease in the future and found new urine biomarkers for diagnosing lupus nephritis (LN) in children with lupus. Findings were reported in the journals *Frontiers in Cardiovascular Medicine* and *Frontiers in Immunology.*

DEEP NERVE STIMULATION

CONSISTENTLY REDUCES BLOOD PRESSURE

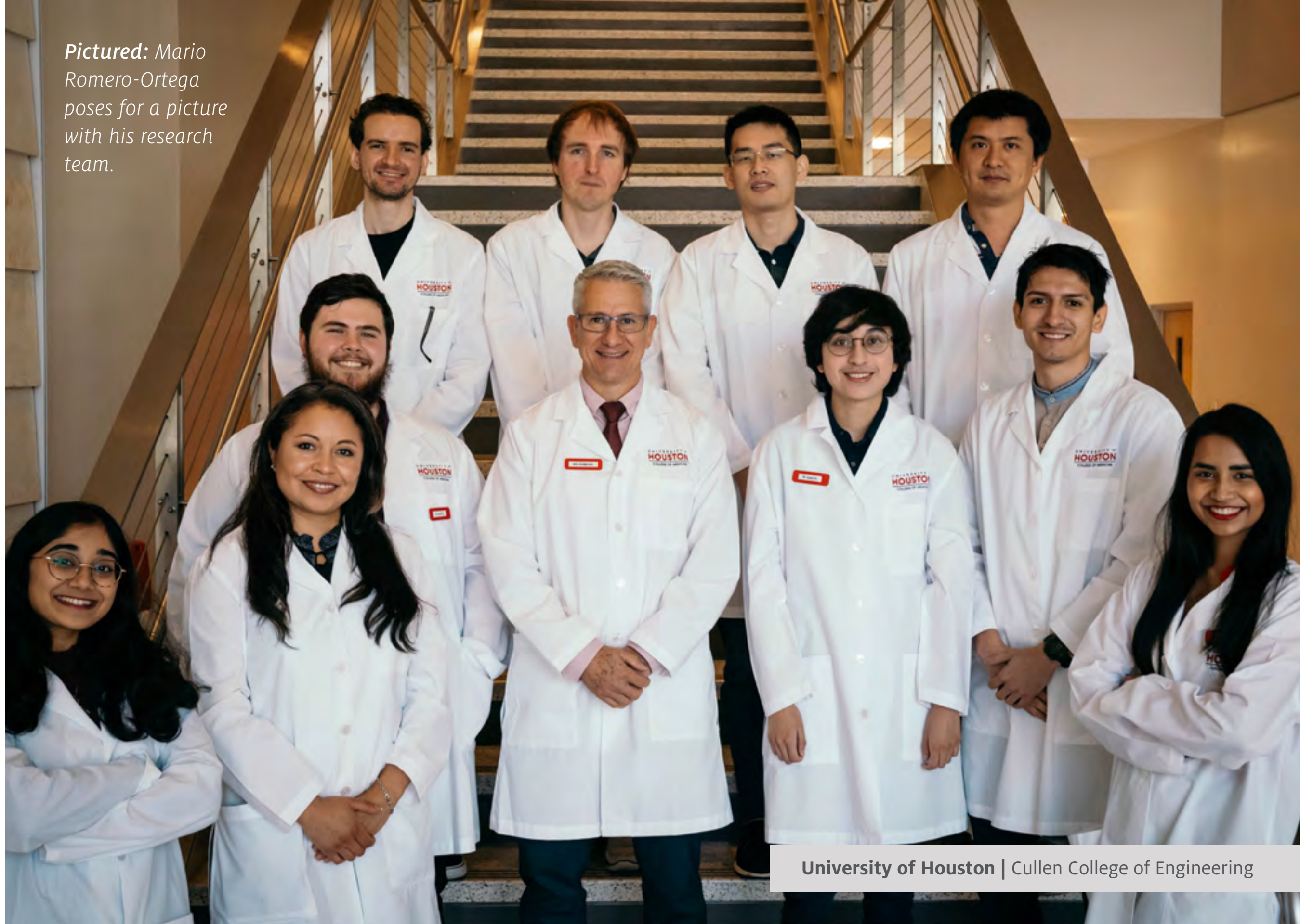
A University of Houston biomedical engineer is expanding the study of wireless electrodes to treat hypertension and is reporting that blood pressure and renal sympathetic nerve activity (RSNA) is controlled by bioelectronic treatment. RSNA is often increased in hypertension and renal disease.

Using a custom-wired electrode, **Mario Romero-Ortega**, Cullen Endowed Professor of Biomedical Engineering, previously reported that deep peroneal nerve stimulation (DPNS) elicits an acute reduction in blood pressure. The current study, published in *Frontiers in Neuroscience*, advances that work, focusing on his development of a small implantable wireless neural stimulation system and exploration of different stimulation parameters to achieve a maximum lowered response.

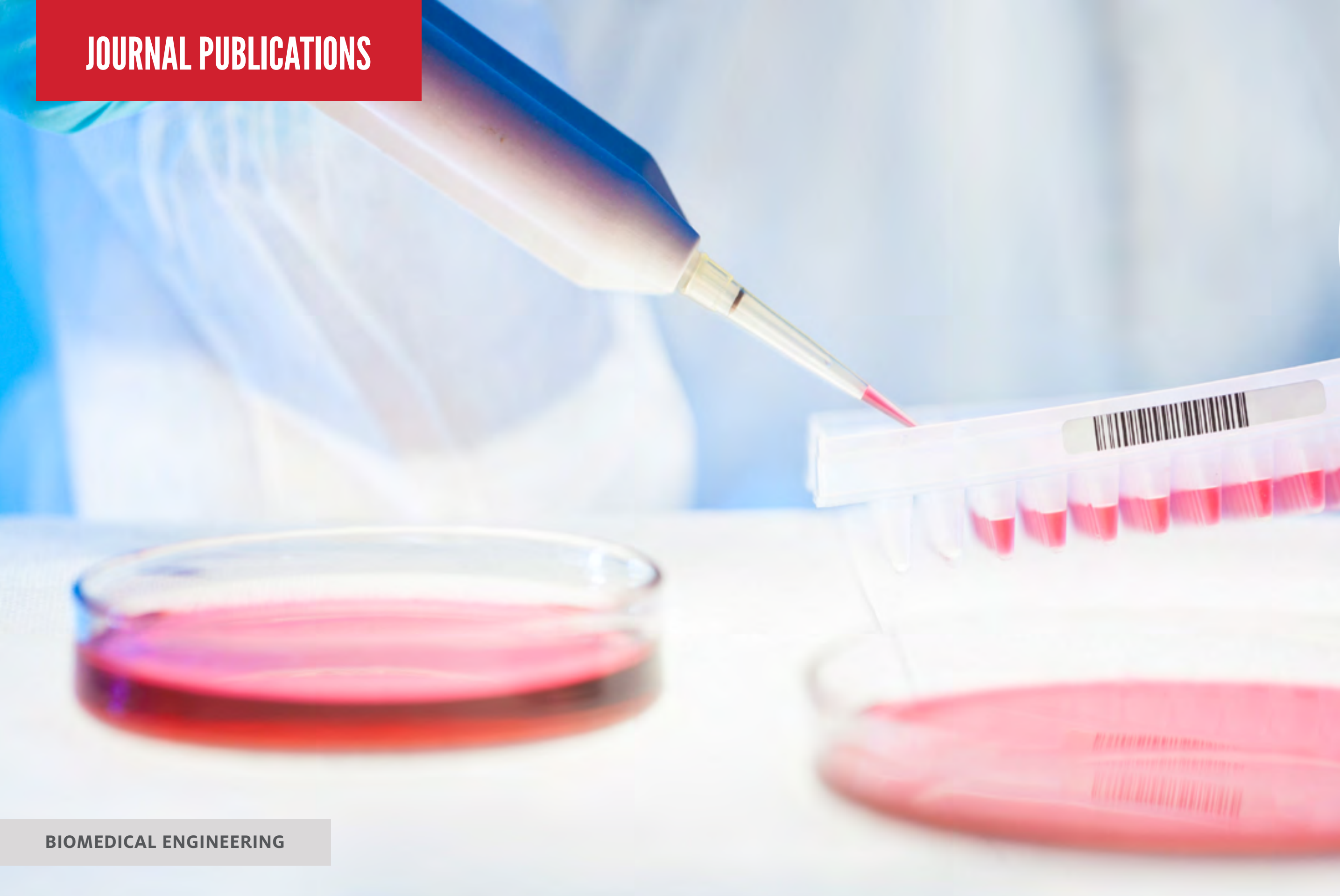
Romero-Ortega integrated a sub-millimeter nerve stimulation circuit with a novel nerve attachment microchannel electrode that facilitates implantation into small nerves and allows external power and DPNS modulation control.

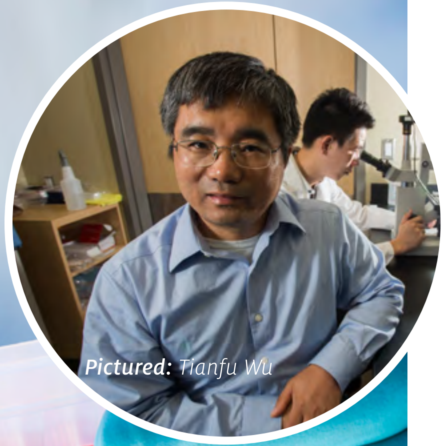
Using this implantable device, his team demonstrated that systolic blood pressure can be lowered 10% in one hour and 16% two hours after nerve stimulation.

Hypertension, often called the ‘silent killer’ speaks loudly in statistics. In the United States, it is the number one cause of death. While pharmacological treatments are effective, blood pressure remains uncontrolled in 50 percent to 60 percent of resistant hypertensive subjects. Unfortunately, despite the use of multiple anti-hypertensive drugs in combination, blood pressure remains poorly controlled in 50 percent to 60 percent of the hypertensive population and approximately 12 percent to 18 percent of them develop resistant hypertension, defined as blood pressure greater than 140/90 mmHg despite the use of antihypertensive drugs.



Pictured: *Mario Romero-Ortega poses for a picture with his research team.*





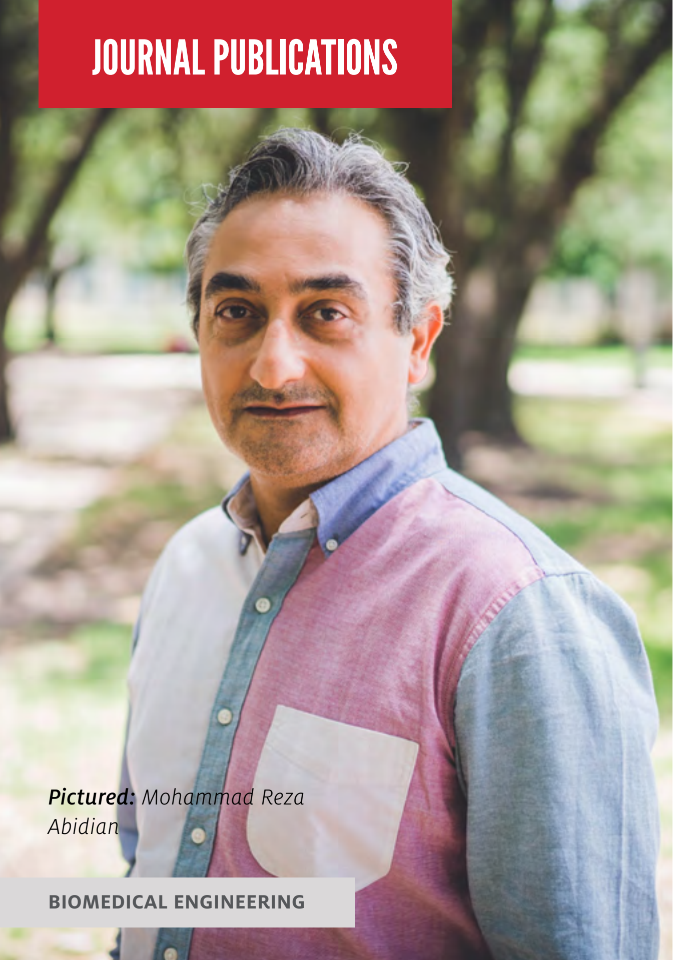
Pictured: *Tianfu Wu*

PROGRESS ON **EARLY ALZHEIMER'S DISEASE**

Inside the body, some seemingly harmless proteins have sinister potential. In the case of Alzheimer's disease, the amyloid-beta (Aβ) protein, which is vital for brain growth, can become tainted and destroy cells, which leads to forgetfulness and memory loss. Proteins are neat little things that can only perform their functions if folded properly. Thus, the misfolding and deposition of amyloid beta in the brain is the main hallmark of Alzheimer's disease.

"One of the drivers of Alzheimer's pathogenesis is the production of soluble oligomeric Aβ, which could potentially serve as a biomarker of Alzheimer's disease," said **Tianfu Wu**, an Associate Professor of Biomedical Engineering at the Cullen College of Engineering. Oligomeric proteins are comprised of several protein chains or subunits packed tightly together.

"We synthesized a near-infrared fluorescence-imaging probe to detect both soluble and insoluble Aβ. It not only binds oligomeric Aβ but also interposes self-assembly of Aβ," reports Wu in the journal Alzheimer's and Dementia. "This work holds great promise in the early diagnosis of Alzheimer's and may provide an alternative way to prevent and intervene in Alzheimer's disease and other amyloidosis."



Pictured: *Mohammad Reza Abidian*

3-D PRINTING OF

'ORGANIC ELECTRONICS'

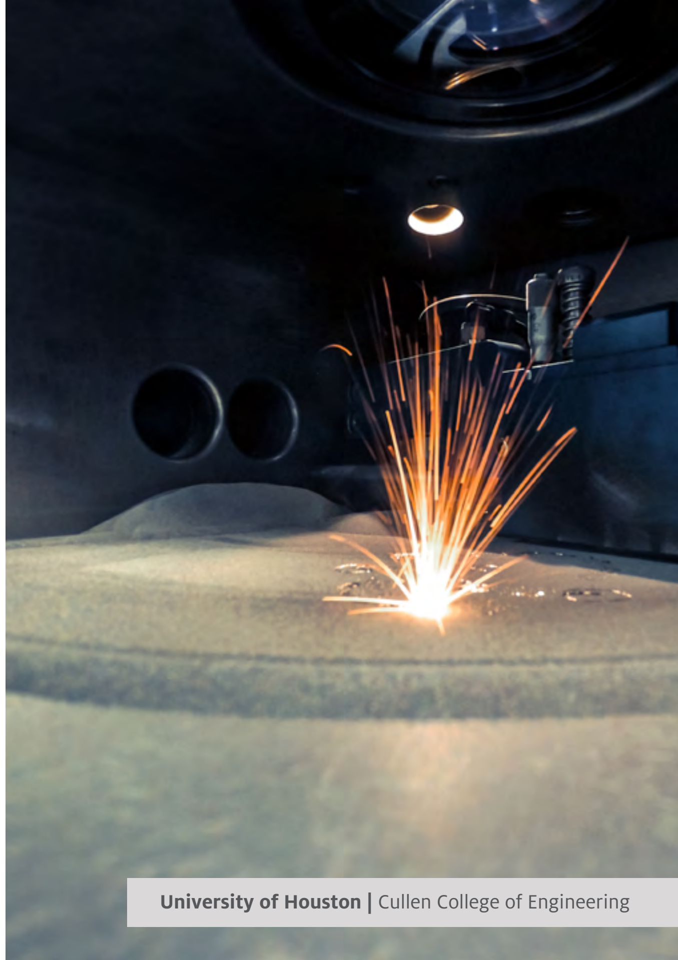
When looking at the future of production of micro-scale organic electronics, **Mohammad Reza Abidian** – Associate Professor of Biomedical Engineering at the Cullen College of Engineering – sees their potential for use in flexible electronics and bioelectronics, via multiphoton 3-D printers.

The newest paper from his research group examines the possibility of that technology. “Multiphoton Lithography of Organic Semiconductor Devices for 3D Printing of Flexible Electronic Circuits, Biosensors, and Bioelectronics” was published online June 16 in *Advanced Materials*, which has an impact factor of 30.85 as of 2020.

Three dimensional bioprinting of organic semiconductor microdevices based on MPL has potential in biomedical applications including tissue engineering, bioelectronics and biosensors. Abidian’s team successfully incorporated bioactive molecules such as laminin and glucose oxidase into the OS composite microstructures (OSCMs). To confirm that the bioactivity of laminin was retained throughout the entire MPL process, primary mouse endothelial cells were cultured on OS composite microstructures. Cells seeded on laminin incorporated OSCMs displayed evidence of adherence to substrate, proliferation, and enhanced survival.

Co-authors on the paper include former graduate students **Omid Dadras-Toussi** and **Milad Khorrami**; and postdoctoral researcher **Anto Sam Crosslee Louis Sam Titus**. Abidian praised the work of his students on this research.

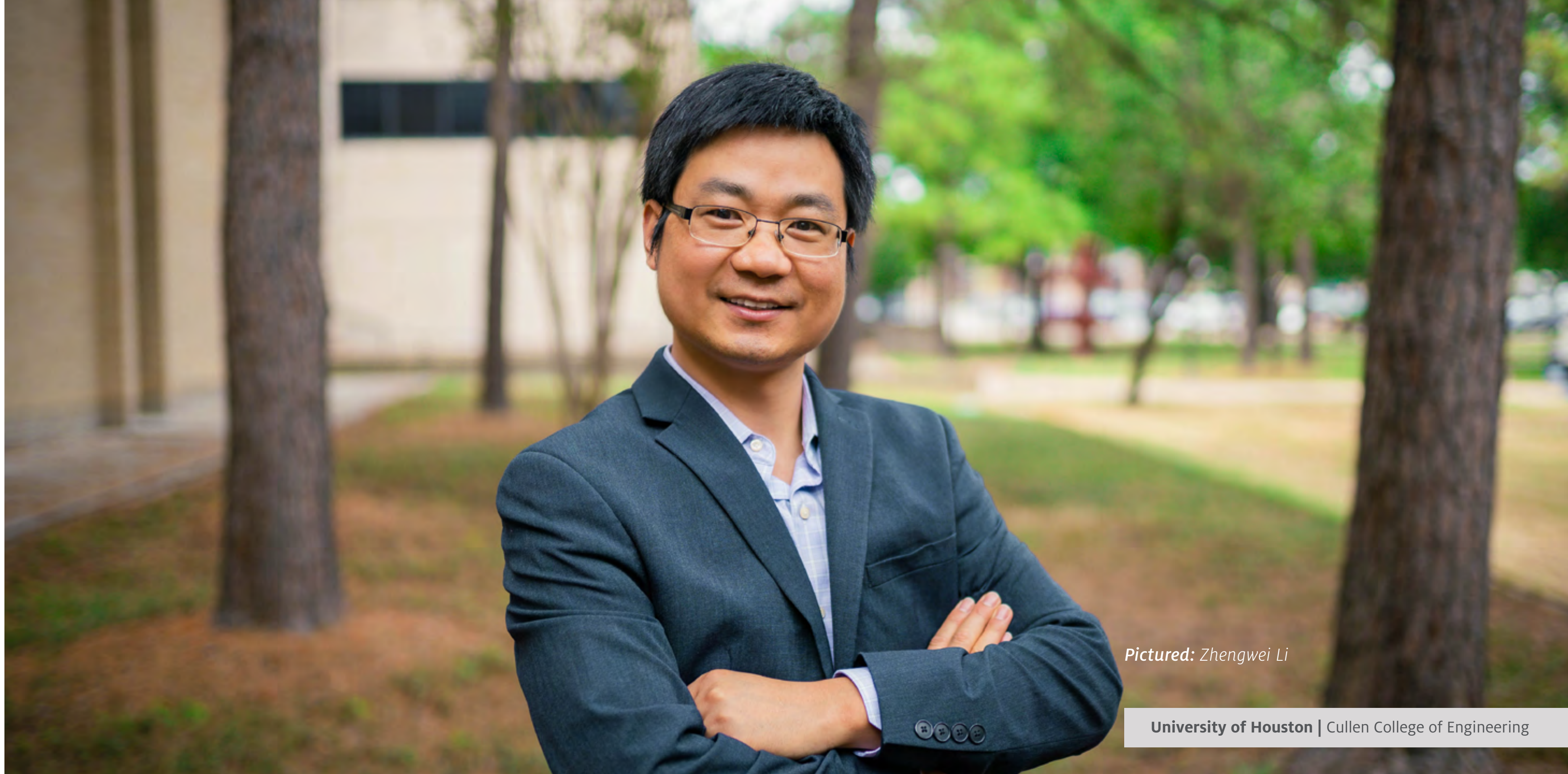
Sheereen Majd, Associate Professor of Biomedical Engineering, and **Chandra Mohan**, Hugh Roy and Lillie Cranz Cullen Endowed Professor of Biomedical Engineering, are also co-authors on the paper from the Cullen College of Engineering. Abidian said his colleagues were significant collaborators for the research.



ZHENGWEI LI JOINS BIOMEDICAL ENGINEERING DEPARTMENT

Zhengwei Li has joined the UH Department of Biomedical Engineering as an assistant professor for Fall 2022.

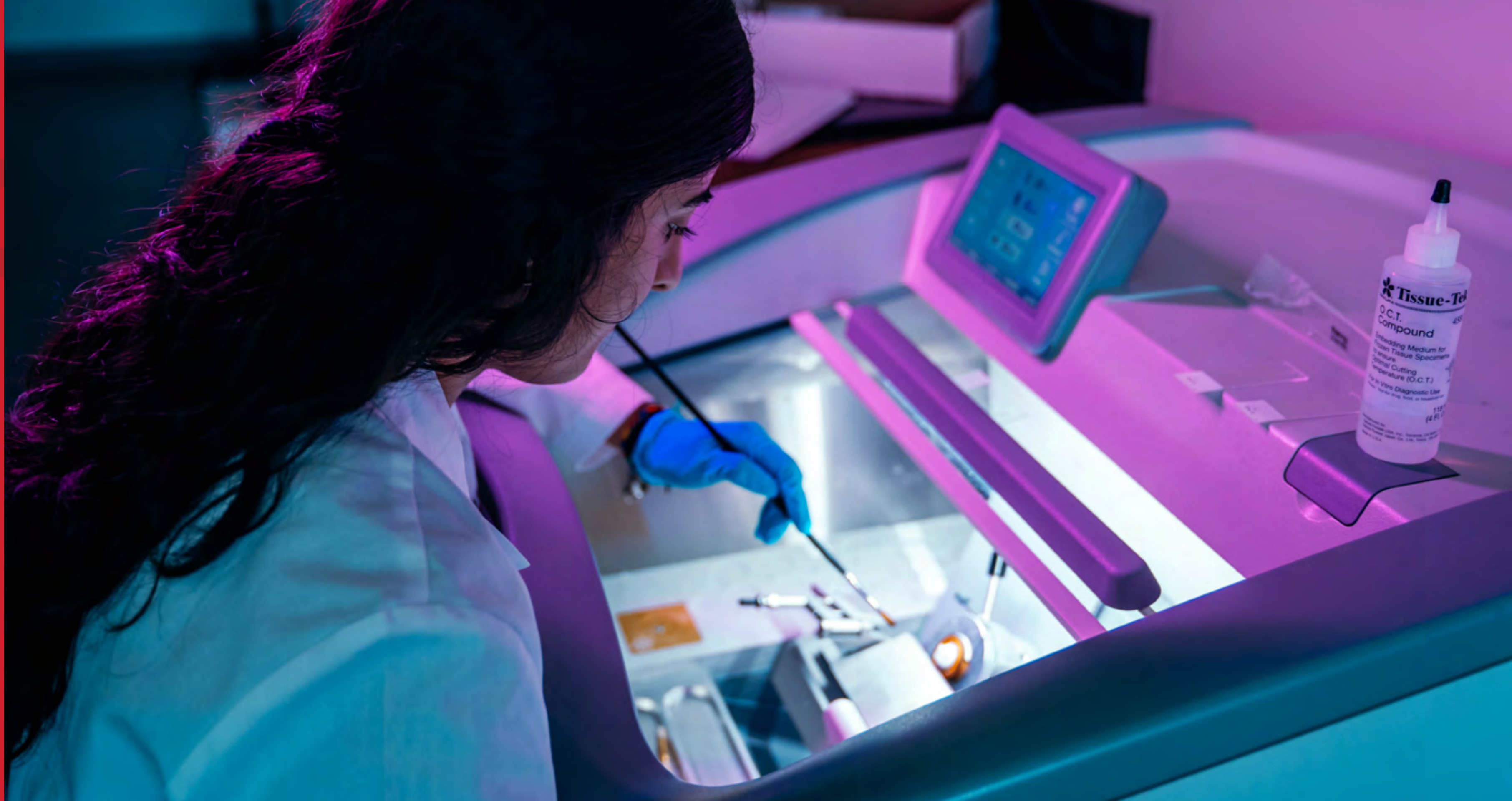
A 2017 doctoral graduate of the University of Colorado, Li spent the past year working as a postdoctoral fellow at Northwestern University, researching the fabrication of wireless, optogenetic electronics for neuroscience research. Li also served as a postdoctoral research associate at the University of Illinois for three years.



Pictured: *Zhengwei Li*

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 spear-heading research that has a real, direct impact in the Houston region and beyond.



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UNIVERSITY OF HOUSTON

UH Cullen College of Engineering
Department of Biomedical Engineering
Science & Engineering Research Center
3517 Cullen Blvd, Room 2027
Houston, TX 77204-5060
@UHEngineering

Innovation in
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