TEXAS A&M UNIVERSITY

Dr. Arum Han
Professor and Presidential Impact Fellow

Han is one of several faculty members in the department actively involved in impactful and crucial COVID-19-related research. See back cover for details.

2020

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

LETTER FROM THE
DEPARTMENT HEAD

We are leading in times of unprecedented challenges for our world, for our country and for higher education. Over the course of a couple of decades, there have been growing discussions about the role that universities have to fulfill – the role to create a well-trained and ready workforce for all aspects of engineering employment and support within manufacturing companies, service companies, consulting firms, government agencies and elsewhere. Texas A&M University represents one of the schools that has been successful in creating a stream of well-trained engineers ready to enter the workforce.

The mission of the College of Engineering is to serve Texas, the nation and the global community by providing engineering graduates who are well-rounded in engineering fundamentals, instilled with the highest standards of professional and ethical behavior, and prepared to meet the complex technical challenges of society. In 2019, 57% of our graduates were employed immediately upon graduation and poised to fill the gap of engineers needed to make real change in our field.

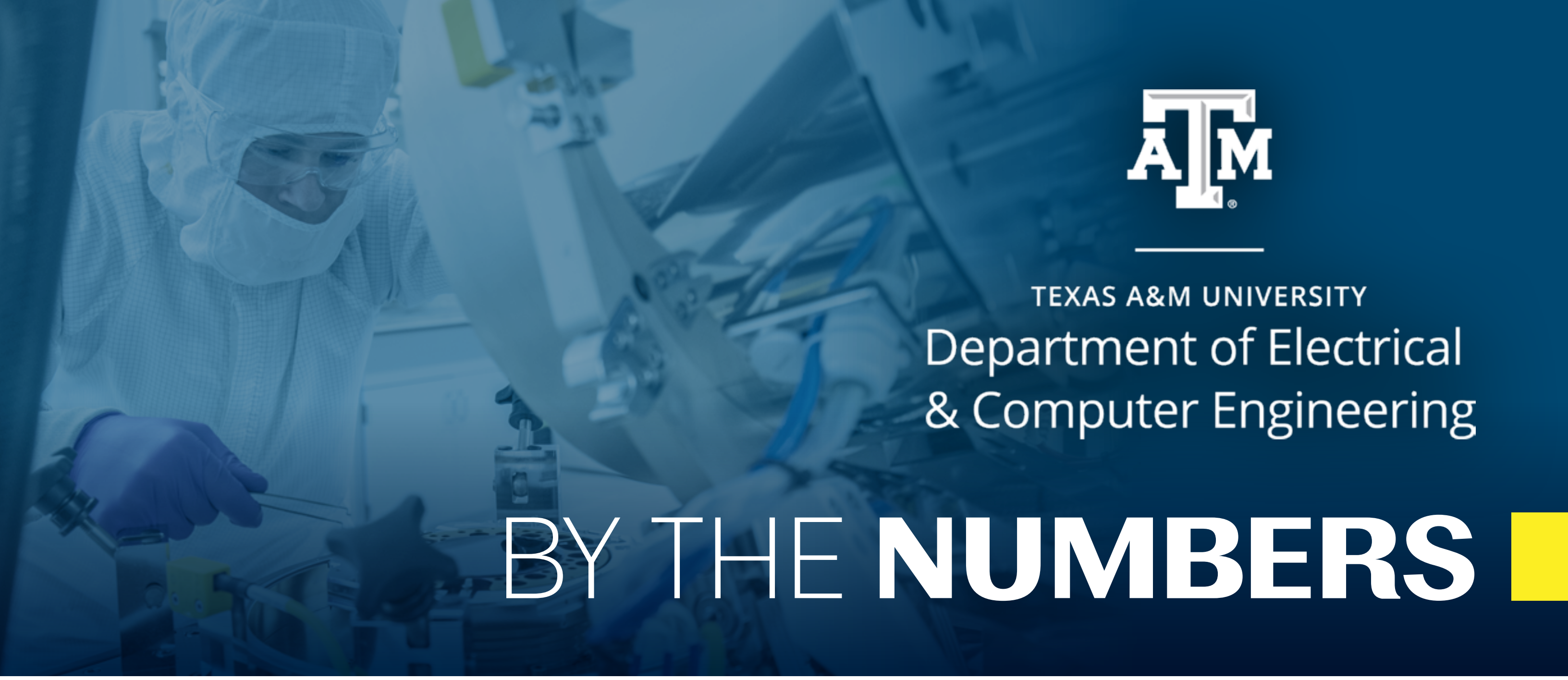
We are facing the unique challenge of bringing students on campus and preparing them to be the top candidates in the job market. We are working to fulfill those needs for well-trained engineers as the geopolitical situation is continually changing and many of our students are facing financial and other difficulties. We are responding by offering Texas A&M engineering students graduating this spring and summer, with a 3.0 GPA or higher, expedited admittance to a Master of Engineering program through an application process called Quick Admit, to help them become better prepared to enter the job market following the economic storm that we are experiencing right now.

As enablers of that process, our faculty members have responded with resilience by making strides to not only continue with our mission to develop a strong engineering workforce, but to adapt and further expand our research operations and methods for student success. Several of our faculty have been actively involved in COVID-19-related research as a consequence of the sudden needs that the pandemic has created. In addition, faculty have adapted to the new teaching environment by developing and refining techniques for remote and online course and lab delivery while making a sustained effort to provide face-to-face instruction as much as safely possible. Further, they are investigating ways that these instructional techniques can be repurposed into normal teaching activities once the pandemic has concluded.

In this publication, you will see research and advancements made over the past year from our faculty, both senior and young faculty, in the areas of power and energy and biomedical engineering, and in the applications of lasers. We are looking forward to another productive year in spite of our circumstances. We wish the same for you.

Sincerely,

Miroslav M. Begovic
Department Head
College of Engineering Excellence Professor



TEXAS A&M UNIVERSITY
Department of Electrical & Computer Engineering

BY THE NUMBERS

RESEARCH LAB SPACE

52,812 Total Square Footage

RESEARCH EXPENDITURES

$22.49 MILLION IN 2019

The Zachry Engineering Education Complex adds over half a million instructional space and top-notch labs for students

ENROLLMENT*

(FALL 2020)

1,449 Undergraduates

579 Graduates

*preliminary

FACULTY

71 Tenured/Tenure-Track faculty

11 Non-Tenure Track faculty

7 Chairs

16 Professorships

3 Distinguished Professors

6 Members of the National Academies

32 IEEE Fellows

DEGREES AWARDED (FALL 2019-SPRING 2020)

277 Bachelor's

174 Master's

31 Ph.D.

A 'CRYSTAL BALL' TO STOP WILDFIRES

A new technology — unlike anything else currently in use — has been developed at Texas A&M to help electric utilities prevent wildfires and outages.

This one-of-a-kind hardware and software system called Distribution Fault Anticipation (DFA) can diagnose problems on utility lines before outages darken neighborhoods, power failures spark wildfires or fears of wildfires prompt massive, preemptive power outages. DFA interprets variations in electrical currents on utility circuits caused by deteriorating equipment. It warns utility operators to respond to particular problems before they begin.

Engineers at Texas A&M developed DFA over 20 years of research and testing at more than a dozen utility companies across the nation.

Due to the widespread interest in preventing wildfires, Dr. B. Don Russell testified in December 2019 before the U.S. Senate Energy and Natural Resources Committee to explain the technology's advantages.

Until now, utility companies had to wait and react to failures because electrical equipment is durable and deterioration of devices is difficult to see. That makes visual inspection and preventive maintenance only marginally helpful.

Utility representatives have long recognized that something new is needed to address the nation's aging infrastructure. DFA answers this need.

DFA was developed as a 'crystal ball' to help utility companies forecast reliability, but the team also saw its potential for preventing wildfires, as more than 4,000 Texas wildfires were caused by power lines in 2009, 2010 and 2011, the Texas A&M Forest Service found.

The Texas A&M research team is led by Russell and Dr. Carl L. Benner.

FEATURED RESEARCHERS

Dr. B. Don Russell
Engineering Research Chair Professor, Regents Professor, Harry E. Bovay, Jr. Chair
bdrussell@tamu.edu

Dr. Carl Benner
Research Professor
carl.benner@tamu.edu

GRANT TO ENHANCE SOLAR TECHNOLOGY

To support the progression of solar power as the cleanest and most abundant renewable energy source available, the Department of Energy announced it would provide $128 million in funding to advance solar technologies. Among the 75 teams awarded is a group led by Dr. Le Xie, Dr. P.R. Kumar and Dr. Prasad Enjeti, who received $4.4 million for their project, "Secure Monitoring and Control of Solar PV Systems through Dynamic Watermarking."

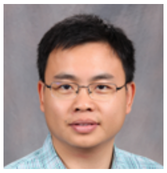
They will develop and demonstrate an active defense mechanism of the photovoltaic (PV) distribution system operation using a dynamic watermarking technique to monitor cybersecurity. The technique involves injecting a probe signal onto the grid to authenticate grid actions, allowing the team to determine if the grid is manipulated by hackers. The approach will include real-time deployment of online computational algorithms in critical locations.

In the smart grid, the cyber and physical layers are heavily intertwined, and while this collaboration is extremely valuable, hackers are able to compromise the PV distribution system by intruding into the cyber layer or manipulating the meter readings.

In December 2015, a grid cybersecurity attack in Ukraine left 225,000 people without power. A similar attack was carried out a year later that caused an outage of 200 megawatts. The first grid cybersecurity attack in the U.S. was in March 2019.

"We propose a defense framework against any cyberattacks on the telemetered measurements in the PV-dominated distribution system, regardless of the attack model [or] objective," Xie said. "This is valuable in terms of providing a general-purpose guarantee since the objectives of adversaries are unpredictable." ◤

FEATURED RESEARCHERS



Dr. Le Xie
Professor
le.xie@tamu.edu

Dr. P.R. Kumar
Regents Professor, Distinguished Professor, College of Engineering Chair in Computer Engineering

Dr. Prasad Enjeti
TI Professor III in Analog Engineering
enjeti@tamu.edu

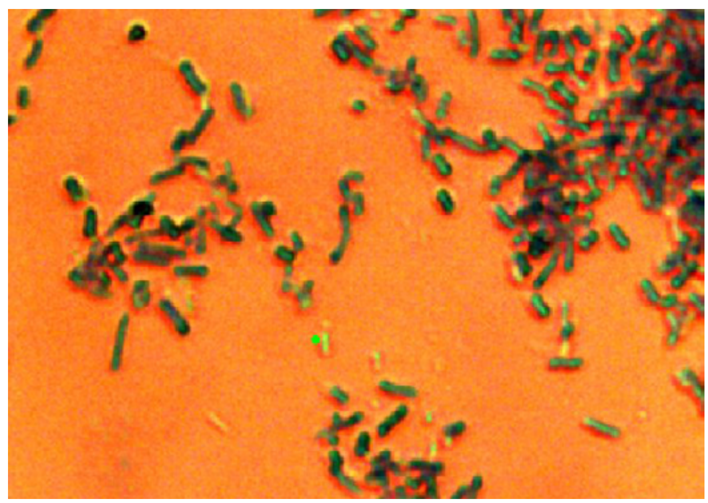
ZAPPING BACTERIA
WITH ULTRAVIOLET LIGHT

Ultraviolet light is a powerful tool against many pathogens. Although ultraviolet light can wipe out several germs, the exact mechanisms for radiation's damaging action are elusive. In a study published in the September 2019 issue of *PNAS*, Texas A&M researchers provided the science behind the germicidal action of ultraviolet light.

The team, led by Dr. Peter Rentzepis, reported that ultraviolet radiation creates holes in the microbes' outer protective sheath by dislodging tryptophan — a molecule that is an important component of the bacteria's outer covering. These holes provide gateways for ultraviolet radiation to permeate the bacteria and disrupt its DNA, which then stops the microbes from replicating.

For their experiments, the team looked at the fluorescent light emitted by tryptophan molecules in *Escherichia coli* — better known as *E. coli* — and *Bacillus subtilis* bacteria after shining a beam of ultraviolet radiation on them. As expected, they found the fluorescent light emitted by the tryptophan molecules was drastically reduced at the end of radiation, which typically lasted several minutes. Cell-counting measurements indicated that this reduced fluorescence amounted to a 70% reduction in viable bacteria within the first minute. To the team's surprise, this decreased fluorescent light came after an initial increase immediately after the radiation was turned on.

Rentzepis' research group's findings suggest that in bacteria, ultraviolet light might unfold membrane proteins and detach



tryptophan molecules. In turn, this may cause an initial increase in the emitted light signal. With tryptophan plucked out of the cell membrane, the space left behind forms gaping holes for the ultraviolet light to enter and damage DNA.

Rentzepis and his team have also developed and patented the technology for a handheld device that can collect emitted light from bacteria during the radiation process.

FEATURED RESEARCHER

Dr. Peter Rentzepis
Professor
TI Chair II
prentzepis@tamu.edu

HELPING ROBOTS ACQUIRE STEADIER HANDS FOR SURGERY

In a study published in the January issue of the journal *Scientific Reports*, researchers at Texas A&M show that by delivering small, yet perceptible buzzes of electrical currents to fingertips, users can receive an accurate perception of distance to contact. This is critical during intricate procedures often performed remotely by surgeons using robot-assisted surgical systems.

These insights enabled users to control their robotic fingers precisely enough to gently land on fragile surfaces. This may be an effective way to help surgeons reduce inadvertent injuries during certain procedures.

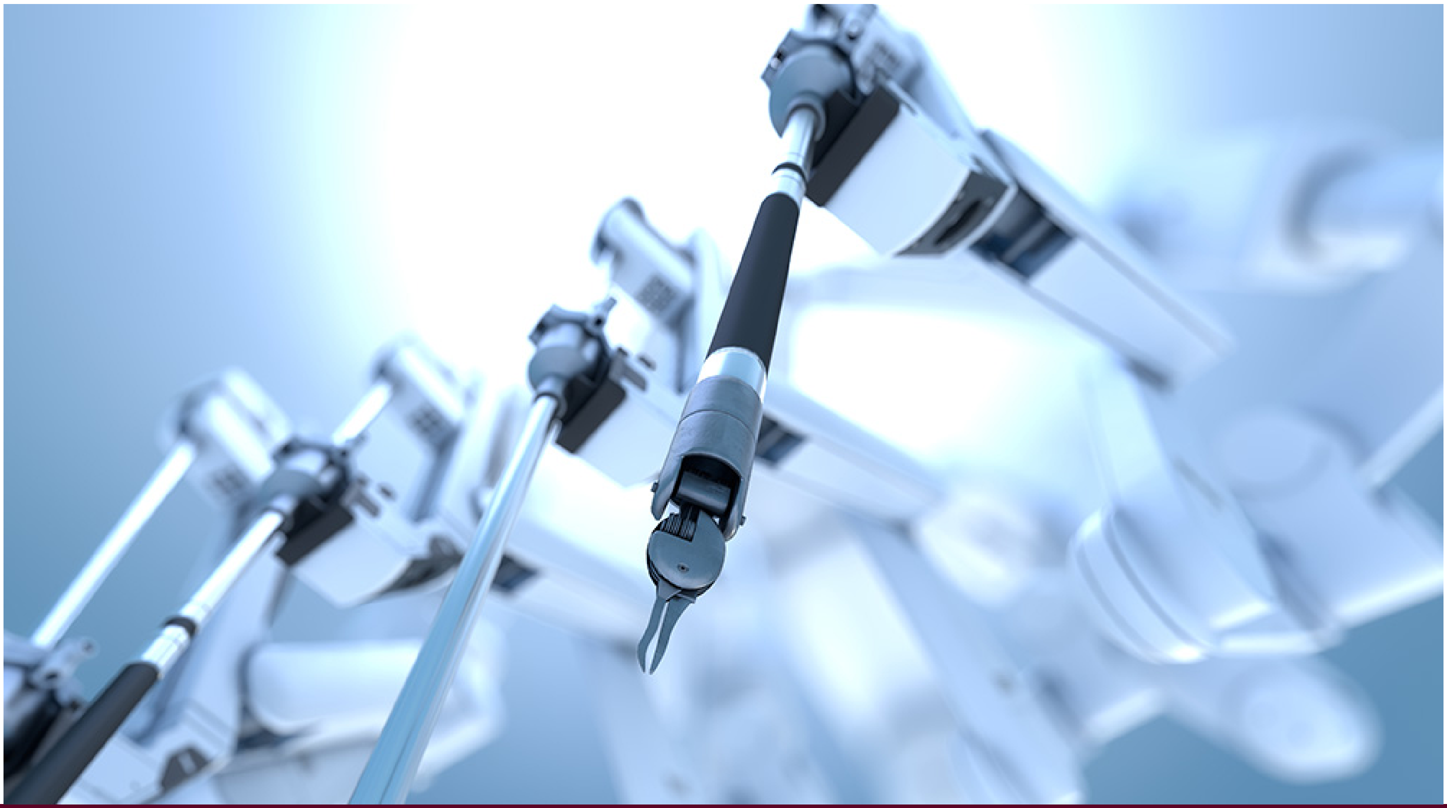
To move their robotic fingers precisely, surgeons rely on live streaming visual information from cameras fitted on telerobotic arms. However, visual information is not enough to guide fine finger movements, which is critical when the fingers are in close vicinity of the brain or other delicate tissue.

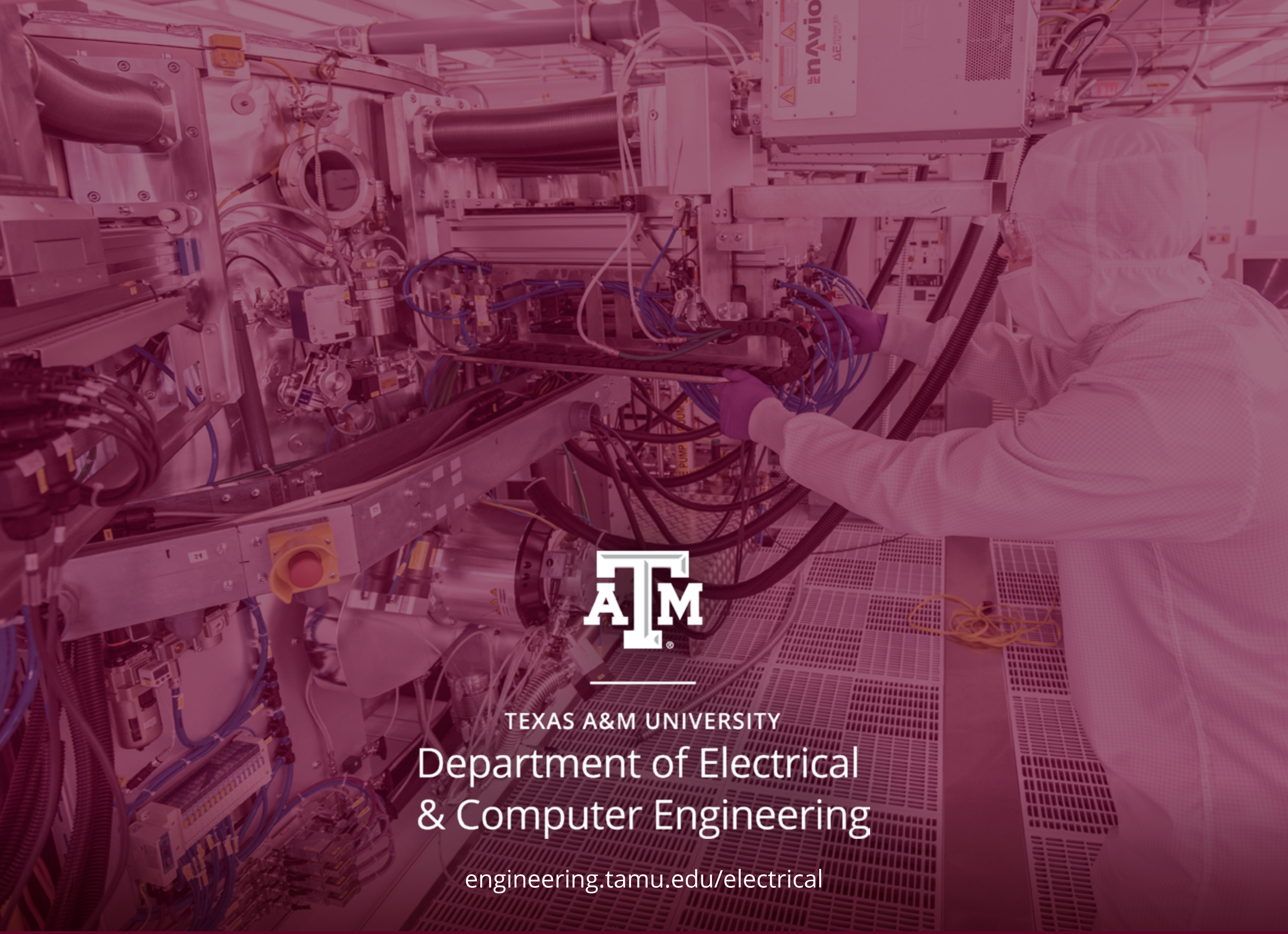
To address this problem, Dr. Hangue Park and his team came up with an alternate way to deliver distance information that is independent of visual feedback. By passing different frequencies of electrical currents onto fingertips via gloves fitted with stimulation probes, the researchers trained users to associate the frequency of current pulses with distance, that is, increasing current frequencies indicated the closing distance from a test object. Park and his team also tailored their technology according to the user's sensitivity to electrical current frequencies.

The researchers found that users receiving electrical pulses were more aware of the proximity to underlying surfaces and could lower their force of contact by around 70%, performing much better than the other group. Overall, they observed that proximity information delivered through mild electric pulses was about three times more effective than with visual information alone.

FEATURED RESEARCHER

Dr. Hangue Park
Assistant Professor
hangue.park@tamu.edu





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
- Energy and Power
- Information Science and Systems

COVER:

Han is co-leading the development of the PRESCIENT microfluidic device that can be used to rapidly identify antibodies produced by human B cells that can neutralize infection by SARS-CoV-2, the causative agent of COVID-19. His team hopes that once neutralizing antibodies are discovered, they can then be quickly utilized to develop therapeutics and vaccines to combat COVID-19.