THE FUTURE IS WHAT WE DO

RESEARCH MILESTONES IN ELECTRICAL & COMPUTER ENGINEERING

UNIVERSITY of HOUSTON | ECE

Letter from the Chair

Dear Alumni and Friends of the UH Electrical and Computer Engineering Department,

I am proud to highlight the many exciting accomplishments of the UH ECE community. These are exciting times for the department, and we welcome the opportunity to share the stories of our progress with you. This year is off to a great start. In 2019, our professors have brought in multi-million-dollar grants, covering a wide range of topics, from embryo imaging to diagnostics of solid-state lithium batteries. Notably, ECE faculty published a record number of journal publications last year, wrote new books and were featured internationally in the media.

We also owe a great deal of thanks to our department's supporters. Earlier this year, we unveiled the new, state-of-the-art Omron Senior Design and Robotics Laboratory. The Omron Senior Design and Robotics Lab is truly a game changer for the electrical and computer engineering department because it gives our students the opportunity to work with the latest technology, the latest equipment and the latest software — all provided by Omron.

As our enrollment continues to grow, our admission standards are also increasing. I am proud to say that our current body of ECE students at the UH Cullen College of Engineering is made up of the strongest and most talented individuals our department has ever had the pleasure of educating.

Thank you for being a friend of the UH ECE Department. I look forward to hearing from you and seeing you at upcoming departmental, college and University events!

Warm regards,

Badri Roysam
Hugh Roy and Lillie Cranz Cullen University Professor, and Department Chair
Electrical and Computer Engineering
Cullen College of Engineering
University of Houston

UH ECE BY THE NUMBERS

#72

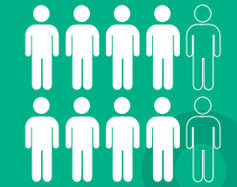
Best Electricial Engineering Program in the U.S.
(Source: U.S. News and World Report)

BEST GRAD SCHOOLS U.S.News & WORLD REPORT ENGINEERING

228 Graduate Students + **614** Undergraduate Students = **842** Total Students

Best Engineering Program of **2020**

22:1 University-Wide Student to Faculty Ratio



80%

of UH Engineering Undergrads are Employed Within

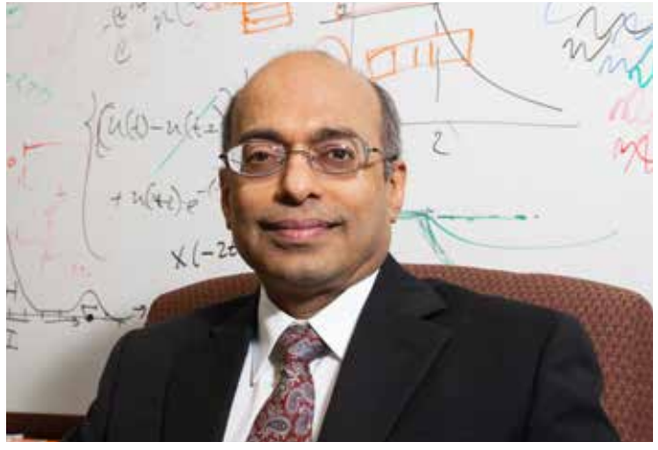
1

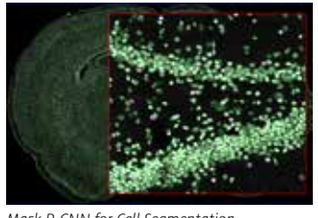
Year of Graduation

Targeting New Treatments for Concussions by

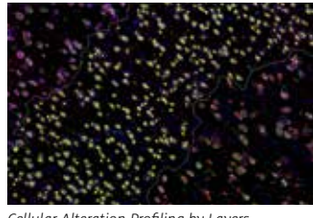
TRANSFORMING BRAIN PATHOLOGY

Badri Roysam, chair of the Department of Electrical and Computer Engineering at the UH Cullen College of Engineering, is leading a $3.19 million project to create new technology that could provide an unprecedented look at the injured brain. The technology is a marriage, as Roysam calls it, between a new generation of "super microscopes" that deliver detailed multi-spectral images of brain tissue, and the UH supercomputer at the HPE Data Science Institute, which interprets the data. Funded by the National Institute of Neurological Disorders and Stroke (NINDS), the project will help researchers understand the body's complicated natural processes coupled with drug treatments and side effects following a brain injury. Untangling these processes will allow the team to develop new medication "cocktails" of two or more drugs. Once validated, the new technology can also be applied to strokes, brain cancer and other degenerative diseases of the brain.





Mask R-CNN for Cell Segmentation



Cellular Alteration Profiling by Layers

BRAIN STIMULATION

for PTSD Patients

For the 8 million adults who suffer from post-traumatic stress disorder in any given year, medication and cognitive therapy have been the treatment protocol. Now, University of Houston assistant professor of electrical engineering **Rose T. Faghih** is reporting in *Frontiers in Neuroscience* that a closed-loop brain stimulator, based on sweat response, can be developed not only for PTSD patients, but also for those who suffer an array of neuropsychiatric disorders. The ultimate goal will be to develop closed-loop prototypes that can eventually be used for treating patients in a variety of neuropsychiatric disorders. Faghih's graduate researchers Dilranjan Wickramasuriya and Md. Rafiul Amin were first and second authors, respectively, of the article. This project was supported, in part, by a grant from the National Science Foundation.

Faculty Spotlight on

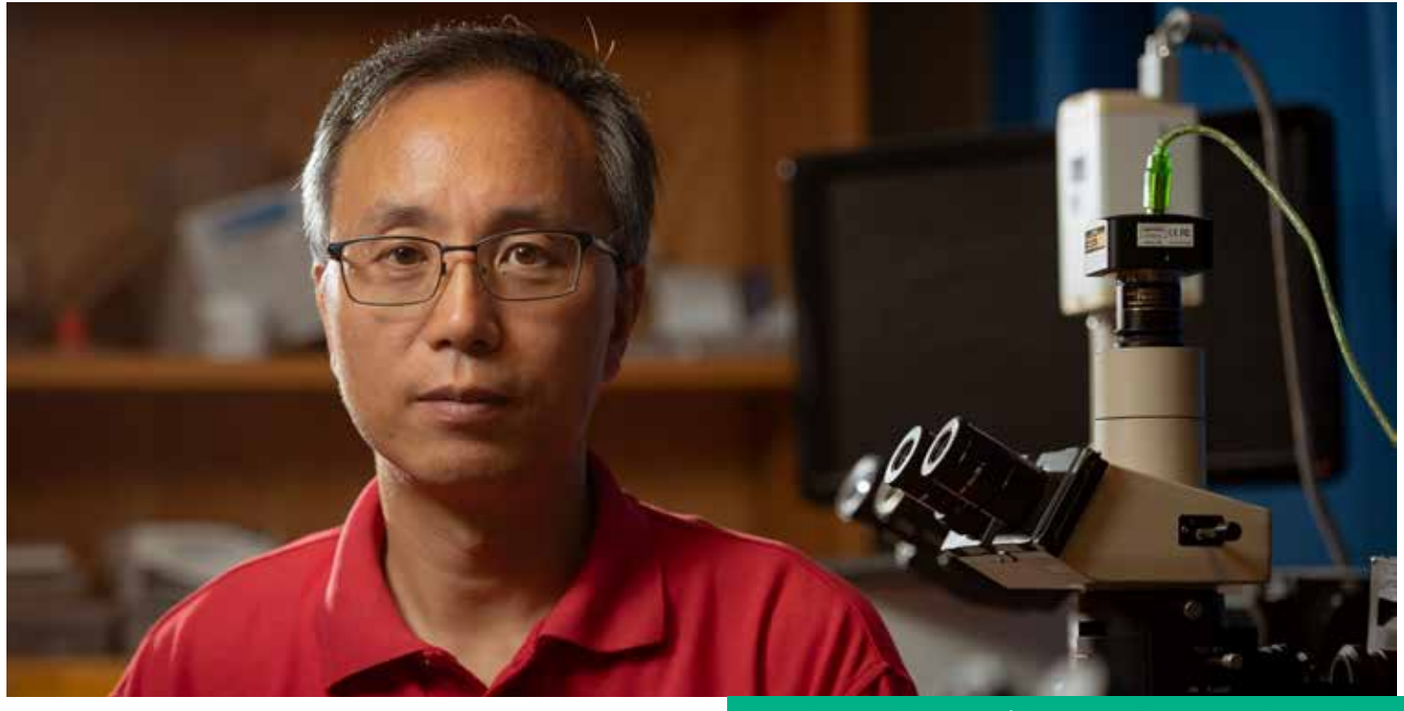
JIMING BAO

Jiming Bao, professor of electrical and computer engineering, has had a tremendous year so far.

Bao's work regarding visible light from 2D Lead Halide Perovskites was recently reported in the journal *Advanced Materials*. Researchers drew attention three years ago when they reported that a two-dimensional perovskite — a material with a specific crystal structure — composed of cesium, lead and bromine emitted a strong green light, an important finding for optical applications ranging from light-emitting devices to sensitive diagnostic tools. In the journal article, researchers led by Bao state that they have used sophisticated optical and high-pressure diamond anvil cell techniques to determine not only the mechanism for the light emission but also how to replicate it. The new understanding of the light emission will yield new opportunities to design and fabricate novel optoelectronic devices.

Bao also recently reported findings of a new light-activated micro pump in *Proceedings of the National Academy of Sciences*. Using a plasmonic quartz plate implanted with gold atoms, the researchers demonstrated the ability to move liquids by using a laser to generate an ultrasonic wave. The work is based on a new optofluidics principle discovered by Bao's lab and reported in 2017. That work explained how a laser could be used to trigger a stream of liquid, coupling photoacoustics with acoustic streaming.

Earlier this year, Bao also earned a $240,000 award — his fourth Welch award — to continue studying cobalt oxides as viable catalysts for energy generation. He was also recently elected as a Fellow of the American Physical Society (APS).



Enhancing Mobile **VIRTUAL REALITY**/Augmented Reality User Experiences

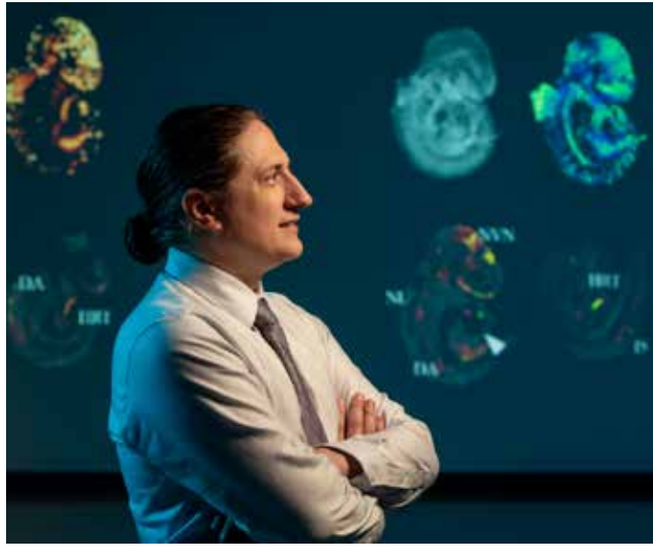
The National Science Foundation recently awarded three universities a $450,000 grant to work on a project titled "Enhancing Mobile VR/AR User Experience: An integrated Architecture-System Approach." The institutions involved are: the University of Florida as the lead, the University of Houston and Western New England University.

Xin Fu, associate professor of electrical and computer engineering, is the UH principal investigator on the project. The proposed research, which leverages the unique features of VR/AR to holistically and cooperatively tackle these challenges with integrated architecture and system support, will open the door for the next generation of mobile platforms that provide high-quality low-power VR/AR services to satisfy numerous mobile users. The results of the research could impact VR/AR products and applications in a great number of fields, including education, medical and entertainment. According to Fu, the proposed research will enable mobile devices to meet the increasing demands for excellent VR/AR user experience. It will also enable the launch of more innovative VR/AR applications into the mobile device market, making everyday living and working more convenient and efficient.

Imaging Technology Will Offer New Clues to **EMBRYONIC DEVELOPMENT**

Soon after conception, an embryo's circulatory system connects to that of its mother. Complications that occur at this critical time can result in miscarriage or birth defects with long-term chronic conditions. Unfortunately, limitations in imaging technologies prevent researchers from fully understanding the cellular-level events leading up to this crucial point.

Researchers from the University of Houston's Cullen College of Engineering and Baylor College of Medicine are developing a new technology to allow simultaneous imaging of both embryonic structural development and the molecular underpinnings that occur in the developing circulatory system. **David Mayerich**, assistant professor of electrical and computer engineering at UH, is leading the $3.7 million project funded by the National Heart, Lung and Blood Institute,



with Kirill Larin, professor of biomedical engineering at UH. Ultimately, they hope to identify biomarkers correlated with certain birth defects, improving early detection and potentially leading to treatments that could help avoid miscarriage and fetal death.

Evolving Solid-State **LITHIUM BATTERIES**

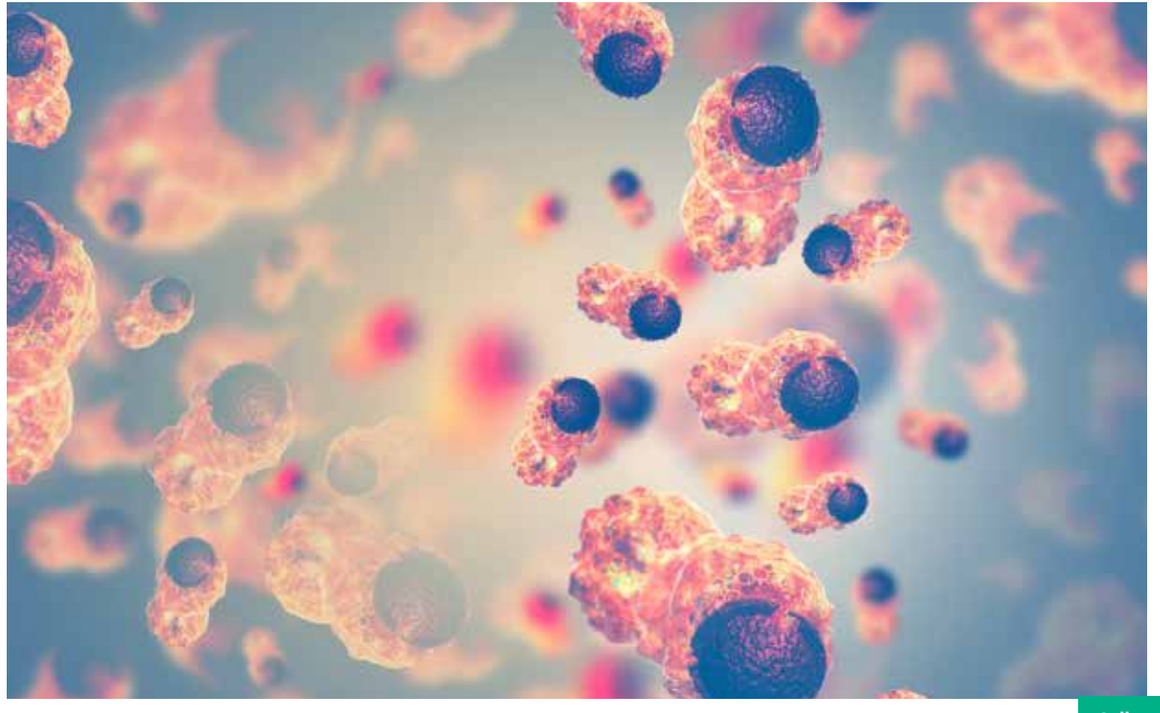
Yan Yao, associate professor of electrical and computer engineering, was recently awarded $1 million by the U.S. Department of Energy for his proposed project titled, "Multidimensional Diagnostics of the Interface Evolutions in Solid-State Lithium Batteries". The objective of this project is to research, develop, and demonstrate combined chemical, structural, and mechanical diagnostics of the interfaces and their evolutions during cell operation using in situ time-of-flight secondary ion mass spectrometry (ToF-SIMS), focused ion beam scanning electron microscopy (FIB-SEM), in-SEM nanoindentations and atomic force microscopy (AFM) in ToF-SIMS.

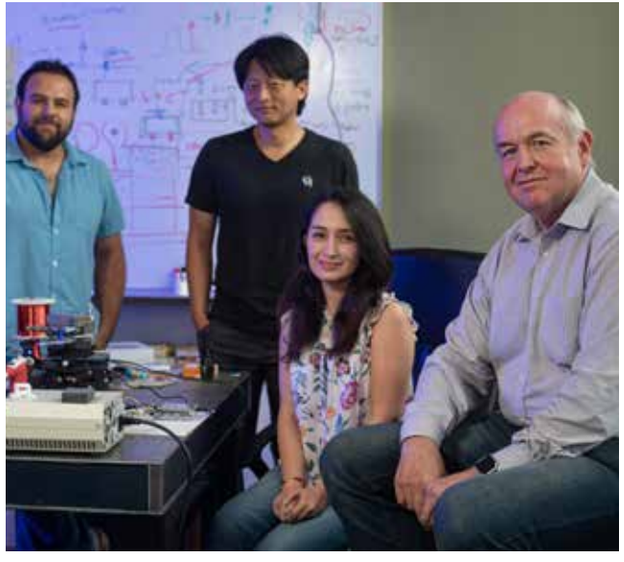
IMPROVING OUTCOMES

for Prostate Cancer Patients

Dmitri Litvinov, professor of electrical and computer engineering at the University of Houston, is leading a team working to bring a new biosensor for detecting the recurrence of prostate cancer to the doctor's office. According to Litvinov, such tests exist in clinical laboratories, but there remains a critical need for inexpensive, versatile and high-sensitivity diagnostic platforms. The work is funded by a $399,988 grant from the National Science Foundation.

The population that would immediately benefit from such a point-of-care test are prostate cancer patients who have undergone radical prostatectomy but have positive surgical margins, with cancer cells detected at the edge of the removed tissue. These patients are at high risk for recurrence, and long-term ultrasensitive prostate specific antigen (PSA) monitoring is required. The proposed biosensor platform will be based on an ultrahigh sensitivity magnetic nanoparticles detector and will look similar to a home pregnancy test with an electronic readout. As a bonus for healthcare providers and patients alike, it's expected to cost under $3 per test. Because the tool will provide immediate information and be





easily accessible, Litvinov believes it will provide early and affordable detection of disease recurrence. Timely identification of the appropriate treatment options can improve long-term patient outcomes.

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 $30 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.

UNIVERSITY of HOUSTON | ECE

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Research MILESTONES