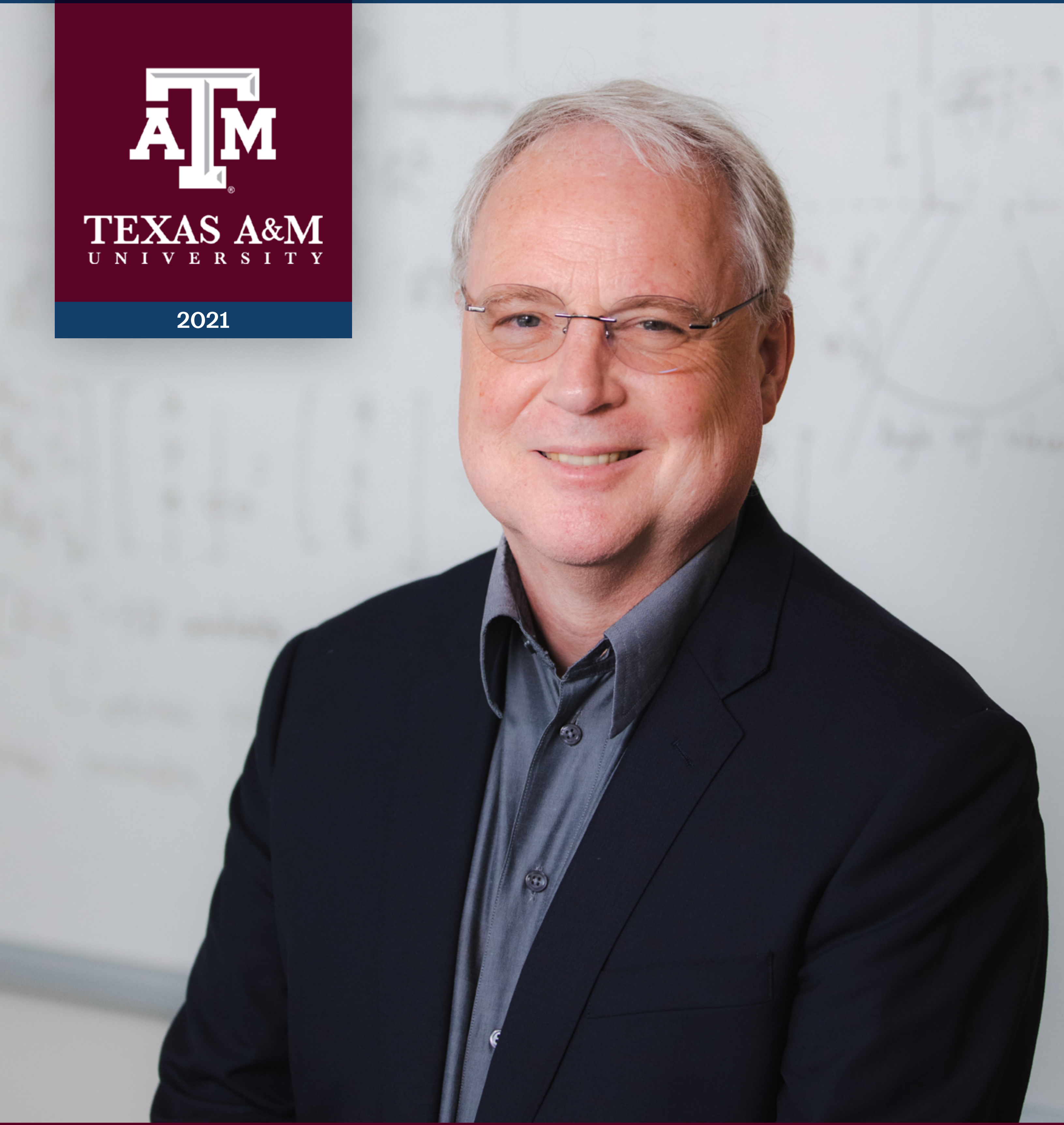
TEXAS A&M UNIVERSITY

2021



DEPARTMENT OF

ELECTRICAL & COMPUTER ENGINEERING

LETTER FROM THE DEPARTMENT HEAD

Over the last year, a major challenge for both students and instructors was the abrupt transition to remote teaching. After a short period of time, both students and instructors have developed familiarity with these new practices and applied them successfully.

There have also been significant changes in our graduate student admissions due to the impact of the pandemic on travel and, even in that environment, we have been quite successful in getting students on campus. The circumstances affect various universities differently, but we were prepared and pleased with the outcome. The Texas A&M University College of Engineering's Quick Admit Graduate Program was recently established and is available to students graduating from any of our engineering bachelor's degree programs. The program provides an expedited application review process to our graduate programs for students facing one of the most precarious economies and worst hiring seasons since the financial crisis of 2007-08 due to COVID-19. This initiative will enable an increase of domestic graduate students, notably in the master's degree programs. During the 2020-21 academic year, the College of Engineering had 275 students admitted to this program.

Despite these challenges with our graduate program, our undergraduate enrollment has continued to grow throughout the pandemic. From fall 2019 to fall 2020, the College of Engineering enrollment increased by 5.6% and our department saw an enrollment increase of 10.4% over the same time period.

We kept our classrooms open and made ourselves accessible to our students. A number of our faculty volunteered to teach face-to-face classes and maintain important direct communication with students during this time.

Several of our research activities have been steadily growing and continue to do so. These initiatives include, but are not limited to, cybersecurity, machine learning, power and energy, and biomedical and COVID-related subjects. Our power and energy group faced tremendous challenges during the winter storm in February, and the Texas A&M Engineering Experiment Station Smart Grid Center addressed these challenges head on. The center is currently handling a number of projects directly and indirectly related to those circumstances. Biomedical and COVID-related projects continue to come and have helped our graduate research enterprise continue. In addition, we are planning a renewed focus on applied electromagnetics, which is an area that Texas A&M was a leader in developing a couple of decades ago.

All universities are experiencing a decline in graduate admissions. It will be a problem that will continue in the future. However, we are coping with this like many of our peers, and are hopeful that more normal operating circumstances are to come by developing more active engagement with prospective graduate student candidates.

Looking back at how we've weathered the storm, both literally and figuratively, we feel our department has had great involvement and dedication from our faculty. We are also proud to have had full participation and support from our students to allow us to succeed in as close to normal operating procedures as possible during the pandemic. When the going gets tough, Aggies deliver.

In this publication, you will see research advancements and collaborative efforts made over the last year from both our senior and young faculty.

Sincerely,

Dr. Miroslav M. Begovic, FIEEE

Department Head and Moore Professor

TEXAS A&M UNIVERSITY
Department of Electrical & Computer Engineering

BY THE **NUMBERS**

RANKINGS (*U.S. News & World Report*, 2022)

GRADUATE (Public)

#12 for Computer Engineering

#12 for Electrical Engineering

UNDERGRADUATE (Public)

#11 for Computer Engineering

#8 for Electrical Engineering

GRADUATE (Overall)

#22 for Computer Engineering

#20 for Electrical Engineering

UNDERGRADUATE (Overall)

#17 for Computer Engineering

#14 for Electrical Engineering

ENROLLMENT* (FALL 2021)

**preliminary, 5th class day*

1,500 Undergraduate

555 Graduate

DEGREES AWARDED*

(AY 2020-21) **preliminary*

335 B.S. **198** M.S. **42** Ph.D.

DIVERSITY

21.1% Female Graduate Students

15.1% First Generation Students *(Undergraduate and Graduate)*

FACULTY

71 Tenured/Tenure-Track faculty

11 Academic Professional Track faculty

4 Distinguished Professors

9 Chairs

6 Members of the National Academies

14 Professorships

35 IEEE Fellows

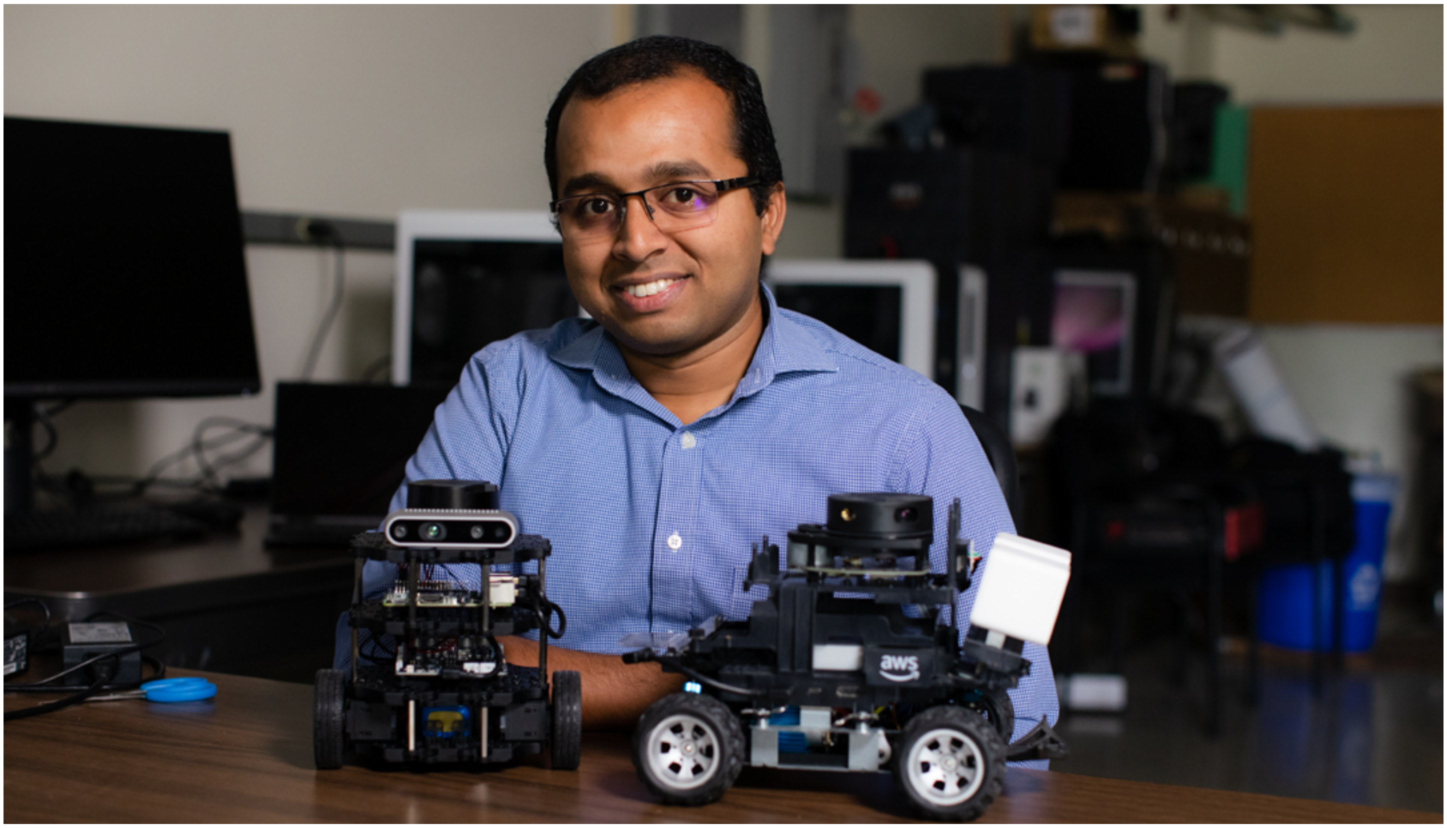
RESEARCH EXPENDITURES

$31.64 MILLION IN 2020

RESEARCH LAB SPACE

52,375 Total Square Footage

KALATHIL RECEIVES NSF CAREER AWARD
TO EXPLORE REINFORCEMENT LEARNING



Dr. Dileep Kalathil received the NSF Faculty Early Career Development (CAREER) Award for his proposal titled “Towards a Principled Framework for Resilient, Data Efficient and Scalable Reinforcement Learning for Control.” He will use this award to address three significant challenges of the artificial intelligence evolution — resiliency, scalability and data efficiency of the system.

To tackle these challenges, he is using reinforcement learning principles and investigating the issue of scalability so that machine-learning systems can be integrated for large-scale technologies, such as massive power systems. He is also exploring ways in which progress in this area of machine learning can continue, despite the fact that there is limited data available.

Kalathil will also utilize an experiential learning approach to integrate this reinforcement learning research into his educational curriculum by working with students on the Aggie Deep Racer project — a tiny autonomous toy car used for testing reinforcement learning models. The idea is that the algorithm can be integrated into the toy car’s system and the application can be put to practice on a real track.

“One thing I believe we should do as an engineering department is to give students the opportunity of experiential learning,” Kalathil said. “They should be able to try things, work on real-world problems and act as engineers.”

Other domains of applicability for reinforcement learning include the smart grid infrastructure, autonomous driving, natural language processing, health care and gaming applications. Recently, there has been a lot of interest in using reinforcement learning in power systems applications, especially in the control of distributed energy resources. Electricity systems are undergoing a dramatic transformation with the increasing penetration of renewable generation and proliferation of distributed energy resources (DERs), such as electric vehicles, electricity storage, rooftop photovoltaic panels and smart heating, ventilation and air conditioning systems. The capacity of DERs in the U.S. is expected to reach around 400GW by 2025 with a total investment of $80 billion. Reinforcement learning can dramatically reduce the operating cost, increase the efficiency and significantly increase the reliability of the overall energy system.

FEATURED RESEARCHER

Dr. Dileep Kalathil

Assistant Professor

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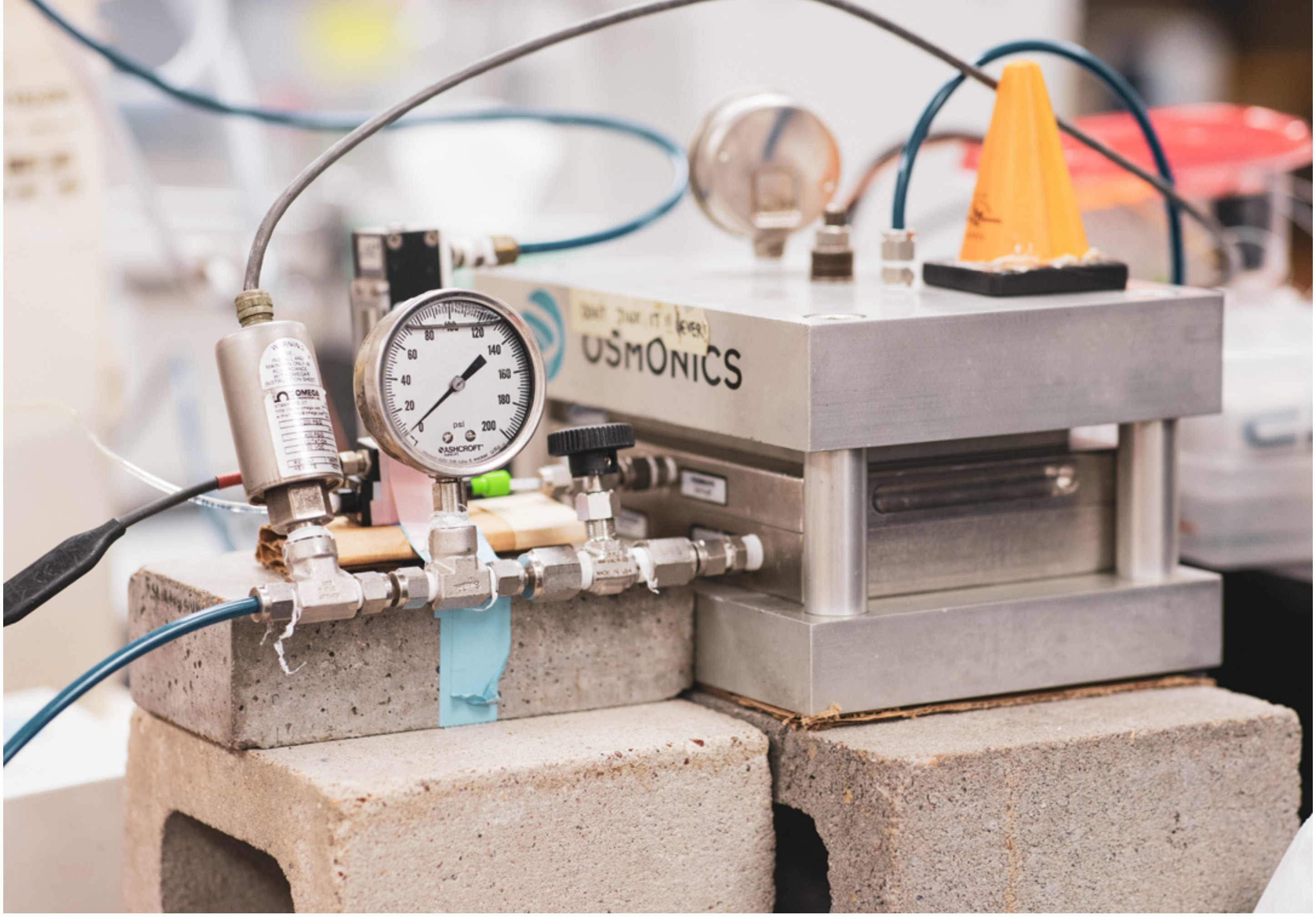

ADDRESSING BASIC NEEDS FOR UNDERPRIVILEGED COMMUNITIES

In the era of smartphones and self-driving cars, many communities still lack access to electricity and clean water. A multidisciplinary research team developed an economical, green solution capable of addressing these needs.

Their standalone water-energy nanogrid consists of a purification system that uses solar energy to decontaminate water. The setup is mathematically tuned to optimally utilize solar energy so that the water filtration is unhindered by the fluctuations of solar energy during the day.

An efficient way to decontaminate water is by passing it through purification systems that utilize pumps to push water through a filter. However, the pumps require electricity, which is scarce in many remote regions. The researchers looked for a solution that would support the power and water requirements of these communities.

Their model revealed that by using nanofiltration, a type of purification technique, harvesting solar energy during peak availability only was sufficient to run pumps and purify water. In other words, the water nanofiltration system was largely unaffected by the day-to-day vagaries in solar energy and could purify enough water to meet the weekly needs of the community.

Any excess solar power unused for filtration could be stashed away either for storage in the battery pack or other basic household needs, like charging cell phone batteries.

Using a rigorous mathematical approach to interlink water purification and energy provision, a robust quantitative framework was developed that can be used in any scenario based on local conditions.

This work was supported in part by the Texas A&M Engineering Experiment Station, the Texas A&M Energy Institute and the National Science Foundation.

FEATURED RESEARCHER

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COMBATING **OBESITY**

Complications associated with obesity have a significant economic impact on the health care system in the United States, costing $147 billion a year.

Dr. Sung Il Park and his collaborators are working on a medical device that could help with weight loss and requires a simpler operative procedure for implantation than current solutions.

The centimeter-sized device provides the feeling of fullness by stimulating the endings of the vagus nerve with light. Unlike other devices that require a power cord, the team's device is wireless and can be controlled externally from a remote radio frequency source.

In recent years, the vagus nerve has received much attention as a target for treating obesity since it provides sensory information about fullness from the stomach lining to the brain. Although there are medical devices that can stimulate the vagus nerve endings and consequently help curb hunger, these devices are similar in design to a pacemaker; that is, wires connected to a current source provide electrical jolts to activate the tips of the nerve.

Alternatively, Park said that wireless technology and the application of advanced genetic and optical tools have the potential to make nerve stimulation devices less cumbersome and more comfortable for the patient. He also explained that there is no risk to patients as pacemakers and nerve stimulation devices have been approved by the United States Food and Drug Administration.

"Our novel tool now enables interrogation of neuronal function in the peripheral nervous systems in a way that was impossible with existing approaches," said Park.

This work has been supported by grants from the interdisciplinary X-Grants Program, a NARSARD Young Investigator Award from the Brain and Behavior Research Foundation, the National Science Foundation's Engineering Research Center for Precise Advanced Technologies and Health Systems (PATHS-UP), the University of Washington Diabetes Research Center and the National Institutes of Health.

FEATURED RESEARCHER

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DESIGNING CUSTOM PROCESSORS WITH BOLSTERED SECURITY

Dr. Jeyavijayan "JV" Rajendran is partnering with Intel Corporation for the DARPA-Structured Array Hardware for Automatically Realized Applications (SAHARA) project. The three-year partnership enables the design of custom computer chips that incorporate advanced security countermeasure technologies for widespread applications, including government security.

The SAHARA project is facilitating the automated conversion of field-programmable gate arrays (FPGAs), which provide basic functionality that can be modified post-production into secure application-specific integrated circuits (ASICs), providing fixed functionality. This integration will strengthen the security of the processors and improve overall performance.

"What Intel is doing with this ASIC technology is they are taking the best of both worlds, where you can have the configurability of FPGA style but close to ASIC-like performance," Rajendran said.

Rajendran explained that this project will bolster the semiconductor industry and have widespread impact in industries, such as the smart grid and other critical infrastructure elements.

"The goal of the SAHARA program is to utilize structured ASICs to meet the performance and security needs of the electronic components used in diverse Department of Defense applications," said Kostas Amberiadis, ASIC design engineer at Intel Corporation.

"SAHARA aims to enable a 60% reduction in design time, a 10-times reduction in engineering costs and a 50% reduction in power consumption by automating the FPGA-to-structured-ASICs conversion," said Serge Leef, a program manager in DARPA's Microsystems Technology Office, when announcing the project.

Dr. Jeyavijayan "JV" Rajendran
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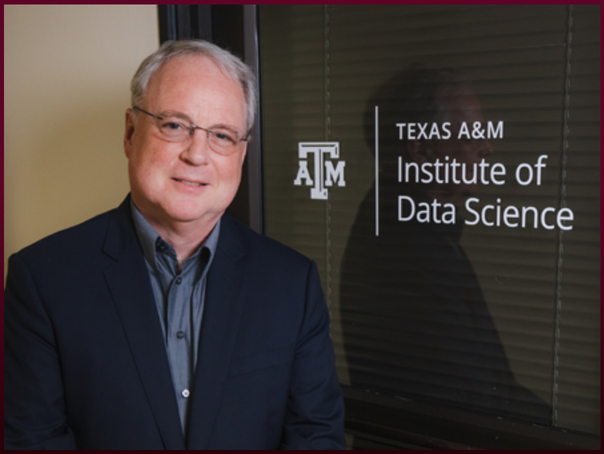
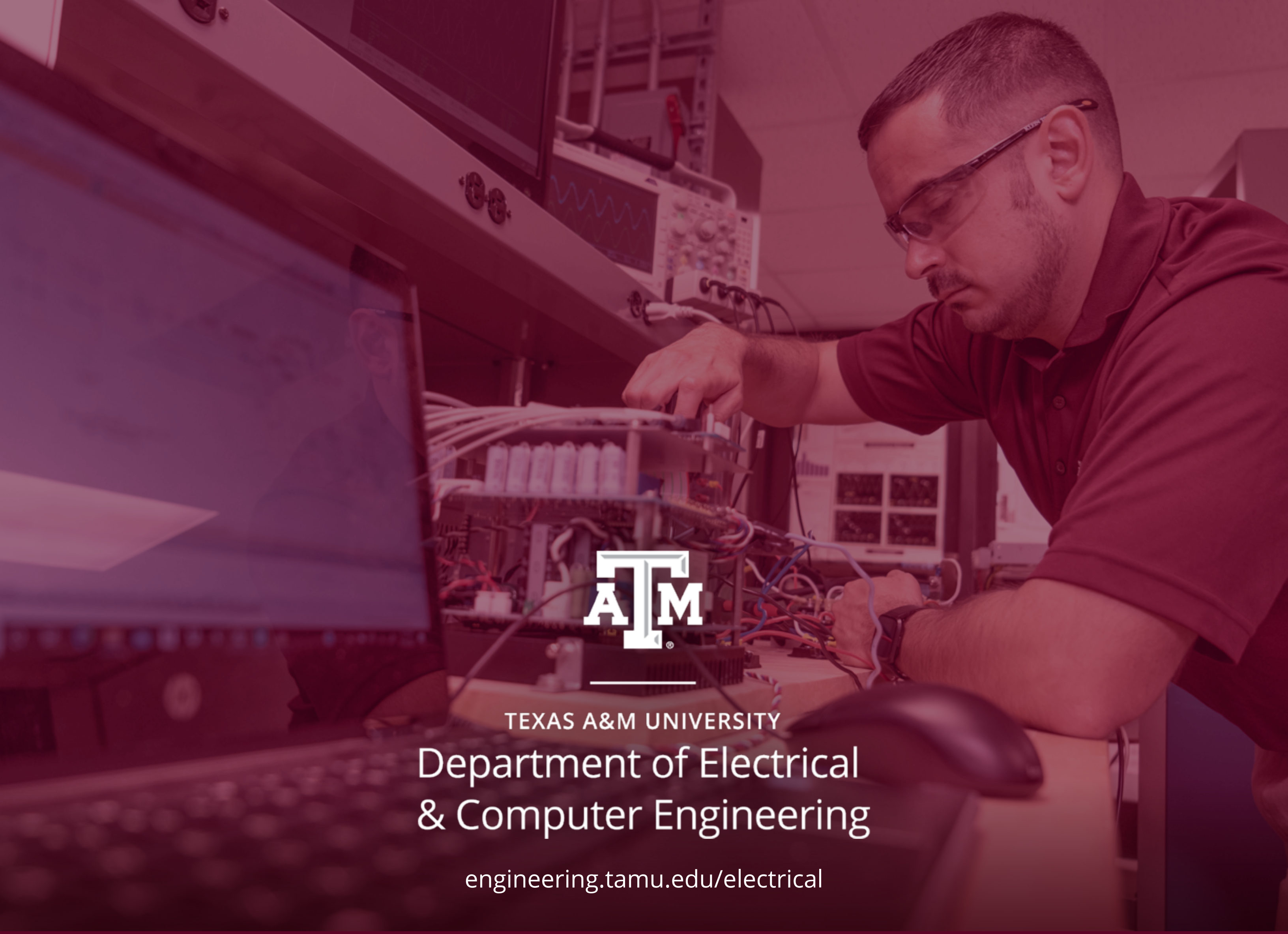
Rajendran's students and postdoctoral researchers are also working closely with Intel on this project and receiving invaluable experience at this stage of their academic and professional careers to bridge the gap between academia and industry.

ON THE COVER:

Dr. Nick Duffield is the director of the Texas A&M Institute of Data Science (TAMIDS). TAMIDS pursues new approaches to data science research, education, operations and partnership that cross college boundaries to connect elements of data science from engineering, technology, science and the humanities, and inform wider social challenges. TAMIDS now offers a Master of Science in Data Science, an on-campus interdisciplinary program that is offered by several departments and administered jointly with the institute.

Dr. Nick Duffield
Royce E. Wisenbaker Professor I
Electrical and Computer Engineering





DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

AREAS OF FOCUS

- Analog and Mixed Signal
- Biomedical Imaging, Sensing and Genomic Signal Processing
- Computer Engineering and Systems
- Device Science and Nanotechnology
- Electromagnetics and Microwaves
- Power and Energy
- Information Science and Learning Systems