Spring 2019

NJIT
New Jersey Institute of Technology

A World-Class Technological Research University

RANKED #1 NATIONALLY BY FORBES
FOR STUDENT UPWARD ECONOMIC MOBILITY

RECOGNIZING AN NJIT INVENTOR

ENSURING DATA SECURITY

REFORESTATION USING DRONES

IMPROVING 3D UX

ENGINEERING NEW MEDICAL TECHNOLOGIES

DEVELOPING BIOMATERIALS

Using technology to aid reforestation efforts

Nancy L. Jackson is an environmental scientist at NJIT with deep expertise in math and computer science. Much of her career has been spent studying how the forces of wind and water, combined with human development, shape and reshape ocean beaches and the dunes that stabilize them. More recently, however, Dr. Jackson has also turned her sights inland, serving as an advisor to a team of biology, engineering and business students working to develop software and drone technologies to help manage America's forests.

With the help of Dr. Jackson and a National Science Foundation (NSF) grant, the team has explored the commercial viability of using unmanned aerial vehicles to disperse and plant customized seed pellets in different types of soils, at different depths. A machine-learning algorithm for analyzing remotely sensed images is capable of directing the flight as well as the planting pattern.

The unmanned aerial vehicle and machine-learning algorithm are also useful forest management tools, providing landowners with a more cost-effective way to monitor and analyze their holdings. The ability to assess forest conditions and identify threats promises to improve remediation and sustainability efforts.

Engineering new medical technologies at the nanoscale

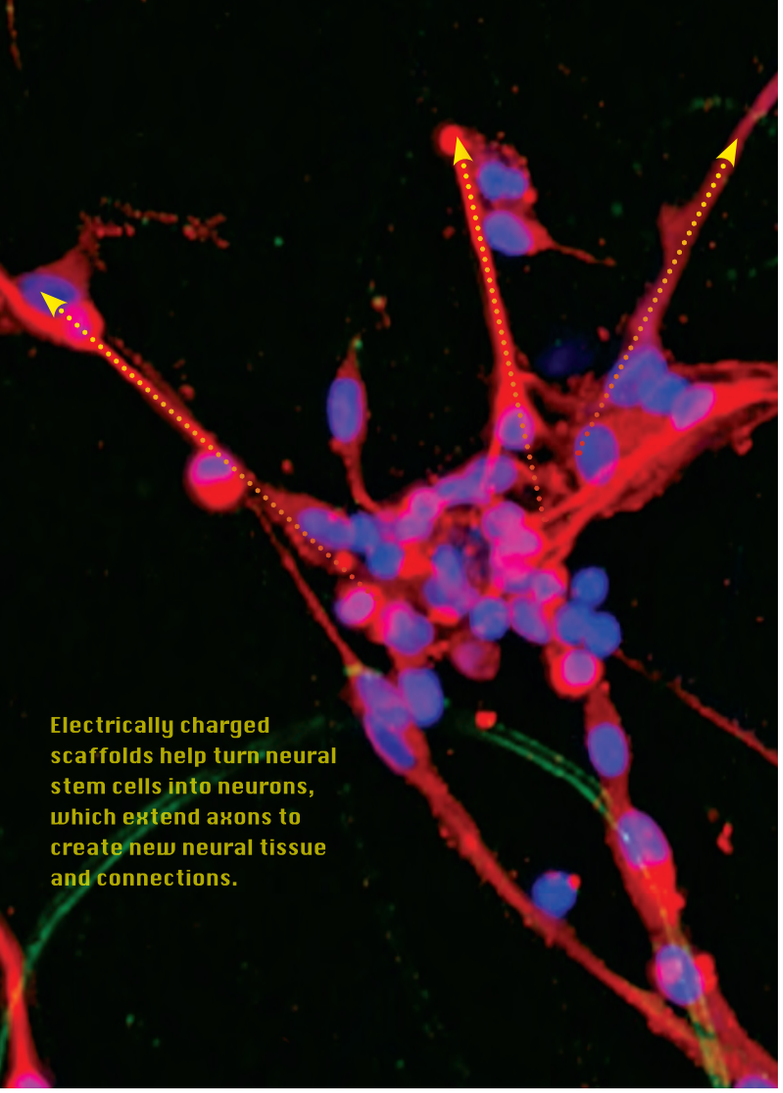
The meeting of biomaterials and medicine promises to revolutionize healthcare, and nowhere is that revolution more visible than in the lab of **Xiaoyang Xu**.

An assistant professor at NJIT's Newark College of Engineering, Dr. Xu's work combines chemistry, materials science and engineering techniques. His aim is to develop new biomaterials and nanotechnologies that help doctors in diagnosis, bioimaging, controlled drug delivery and regenerative medicine.

Dr. Xu's work is on multiple fronts. A biocompatible nanoparticle he synthesized keeps cancer cells susceptible to chemotherapy while simultaneously suppressing tumor growth. A new biomaterial used as a wound dressing eradicates existing bacteria, inhibits infection and accelerates healing, all while minimizing antibiotic side effects. And a minimally invasive, biodegradable material has the potential to improve physical recovery when injected after a heart attack.

Dr. Xu's research is supported by the American Heart Association, the New Jersey Health Foundation and the National Science Foundation (NSF).

New Jersey Institute of Technology



Electrically charged scaffolds help turn neural stem cells into neurons, which extend axons to create new neural tissue and connections.

Developing new biomaterials for regenerative medicine

Treena Livingston Arinzeh, professor of biomedical engineering, has pursued a brilliant idea — creating scaffolds on a microscopic scale and using them to support and stimulate the growth of native or implanted stem cells to rebuild damaged bone, cartilage and nerve tissues.

Her breakthrough research has earned her national recognition as one of the leading young regenerative medicine researchers. Her approach has evolved into a highly collaborative process involving biomedical, electrical and mechanical engineers as well as surgeons and clinicians. She has received federal, state and private funding.

Today, Dr. Arinzeh and her collaborators have several therapeutic technologies under evaluation in clinical settings. They are testing a procedure to stimulate growth and regenerate nerve tissue in spinal cord injuries that involves injecting neural cells in combination with a scaffold of electrically charged fibrous material. The scaffold helps the nerve cells to extend their axons over the spine's damaged section. She is also working to commercialize a bioactive composite matrix that could reduce recovery time and costs associated with bone graft procedures.

Ensuring data security in the face of intentional sabotage

Cryptography — literally "hidden writing"— is the discipline that develops the digital tools used across the globe to ensure data privacy and security. However, with the broad deployment of these tools, unconventional but devastating types of cyberattacks have emerged, turning the very methods designed to protect data into a covert means of subverting it.

These acts of intentional sabotage can be carried out by myriad players: the author of a software package, the manufacturer of a hardware device, or an outside party. Recent high-profile incidents reflect a serious and growing risk.

To combat the expanding threats, **Qiang Tang**, assistant professor in NJIT's Ying Wu College of Computing, is analyzing and designing new cryptographic tools and testing procedures. His aim is to protect classified communication and information even in the presence of malicious software and hardware. He is also studying ways to harden the cryptographic tools that are in widespread use today. His work is supported by the National Science Foundation (NSF).

NJIT professor named a 2018 Fellow of the National Academy of Inventors

Craig Gotsman, NJIT distinguished professor of computer science and dean of the university's Ying Wu College of Computing, was recently elected to the prestigious National Academy of Inventors (NAI).

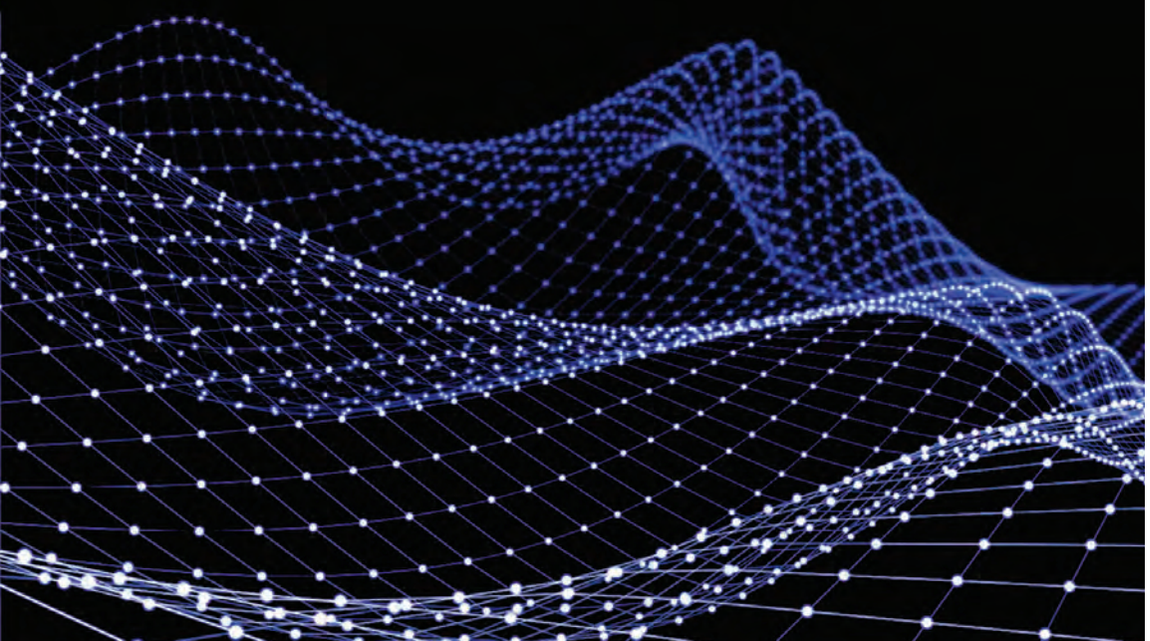
According to the NAI, election to fellow status is the highest professional accolade bestowed on academic inventors who have demonstrated a prolific spirit of innovation in creating or facilitating outstanding inventions that have made a tangible impact on quality of life, economic development and the welfare of society.

Dr. Gotsman's research interests include 3D computer graphics, geometric modeling, animation and computational geometry. A seasoned high-tech entrepreneur, he holds 10 U.S. patents and has commercialized some of his academic research to co-found three startup companies. Dr. Gotsman has published over 180 research papers, won eight best-paper awards at leading conferences, and mentored more than 50 postgraduate students at all levels. He is also a member of Academia Europaea, Europe's leading Academy of Science and Arts.

One of Dr. Gotsman's most recent inventions takes advantage of the new generation of 3D cameras — now present in some advanced smartphones — that produce depth information per pixel, on top of the usual color information. With colleagues from ETH Zurich, Dr. Gotsman developed a process that reconstructs and tracks facial imagery in the output of such cameras, and then uses sophisticated real-time processing of the 3D data embedded in the video stream to enhance the user experience in a video conferencing setup. This academic work was patented and spun off through a startup company, recently acquired by the largest tech company in the world for use in smartphone apps.

Dr. Gotsman joined NJIT in 2017. Prior to that, he was one of the founders of Cornell Tech, a joint partnership between Cornell University and the Technion-Israel Institute of Technology.

Dr. Gotsman shares NAI fellow status with five other NJIT professors elected in the past five years: Gordon Thomas (2014), Somenath Mitra and Atam Dhawan (2015), Kamalesh Sirkar (2016), and Yun-Qin Shi (2017). He will be formally inducted at a ceremony and gala reception at Space Center Houston in April. The 2018 cohort of NAI fellows comprises 148 renowned academic inventors, representing 125 research universities and governmental and nonprofit research institutes worldwide.



100 years
NEWARK COLLEGE OF ENGINEERING
NEW JERSEY INSTITUTE OF TECHNOLOGY

NJIT's Newark College of Engineering Celebrates 100 Years of Excellence in Engineering Education and Research

Founding member
and first president of
Society of Women Engineers
Beatrice Hicks '39

Fifth American in space
Wally Schirra Jr. '41

Civil engineer of record for
Disneyland and
founder of AECOM
Albert Dorman '45

Chief federal official overseeing
safe relocation of residents
impacted by Love Canal disaster
Rita Meyninger Ph.D. '58

Biomedical devices pioneer
and co-inventor of
widely used artificial knee
Michael J. Pappas '59, '64

Co-inventor of the
three-way catalytic converter
John Mooney M.S. '60

Father of superstring theory
Pierre Ramond '65

Third woman in Air Force history
to receive a fourth star
Gen. Ellen Pawlikowski '78

Co-founder of Keurig
single-cup brewing system
Richard Sweeney '81

Chief Information Officer
for New York City
Samir Saini '97

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Haimin Wang is a leading expert in observational solar flare research with a focus on the areas of evolution of magnetic fields associated with flares. He joined NJIT in 1995 and was promoted to distinguished professor of physics in 2004. Along with leading NJIT's new multidisciplinary Institute for Space Weather Sciences, he serves as the chief scientist of the university's Big Bear Solar Observatory in California.

One of the nation's leading public technological universities, New Jersey Institute of Technology (NJIT) is a top-tier research university that prepares students to become leaders in the technology-dependent economy of the 21st century. NJIT's multidisciplinary curriculum and computing-intensive approach to education provide technological proficiency, business acumen and leadership skills. With an enrollment of 11,560 graduate and undergraduate students, NJIT offers small-campus intimacy with the resources of a major public research university. NJIT is a global leader in such fields as solar research, nanotechnology, resilient design, tissue engineering and cybersecurity, in addition to others.

Q&A

Haimin Wang

Director of NJIT's Institute for Space Weather Sciences and Chief Scientist at the University's Big Bear Solar Observatory in California

What is space weather and how does it affect us?

When active regions on the surface of the Sun explode, they release powerful bursts of electromagnetic radiation, known as solar flares, and charged particles, known as coronal mass ejections. Collectively, these phenomena cause the bulk of what we call space weather. As the complexity of engineered systems on Earth increases, as new technologies are invented and deployed, and as humans venture ever further beyond Earth's surface, both human-built systems and humans themselves become more susceptible to the effects of the planet's space environment. On Earth, these storms can disrupt power grids and cause radio blackouts, among other consequences.

What is the Institute for Space Weather Sciences?

With these growing vulnerabilities in mind — and in response to urgent calls from government agencies, insurers, electrical grid operators and others for more sophisticated research, forecasting and mitigation strategies — NJIT formed the multidisciplinary Institute to advance both theoretical and applied research on our civilization's interface with these space weather events. This new entity combines the strengths of the physicists and engineers at our Center for Solar-Terrestrial Research (CSTR) with powerful computing and mathematical capabilities at the Center for Computational Heliophysics, which partners with NASA's Advanced Supercomputing division at the NASA Ames Research Center, and the Center for Big Data.

How do these centers collaborate?

The Center for Solar-Terrestrial Research is events-driven. With powerful imaging instruments, such as our 1.6-meter Goode Solar Telescope at the Big Bear Solar Observatory and radio telescopes at Owens Valley Solar Array, we are able to study the physical mechanisms of flares and coronal mass ejections as they occur. What we need to enhance our capabilities is data analytics. With ever-evolving data processing and image analytics, the algorithms and techniques that computer scientists employ can extract even more information from our images.

Modelers and data experts will also help us detect patterns that can be missed by conventional analyses. For example, CSTR has a huge amount of hydrogen-alpha emission data from solar flares dating back to the 1950s. We aim to better understand the patterns of solar activity over various solar cycles, which should lead to better space weather forecasts.

How will this knowledge help us prepare?

With real-time information on all of the relevant conditions, meteorologists are able to track a hurricane and determine where it will make landing. In a similar manner, high-resolution observations and cutting-edge data analytics should allow us to track the propagation of solar eruptions and the solar wind.

So if we spotted a region on the Sun with potential activity and could predict the potential for its eruption, we should be able to also estimate its path. This would assist in determining whether a spacecraft should go into "safe mode" by powering down vulnerable instruments and turning its solar panels away from the Sun. As another example, forecasts of radio wave bursts from the Sun, which can also knock out GPS tracking, would be vital to GPS-guided technologies such as missile launches or self-driving cars. Furthermore, forecasts of coronal mass ejections are important if aircraft are flying over the North Pole, and as such, might lose HF radio contact and need to be rerouted. You can imagine that the government and commercial sector are keenly interested in this capability!

What new solar research is on the horizon?

Using our solar and radio telescopes, we can now trace the eruption of solar active regions from the Sun's surface and into the solar corona, giving us ever-greater insights into triggering mechanisms. By combining our observations of the magnetic fields with sophisticated models, we're now creating 3D models of the Sun's magnetic field lines, and even 4D if you add in the dimension of time.

With partners in other research centers, such as Jason Wang, a computer scientist who develops deep learning technologies, we are beginning to be able to predict solar flares. In research recently published in the Astrophysical Journal, we demonstrated how we trained a machine-learning algorithm, called random forest, to predict the occurrence of a certain class of flares in a given active region within the next 24 to 48 hours.

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RESEARCHSNAPSHOTS

Transforming a Dreaded Dental Procedure

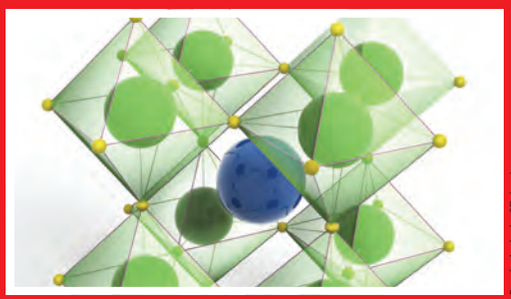
Vivek Kumar is working to improve current root canal therapy for infected teeth. He and his team have engineered a biomaterial that is both a scaffold and a delivery system for stimulating growth in the tooth cavity after the extraction of infected tissue. The injectable peptide hydrogel fosters the development of new blood vessels and the regeneration of dental pulp stem cells. Dr. Kumar envisions a version of the hydrogel containing antimicrobial agents that would kill the infection and keep the tooth alive in a single minimally invasive procedure.

Improving User Experience in 3D Simulations

Margarita Vinnikov, who specializes in human-computer interaction, is exploring ways to make the auditory experience of virtual reality (VR) more natural and realistic, particularly in simulations of groups and crowds. She and her colleagues have developed a VR display that tracks a user's gaze and modifies the volume of the VR characters' voices based on the user's area of attention.

Breaking Down the Barrier Between Art and Audience

Hannah Kum-Biocca focuses on the relationship between artist, art and audience. Using principles of visual communication and human-computer interaction, she seeks to better serve audiences who want to acquire knowledge of an object on exhibit. Her research on the role of digital media in exhibition design includes the layering of information via user-interface and user-interaction design, as well as virtual and augmented reality.



Ramón Andrade, 3Dciencia

Exploring New Materials for Data Storage

Trevor Tyson is studying new materials at the atomic and nanoscale level in a quest to revolutionize data storage and increase the efficiency of computer processing in the era of big data. The ultimate aim of his investigation of hexagonal rare earth oxides (a class of promising material) is to enhance the material's functionality with new components and unique properties for use in high-performing digital devices.

40+

new labs created over the past four years

345

total faculty members anticipated by 2020 as a result of the current multiyear hiring effort

$2.3 MILLION

in undergraduate student research stipends and grants since 2015

20+

number of NJIT instruments in Antarctica

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