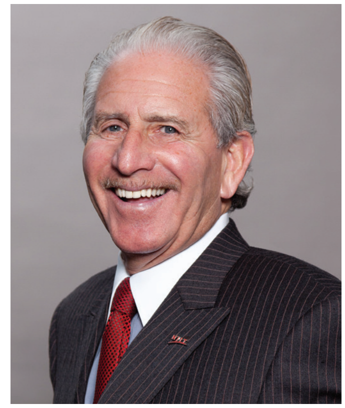
NJIT PRESIDENT'S FORUM AND FACULTY RESEARCH SHOWCASE

Tuesday, April 2, 2019

NJIT

New Jersey Institute of Technology

The President's Forum



As one of only 32 polytechnic universities in the United States, New Jersey Institute of Technology (NJIT) fills a critical role in a world that is being driven by technological innovation. All the major industries that drive our global economy are technology enterprises at their core, and they rely upon scientific and technological innovations to enhance efficiency and yield new and/or improve products. In addition to educating a highly diverse and exceptionally accomplished student body and preparing them to become the science, technology, engineering and math (STEM) workforce sought after by all industries, NJIT is an elite research university. We now conduct more than $162 million in applied research annually, solving real-world problems in areas that include civil infrastructure, advanced manufacturing, cybersecurity, transportation, medical devices, clean energy, national defense, health care and many others. The growth of our research portfolio has earned us the recently announced distinction of being designated an "R1" research university by the Carnegie Classification®, which indicates the highest level of research activity. NJIT is one of only 131 universities nationally and just three in New Jersey—Princeton and Rutgers are the others—to achieve this recognition.

NJIT hosts the President's Forum and Faculty Research Showcase each year to highlight a range of research initiatives and stimulate collaboration around significant opportunities for future exploration. As part of the Albert Dorman Honors College Colloquium Series and through the generous support of the DeCaprio family, the President's Forum provides for the NJIT community a unique opportunity for learning and discussion. The Faculty Research Showcase offers an overview of the future of research at NJIT, with presentations that introduce our newest faculty and their impressive work to NJIT's research community, in addition to seed grant posters that illustrate the ideas and innovations being produced by long-standing members of the NJIT community. Faculty seed grants represent NJIT's commitment to supporting promising research with funding that enables development of a concept into a proposal that can attract significant external resources from the National Science Foundation and the National Institutes of Health, as well as other agencies and foundations.

This day allows us to celebrate the exceptional research and innovation occurring at NJIT while demonstrating the extraordinary ability of our faculty and the importance of their work in improving our world and our lives.

Joel S. Bloom
President of NJIT

Transforming the Research Enterprise at NJIT

Over the past four decades, NJIT has evolved from a commuter school teaching applied engineering skills into a nationally ranked public research university. In 1979, our research expenditures totaled $375,000; today they surpass $160 million. As our research profile grew, so did our capacity as an educational institution. NJIT has been awarding doctoral degrees for more than 50 years; since 2014, the Ph.D. student population has increased by 30 percent, while the number of degrees awarded last year was 73, the highest ever.

As evidence of our remarkable transformation, NJIT recently joined the top tier of research universities with a designation of R1 by the Carnegie Classification®. We are one of just three universities in New Jersey to occupy the category indicating "very high research activity."

Developing knowledge and applying it to the benefit of society requires talent, substance and resources. We are actively recruiting, developing, supporting and retaining an exceptional faculty, and are continually striving to provide the environment necessary for success from the moment of their appointment to the peak of our scholars' academic careers. We also aim to break down barriers to multidisciplinary collaborations as contemporary research demands it. We value entrepreneurial research, promote our inventions and facilitate technology transfer.

As we embark on our new strategic plan, *NJIT 2025*, research remains one of our five core priorities. We will continue to encourage and promote groundbreaking research in many fields as we aim for prominence. Our ambition is nowhere more apparent than in our people. Over the past six years, NJIT has hired nearly 130 new faculty members as we deepen our capabilities across STEM and other disciplines, increasing its faculty from 268 in 2014 to a projected 345 by 2020. They include experts on topics such as machine learning, data analytics, biomaterials and biomechanics. These enterprising scholars bring us not only original research and cutting-edge investigative methods from the country's top academic institutions, but an energizing diversity that renews our traditional disciplines and broadens our research scope. Over the past four years, 12 young researchers have won CAREER awards from the National Science Foundation.

So it is with enormous pride that NJIT showcases its growing research talent in the Sixth Faculty Research Showcase. Some of the presentations you will hear today represent interdisciplinary collaborations brought to life on campus with seed funding from an NJIT research program designed to tackle problems that represent the university's core strengths in fields such as the life sciences and health care, sustainable systems and data science. They bridge disciplines as distinct as physics and design. As we create new academic hubs on campus, we hope to inspire many more productive partnerships. We have more than doubled research funding from external sources since the 2014 baseline of our current strategic plan, *2020 Vision*.

We will also measure the impact of our ambitious transformation from multiple perspectives. Critically, we will assess our success in materially improving lives both in our immediate region and in communities across the globe that benefit from the technology we develop and effectively deploy. Just as importantly, we will judge our achievement by the number of technology innovators we nurture in our undergraduate and graduate programs, exposing them to high-level research and real-world applications, so they are empowered to confidently take on the problems of tomorrow.

Fadi-Pierre Deek

Fadi P. Deek
Provost and Senior Executive Vice President

Program

Campus Center, Ballrooms A and B

10 a.m. – 10:15 a.m.	**Welcome Remarks** Joel Bloom *President of NJIT* Vince DeCaprio *Vice Chair, NJIT Board of Trustees* Fadi Deek *Provost and Senior Executive Vice President*
10:15 a.m. – 10:20 a.m.	**Speaker Introduction** Atam Dhawan *Senior Vice Provost for Research*
10:20 a.m. – 11:30 a.m.	**President's Forum: Keynote Lecture** Dr. Chenzhong Li *Program Director, Biosensing Program, CBET, NSF*
11:30 a.m. – 12:15 p.m.	**Lunch and Networking**
12:15 p.m. – 2 p.m.	**New Faculty Presentations**
2 p.m. – 3 p.m.	**Poster Presentations and Networking Session:** New Faculty and Faculty Seed Grant Recipients

**This forum is a featured event in the
Albert Dorman Honors College Colloquium Series
and is made possible in part by the
generous support of the DeCaprio Family.**

Keynote Speaker

Chenzhong Li

Worlds Ahead Professor of Biomedical Engineering, Chemistry and Immunology and Director of the Nanobioengineering/Bioelectronics Lab at Florida International University

Program Director of the Biosensing program in the Division of Chemical, Bioengineering, Environmental and Transport Systems of the National Science Foundation

Chenzhong Li is an expert in bioinstrumentation and bioelectronics, focusing on the development of biomedical devices for both diagnostic and therapeutic applications and with further potential in areas ranging from the environment, to food safety monitoring, to agriculture, to homeland security. He is the co-principal investigator of two newly funded National Science Foundation (NSF) Engineering Research Centers, which focus on developing technologies for smart health diagnosis systems and artificial heart tissues, respectively.

Dr. Li's research has been documented in 10 granted patents, about 140 peer-reviewed journal papers and 10 books and book chapters. His numerous awards include the Kauffman Entrepreneurship Professor Award in 2009 and 2011; the 2014 JSPS (Japan) Professor Fellowship Award; the 2014 Florida International University Excellent Faculty Award in Research; the 2016 Pioneer in Technology Development Award by the Society for Brain Mapping & Therapeutics; and the 2016 Minority-Serving Institution Faculty Award in Cancer Research from the American Association for Cancer Research. He is a fellow of the American Institute for Medical and Biological Engineering; Associate Editor of *Biosensors and Bioelectronics*; and Editor-in-Chief of the *Journal of Critical Review of Biomedical Engineering*.

Keynote Lecture: NSF Perspectives: Challenge and Opportunity in Bioinstrumentation Research

Research funding, as is true of many opportunities, undergoes shifts. As funding levels change, priorities are altered, and application numbers vary, applicants should employ savvy strategies when seeking support. In this presentation, I will present my perspective on developing and sustaining collaborative research projects with particular emphasis on research in the field of Biomedical Engineering and Bioinstrumentation, such as biosensors. The presentation is based on my 25 years of experience gained during my own research, my service as a program director to the NSF Biosensing program and as an editor and reviewer of several flagship journals in the field of bioinstrumentation.

The emphasis is on the funding opportunity of the NSF Biosensing program, which supports fundamental engineering research on devices and methods for the measurement and quantification of biological analytes. However, in keeping with the main aim of this talk of providing a perspective on sustainable project development, other research opportunities within the Chemical, Bioengineering, Environmental and Transport Systems (CBET) Division's "Bio clusters" within the Engineering Directorate of the NSF will be provided. In addition, information about NSF crosscutting initiatives and training grants such as NSF Career Awards, NSF Engineering Research Center and NSF Research Traineeship will also be discussed.

New Faculty Research Presentations

College of Science and Liberal Arts

Travis Askham

Assistant Professor of Mathematical Sciences

Travis Askham comes to NJIT from the University of Washington where he was a research associate of applied mathematics. He engages in research in scientific computing, broadly defined. Recent projects include the development of robust algorithms for data-driven model discovery in dynamical systems; the application of asymptotic analysis to a model of the "frequency combs" of high-throughput optics; and work on the foundations of fast algorithms for solving the classical partial differential equations governing electromagnetism, fluid dynamics and elasticity. These classical and modern models apply to a wide range of topics in science and engineering. They are key components of the analysis of optical communication systems, the machine learning approach to optimal control systems, and the computer-aided design of medical, scientific and military devices for which fluid or electromagnetic fields affect performance. While a Ph.D. student at the Courant Institute of Mathematical Sciences at New York University, Askham was awarded a Dean's Dissertation Fellowship and received a department prize for contributions to mathematics. His research has appeared in top journals, including the *Journal of Computational Physics* and *SIAM Review*.

Title: Modern Methods in Scientific Computing

My work focuses on modern methods for scientific computing. In particular, I am interested in high order methods for simulating the partial differential equations which govern many physical phenomena, including fluid dynamics, electromagnetism and solid mechanics. These methods are based on novel integral equation formulations of the governing equations, so the work entails both a theoretical and algorithmic component. I have also developed methods for efficiently solving the data-fitting and model-discovery problems of machine learning, which allow for domain-specific knowledge to be incorporated into the problem formulation.

Pier Alexandre Champagne

Assistant Professor of Chemistry

Pier Alexandre Champagne joined NJIT from the University of Ottawa, where he was a postdoctoral researcher in the Department of Chemistry and Biomolecular Sciences. His research interests are centered on organic chemistry, with an emphasis on the development of new synthetic methods based on reactive intermediates – transient chemical species that decompose readily. These compounds are then harnessed for use in new processes for synthesizing complex molecules, such as anti-cancer agents, in an efficient, modular fashion that also reduces waste. Champagne also uses computational methods to understand reactivity in the fields of organic chemistry, catalysis and reactive intermediates, then make predictions about ways to improve inefficient or unselective reactions. After obtaining his Ph.D. in organic chemistry from Université Laval in Quebec City, he went on a postdoctoral stint at UCLA to learn applied computational methods for organic chemistry. Overall, Champagne's research has been published in leading journals such as the *Journal of the American Chemical Society* and Wiley's *Angewandte Chemie*.

Title: Developing New Synthetic Tools through Experiments and Computations

The development of new tools aimed at the synthesis of previously unattainable molecules often brings a lot of problems and questions. As such, using computational methods to study reaction mechanisms in parallel with experiments is now a very powerful tool to identify the source of the problems and predict ways to solve the issues. Our research has always been focused on organic chemistry, and we have demonstrated over the years how the combination of experimental and computational methods proved instrumental to uncover the full picture in a variety of organic chemistry projects. Our current research endeavors are approached using the same mindset, that understanding the chemistry can bring better tools to fruition.

Hao Chen

Professor of Chemistry

Hao Chen focuses on the development of modern organic and biological mass spectrometry, a technique which can weigh molecules accurately. Mass spectrometry is a fascinating technology which plays an increasing impact in chemical measurement and imaging for a variety of areas such as analytical chemistry, environmental chemistry, forensic chemistry and life science research nowadays. So far, he has published over 100 papers in peer-reviewed journals such as the *Journal of American Chemical Society and Analytical Chemistry*. He has also obtained 10 patents for novel instrument development. His research awards include the NSF CAREER Award, the American Society for Mass Spectrometry Research Award, the Merck Technology Collaboration Award, the Ron Hites Outstanding Publication Award and the Presidential Research Scholar Award from Ohio University.

Title: Mass Spectrometric Study of Electrochemistry

Electrochemistry coupled with mass spectrometry (EC/MS) is a powerful means for identifying the products or intermediates of electrochemical reactions, which is not only useful for redox reaction mechanism elucidation but also leads to valuable applications in proteomics. The versatility of EC/MS stems from two facts. First, MS can serve as a sensitive and general detector for investigating electrolytic products of proteins. In addition, tandem MS analysis can be used for structural determination based on ion dissociation. Second, electrochemical conversion can improve analyte ionization efficiency, provide desired modification to the analyte prior to MS analysis or even facilitate MS quantitation of chemicals. Attracted by the complementary nature of these two techniques, the marriage of EC and MS appears quite attractive. In this talk, I will focus on the development of electrochemical mass spectrometry and its applications for proteomics study.

Rosanna Dent

Assistant Professor of History

Rosanna Dent received her Ph.D. in History and Sociology of Science from the University of Pennsylvania in 2017 and joins NJIT from a Mellon Postdoctoral Fellowship at McGill University. She teaches and writes about the social and political history of science, medicine and technology in the Global South, particularly Latin America. She is interested in the ethical and affective dynamics of human subjects research, and how knowledge-making shapes those who participate. In her research, Dent combines oral history, ethnography and archival work to illuminate often-overlooked histories of science, focusing on the role of Indigenous people in teaching and training those who come to study them. She co-coordinates a digital archive project to return scientific publications and historical materials to highly studied Xavante communities in Central Brazil. Her work has been supported by Fulbright IIE, the Social Science Research Council, the American Council of Learned Societies and the Andrew W. Mellon Foundation.

Title: Indigenous Histories of Science

What is it like to be studied again and again? How often would you consent to be questioned, measured and sampled? Some Xavante Elders in Central Brazil have hosted so many researchers they no longer remember all the names and project proposals that have come their way since 1958. They know they have been featured in genetics papers, public health journals, anthropology textbooks, and linguistics manuals. They know I am writing a book about their long and sometimes fraught engagement with scientists. Understanding their reasons for participating illuminates the political salience of knowledge production under colonial regimes. It highlights broader implications of scholarship in research-saturated settings where subjects become experts and knowledge and power are inextricably linked.

Hyomin Kim

Assistant Professor of Physics

Hyomin Kim comes to NJIT from Virginia Tech, where he was a postdoctoral research fellow and research assistant professor in the Department of Electrical and Computer Engineering. He researches the impact of solar emissions such as radiation and charged particles on Earth's geomagnetic environment and human technologies. His analysis of magnetic field waves, caused by the interaction of solar wind with space plasma particles, shows how solar energy is transferred to Earth's upper atmosphere. To that end, he serves as Deputy Director of the Center for Solar-Terrestrial Research Polar Engineering Development Center for operation and on-site service of NJIT's Antarctic stations for space research. He is also a science team member of the NASA Radiation Belt Storm Probe Ion Composition Experiment mission to study the Earth's radiation belts. He has visited various Arctic and Antarctic regions for operations of science instruments. He is also interested in collaborations between the arts and sciences to encourage the broader community to engage in science activities.

Title: Large-Scale Multi-Point Observations for Solar-Terrestrial Research

A flow of charged particles released from the upper atmosphere of the Sun, called the solar wind, is connected to the Earth's magnetic environment, forming unique structures called the magnetosphere and ionosphere, and impacting human technologies adversely with what is known as space weather. This talk reports developments in and the operation of ground-based instrument arrays in various Polar Regions in both hemispheres, critical infrastructure for the study of the solar-terrestrial environment and for prediction of space weather. Through collaborations with U.S and international institutes, a large-scale, high-latitude instrument network is now being established and expanded under the leadership of NJIT's Center for Solar-Terrestrial Research. In this talk, examples of large-scale multi-point observations of waves and particles in space plasmas are also presented using data from various spacecraft and high-latitude ground-based instruments. Waves and particles in space provide crucial information to study how energy from the Sun is connected to the Earth's environment.

Enkeleida Lushi

Assistant Professor of Mathematical Sciences

Enkeleida Lushi joins NJIT from the Flatiron Institute where she specialized in soft matter and biological physics. Working at the intersection of biology, physics and fluid mechanics, she specializes in building high-fidelity mathematical models and fast computer simulations to elucidate phenomena such as the self-assembly and guided transport of micro-scale particles and the collective motion of microbes. Her focus so far has been on micro-swimmers such as bacteria and algae, as well as other types of "active" particles, such as electromagnetically-driven colloids. The models describe particle dynamics at the individual and suspension level, but include particle interactions and individual traits which play non-trivial roles in the emerging macroscopic properties of the collective. Her aim is to determine what drives the complex dynamics, and then use this knowledge to predict, for example, what types of confinements can enhance or hinder collective particle motion, or how to build materials with tunable properties. Lushi collaborates with experimentalists and engineers from all over the world and is well known for her work on the area of active matter.

Title: Confined dynamics of micro-swimmers

Interactions between motile microorganisms and solid boundaries play an important role in many biological and technological processes. I will discuss recent advances in modeling, simulations and experiments that aim to understand the motion of micro-swimmers such as bacteria, micro-algae or spermatozoa in confined geometries or structured environments. The results highlight the complex interplay of the fluidic and contact interactions of the individuals with each other and the boundaries that give rise to complex behavior.

James MacLaurin

Assistant Professor of Mathematical Biology

James MacLaurin studies how biological order, synchrony and patterns can arise out of disorder and stochasticity at the microscopic level. One of his major interests is understanding how ensembles of neurons in the brain can display coherent emergent behavior, despite the fact that there can be considerable variability at the level of signal transmission between neurons. Such coherent emergent patterns include traveling waves, spiral waves, and slow rhythmic alternations between activity and quiescence. He is also interested in studying oscillations, coherent behavior and synchronization in the activity of large ensembles of cells – the synchronization can result from correlations in common inputs received by all of the cells. He also has pursued research in the biomechanical modeling of growing cancer tumors in the body. His work determines conditions under which the stress resulting from rapid proliferation of the cancer cells leads to mechanical buckling of the capillaries.

Title: Biological Order and Synchrony Arising out of Microscopic Randomness

Emergent phenomena such as waves and oscillations are integral to normal brain function. They persist in spite of much disorder and seeming randomness at the microscopic level. I outline a method for identifying how microscopic disorder and randomness perturbs the phase of brain-waves. Using this, I can then demonstrate that the orthogonal 'error' stays small for very long periods of time. I also look at the emergence of synchronization in biological oscillators with some coherence in their common input.

Gareth Perry

Assistant Professor of Physics

Gareth Perry joins NJIT's Center for Solar-Terrestrial Research from the University of Calgary, where he was a postdoctoral research associate in the Department of Physics and Astronomy. Perry is an experimental space physicist who studies the interconnections between the Earth's upper atmosphere and plasma environment, and the Sun. His primary focus is on disturbances in these systems and how they can have severe repercussions on a variety of important systems such as the Global Navigation Satellite System, and over-the-horizon communications and radar systems. Perry has extensive experience with ground-based and satellite-based solar-terrestrial science experiments, and served as Scientist in Charge of the Canadian CASSIOPE satellite on several occasions. His work has been published in a number of preeminent solar-terrestrial physics journals, including the *Geophysical Research Letters*, the *Journal of Geophysical Research and Radio Science*. One of his most recent publications in *Radio Science* was recognized as a journal highlight.

Title: Space Weather Impacts on Global Communications Infrastructure

Long-range, over-the-horizon radio communication systems rely on a wireless link established via the ionosphere, a region of plasma in the Earth's upper atmosphere which acts as a reflecting medium for radio waves at particular frequencies. Marconi first demonstrated this link with his famous 1901 transatlantic wireless experiment. Perturbations in the ionosphere's plasma density, called ionospheric irregularities, are generated by energetic processes driven by interactions between the plasma environments of the Sun and the Earth: space weather. The irregularities can scatter radio transmissions and disrupt long-range radio communications and monitoring (radar) altogether. The goal of this research is to provide new and compelling insight into the fundamental plasma physics responsible for radio wave scattering in the Earth's ionosphere, particularly for radio links between the continental United States and the northern polar regions of the Earth.

Newark College of Engineering

Mohsen Azizi

Assistant Professor of Electrical and Computer Engineering

Mohsen Azizi comes to NJIT from Michigan Technological University (MTU), where he was an assistant professor of Electrical Engineering Technology. Prior to that, he was an R&D engineer at Pratt & Whitney Canada (PWC), Inc. His research has focused on the design and development of advanced distributed controllers and fault-diagnosis modules for large-scale systems such as microgrids, mechatronics and aerospace systems. At MTU, he designed optimal and robust controllers and fault-diagnosis filters to maintain the resilient performance of microgrids in the presence of environmental uncertainties, system faults and communication constraints. Also at MTU, he was involved in an industry-sponsored project to establish the Industrial Control and Automation Laboratory and developed the associated curriculum. At PWC, he designed advanced controllers and fault diagnosis modules for jet engines. Azizi is a senior member of IEEE, and has published 10 journal articles and 38 peer-reviewed conference papers.

Title: Distributed Control and Fault Diagnosis in Large-Scale Systems

A "large-scale" system is defined as a system with multiple interconnected subsystems. The objective of this research is to stabilize, regulate, and control the overall large-scale system by designing a local controller for each subsystem, and also to diagnose sensor/actuator faults and system failures by designing a local fault-diagnosis module for each subsystem. The local controllers and fault-diagnosis modules are designed and implemented in a distributed framework, such that they mainly rely on their local information and minimum communications exist among them. This distributed control and fault-diagnosis approach is essential and applicable to a wide range of industrial systems including microgrids, mechatronics and aerospace systems.

Ashish Borgaonkar

Assistant Professor of Engineering Education

Ashish Borgaonkar joined the NJIT faculty this January after serving as Assistant Dean of Newark College of Engineering beginning in 2013. He also obtained his Ph. D. in Environmental Engineering from NJIT. He is interested in engineering education as a discipline, and in innovative teaching methods and pedagogies. These include hands-on, active-learning and peer instruction methods, as well as ways to help underprepared and still-deciding students. He has overseen the development, growth and implementation of several engineering education and academic support programs, including the NJIT mathematics summer boot camp, learning communities, practice placement exams, the first-year seminar, an application-based mathematics course for underprepared students and student design showcases and competitions. He has also developed and co-teaches the Fundamentals of Engineering Design (FED101) course for General Engineering students. He has won several awards at NJIT, including the Excellence in Teaching Awards in three different categories, and most recently, *Outstanding Contribution to Teaching at NJIT*.

Title: Enhancing Engineering Education at NJIT by Utilizing the Makerspace and Active-Learning Activities

Active-learning methods in teaching have widely been reported to increase students' enthusiasm and motivation to persist in their degree pursuit in STEM fields. They have shown to impact students' retention and graduation rates. NJIT's Makerspace has opened up several new opportunities to enhance engineering education and teaching through active and experiential learning. One of the major challenges we face is how to efficiently integrate the Makerspace into engineering and other curricula, while leaving sufficient room for students, faculty and the rest of the NJIT community to utilize the tools and technologies it has to offer. We have approached this challenge in two ways. First, we included Makerspace-based, active-learning activities in a first-year Fundamentals of Engineering Design course for General Engineering students. Second, we offered a university-wide Highlander Drone Competition that provides instruction and training in the Makerspace. Hundreds of students showed interest in the competition with more than 20 teams set to compete on May 1.

Branislav Dimitrijevic

Assistant Professor of Civil and Environmental Engineering

Branislav Dimitrijevic specializes in transportation systems analysis, transportation planning, multimodal freight transportation and intelligent transportation systems (ITS). He earned Ph.D. in Transportation Engineering from NJIT in 2018. Prior to this appointment, he was a Senior Research Scientist at NJIT's Department of Civil and Environmental Engineering. He participated in a multi-year federal research program, Transportation Economic and Land Use System, and was one of the designers of land-use modeling software developed as part of this program. He was also involved in numerous research projects funded by the New Jersey Department of Transportation, including the development and implementation of several regional models for congestion and mobility analysis, as well as signal system prioritization. His current research focuses on transportation data analytics, innovative mobility, traffic-detection integrated corridor management and the use of drones in traffic operations applications.

Title: Application of Probe-Vehicle Data for Traffic Incident Detection

Recent advancements in traffic detection, vehicle tracking and location services data technology have provided numerous opportunities for developing more accurate and effective transportation analytics models. These models can be used to analyze transportation system performance for both operational and planning purposes. My presentation will showcase development of a model that utilizes historical travel speed profiles of highway links and travel speed reported in real time to detect non-recurring congestion. Several challenges and opportunities for further improvement of the model will be presented, including a non-recurring congestion-detection algorithm and model validation. The goal of the proposed models is to enhance the ability of traffic operations personnel to detect and initiate response to traffic incidents, as well as to engage in proactive traffic management.

Carlotta Mummolo

Assistant Professor of Biomedical Engineering

Carlotta Mummolo comes to NJIT from New York University, where she was a postdoctoral associate in the Department of Mechanical and Aerospace Engineering. She received two doctoral degrees through a joint Ph.D. program in Mechanical Engineering between Polytechnic of Bari (Italy) and NYU in January 2016. During her doctoral studies, she developed an index to benchmark the dynamic characteristics of bipedal walking and a stability criterion for the quantitative evaluation of the balance capability in legged systems. At NJIT, Carlotta directs the Coppélia Research Lab in the Department of Biomedical Engineering, where a diverse team of students and researchers studies the principles of bipedal locomotion and balance stability, with applications in the field of motor rehabilitation. She is a member of the American Society of Mechanical Engineers, the American Society for Engineering Education, IEEE Robotics and Automation Society and the Society of Women Engineers. Her work has been published in several peer-reviewed journals and conference proceedings.

Title: Principles of Balance Stability in Legged Systems with Multiple Contact Interactions

Imagine the following actions: walking, stair climbing, standing up from a chair while holding the armrests and reaching for support after receiving a push. These are all examples of everyday life activities that require the coordination between human body motion and the available contact interactions with the environment in order to maintain balance. On one hand, our team explores models and principles that can advance our understanding of the remarkable human ability to plan body motion and contact interactions while achieving agile and efficient movements. On the other hand, we seek the formulation of a mathematical framework to plan and control such coordinated actions in robotic legged systems. We investigate how legged systems move and interact with their environment without falling by integrating fundamental biological and mechanical principles into robotic research platforms. Ultimately, the mission of the Coppélia Research Lab is to translate multidisciplinary research on balance and locomotion into improved bio-engineering solutions for motor assistance and rehabilitation.

Hongtao Sun

Assistant Professor of Mechanical and Industrial Engineering

Hongtao Sun comes to NJIT from the University of California, Los Angeles (UCLA), where he was a postdoctoral fellow in the Department of Chemistry and Biochemistry. He received his Ph.D. degree in the Department of Mechanical, Aerospace and Nuclear Engineering from Rensselaer Polytechnic Institute. His research lies at the intersection of energy science, functional materials and advanced manufacturing. He focuses in particular on the bottom-up manufacturing approaches that can assemble low-dimensional nanoscale materials into 3D hierarchical architectures or integrated, multi-component systems; he studies the physical and chemical phenomena that affect how these manufactured forms transport, store, convert and dissipate energy, which enables novel innovations for energy harvesting, energy storage, advanced sensing and detection. Sun has published more than 40 peer-reviewed papers in leading journals such as *Science*, *Nature Reviews Materials, Nature Communications and Nature Catalysis*.

Title: Fabrication of Three-dimensional (3D) Hierarchical Architectures for Energy Applications

When the size of materials is reduced to the nanoscale dimension, various physical and chemical phenomena cause the material's properties and behaviors to dramatically differ from its bulk counterpart. These phenomena affect how nanoscale materials transport, store, convert and dissipate energy which is essential for a broad range of energy applications. However, key challenges exist in the assembly of these low-dimensional nanomaterials into three-dimensional (3D) macroscopic architectures. This process is usually accompanied by the loss of exceptional nanoscale properties and functionalities. In my research, the emphasis is being placed on the development of scalable nanomanufacturing approaches for the synthesis and hierarchical assembly of 3D hierarchical architectures which allow for the retention of novel features of their nanoscale building blocks. These 3D architectures enable novel innovations in energy storage devices, such as high-power batteries for electrical vehicles, thermal management such as thermal insulation for military and astronautical applications, as well as advanced sensing and detection.

Angelo Tafuni

Assistant Professor of Engineering Technology/Mechanical and Industrial Engineering

Angelo Tafuni joins NJIT from New York University, where he graduated with a Ph.D. in Mechanical Engineering in 2016. In the last two years at NYU, Tafuni was a visiting assistant professor and the director of the Fluid Dynamics and Thermal System Laboratory in the Department of Mechanical and Aerospace Engineering. His research focuses on the development of particle methods for several computational fluid dynamics applications, with a focus on fluid-structure interaction problems and free-surface flow. At NJIT, he is building a laboratory to study the phenomenon of liquid sloshing with applications in the aerospace industry. He is an active member of the American Physical Society, the American Society of Mechanical Engineers, the American Society for Engineering Education and SPHERIC, and his work has been published in peer-reviewed journals and the proceedings of several technical conferences.

Title: A Robust Particle Method for Free-Surface Flow and Other Hydrodynamics Problems

Among the several computational fluid dynamics techniques available for modeling fluid flow in engineering applications, particle methods exhibit stability and robustness for problems with almost all types of boundary and flow conditions. Particularly, these methods are very effective when simulating flow with strong nonlinearities, such as flooding and tsunami inundation, wave breaking and wave structure interactions, moving boundaries in fluids, mixing processes and jet impact. This talk provides an overview of the Smoothed Particle Hydrodynamics method and its implementation in a massively parallel framework. Special emphasis is given on advanced aspects being researched, such as variable resolution and boundary conditions. Some of the relevant work carried out is discussed, spanning a large breadth of applications. Among these, an ongoing study on the hydrodynamics of underwater concept vehicles for future navigation of the hydrocarbon-rich seas of Saturn's largest moon, Titan.

David Venerus

Professor of Chemical and Materials Engineering

David C. Venerus directs the Materials Engineering Program in the Otto H. York Department of Chemical and Materials Engineering at NJIT. His research interests are in the areas of transport phenomena in soft matter, polymer science and the rheology of complex fluids. He is also interested in the theory of interfacial transport phenomena and its applications. In 2018, he co-authored the textbook "A Modern Course in Transport Phenomena," published by Cambridge University Press. He earned Ph.D. and M.S. degrees from Penn State University and a B.S. degree from the University of Rhode Island, all in chemical engineering. Prior to coming to NJIT in the fall of 2018, he was on the faculty in the Department of Chemical and Biological Engineering at IIT in Chicago from 1989 to 2018. He has been a visiting professor in the Department of Materials at the Swiss Federal Institute of Technology (ETH) in Zürich, Switzerland, and at the Institute for Molecular Engineering at the University of Chicago.

Title: Transport Phenomena in Soft Matter

The focus of my research is on a class of materials referred to as soft matter. Soft materials, which are ubiquitous in both nature and technology, include polymers, colloids, foams, gels and biological materials. The common feature of soft materials is the presence of a mesoscale structure that is perturbed by relatively small forces. This feature leads to unique properties and unusual behavior that cannot be described by classical constitutive theories. My research involves the application of novel experimental methods designed to understand the behavior of soft materials and to guide theory for their description.

Xianlian Alex Zhou

Associate Professor of Biomedical Engineering

Xianlian Alex Zhou comes to NJIT from CFD Research Corporation, where he was a principal research scientist and manager of the Human Performance and Biodynamics group. His research focuses on computational biomechanics, robotics and digital human modeling, injury prevention and personalized medicine. Before joining CFD Research, he obtained a Ph.D. degree in mechanical engineering from the University of Iowa. At CFD Research, he served as the PI or Co-PI for many research grants sponsored by U.S. Department of Defense (DoD) organizations and other federal agencies. He has developed advanced computational methods and software tools to analyze human biomechanical loadings under injury conditions, to develop protective and preventive measures against injuries and diseases, and to design and evaluate wearable robotic devices, such as exosuits or exoskeletons. Some of these software tools have been used for war fighter protection by DoD organizations such as the Army Public Health Center, the Naval Air Systems Command and the U.S. Army Natick Soldier Research, Development and Engineering Center.

Title: Design and Evaluation of Exoskeletons with Neuromusculoskeletal Modeling

The design and evaluation of exoskeletons is often a time-consuming and costly process that involves prototype fabrication, human testing and several design iterations. For active exoskeletons, the primary challenge is to detect the movement intent of the wearer and provide potent assistance, which often requires sophisticated control algorithm implementation. The goal of this study is to integrate human neuromusculoskeletal modeling with robot modeling and control for human-in-the-loop simulations. We will present several exoskeleton designs and demonstrate utilization of this integrated approach for virtual evaluation of exoskeletons in terms of their functionalities and biomechanical effects on the wearer's musculoskeletal system.

Ying Wu College of Computing

Department of Informatics

Frank Biocca

Professor of Informatics

Frank Biocca, chair of the department, comes to NJIT from Syracuse University where he was the Newhouse Endowed Chair Professor of Communication, Computer Science and Information, and from Sungkyunkwan (Samsung) University, where he is the World Class University Professor of Interaction Science. His research is in the area of human-computer interaction, including the development of virtual reality and augmented reality interfaces. He explores ways in which virtual and augmented reality systems can support human decision-making, learning and persuasion. Among his more than 200 publications are 10 books and patents in the areas of human-computer interaction and information technology, including on networked augmented reality systems. He has been the principal investigator on more than 40 grants or funded projects. Prior to pursuing graduate studies, Biocca was a Silicon Valley executive who participated in the introduction of mobile computing, including the first portable computer. His research and commentary on computer interfaces and communication has been featured in news and media organizations spanning more than 15 countries, including CNN, the New York Times, the Washington Post and BBC Worldwide.

Title: Virtual and Augmented Reality Interfaces for Human Performance

We present research on the design of virtual and augmented reality systems to improve human cognition and performance. We include research on brain-computer interfaces both for awareness of user performance and as input into the virtual environment.

Aritra Dasgupta

Assistant Professor of Informatics

Aritra Dasgupta joins NJIT from the Pacific Northwest National Laboratory (PNNL), where he was a senior data scientist working at the intersection of information visualization, data analytics and human-computer interaction. He develops visual and interactive means to explore and understand complex patterns in data; the resulting tools integrate automated methods based on statistics and machine learning with high-dimensional data visualization techniques. Through this integration, Dasgupta aims to preserve the best of both computation and human judgment: computational power for fast extraction of patterns that aid experts in reasoning about the context and significance of the machine-detected patterns, ultimately leading to greater human-machine trust. Dasgupta has been the principal investigator of two projects funded by the U.S. Department of Energy's Lab Directed Research and Development program, leading interdisciplinary and multi-institution research teams. The first project seeks to help domain experts develop trust in machine-learning models through transparent visual explanation methods. The second helps improve climate models by giving scientists more effective visualization tools for model comparison and calibration. At PNNL, his research was recognized with an outstanding performance award in 2015. Dasgupta has co-authored more than 20 peer-reviewed articles, including publications in top-tier journals such as *IEEE Transactions on Visualization and Computer Graphics*, and presented his research at conferences such as ACM's Special Interest Group on Computer–Human Interaction.

Title: Visualization as a Driver of Transparency in Human-Data Interaction

We live in an era in which data promises to save lives, fuel scientific discoveries, shape opinions and policies and influence our daily life choices. But data is only as good as the insights derived from it, and data availability is only the starting point for solving a problem. My research aims to transform big, heterogeneous data into analytical value for humans by developing visual and interactive means of exploring, understanding and communicating complex patterns. To this end, I pursue research in the cross-cutting areas of information visualization, visual analytics and human-computer interaction. The systems and techniques I build leverage visualization as a driver of transparency in human-data interaction: automated methods like statistics and machine learning are combined with interactive visualizations for enabling human judgment and reasoning about machine-detected patterns. This integration ensures we leverage the best of both worlds: computational power for fast extraction of patterns, such as a predictive model trained on millions of transactions for flagging suspicious individuals; and our perceptual and cognitive faculties that enable experts to transparently reason about the context and significance of the patterns, such as financial analysts visualizing the past and present behavior of individuals to understand the context of predictions.

Margarita Vinnikov

Assistant Professor of Informatics

Margarita Vinnikov joined NJIT from the National Research Council (NRC) of Canada where she was a human factor research officer, specializing in cross reality and immersive displays, including flight and driving simulations. She has extensive experience in prototyping and developing experimental platforms for these kinds of simulations using various languages, libraries and platforms. While at the NRC, for example, she worked with pilots and aircrew using augmented and virtual reality technology to improve the safe operation of helicopters and other aircraft during low visibility conditions. She also studied human-computer interaction, with an emphasis on visual and audio perception. While earning her Ph.D. at York University, she researched gaze-contingent, multi-sensory immersive environments, which change the display based on a user's gaze location, with real-time simulations of impaired vision. She used eye- and head-tracking to simulate different visual defects to conduct psychophysical experimentation, using quantitative methods to investigate the relationship between visual and auditory stimuli and a participant's experience or behavior, in various virtual environments. She also had worked for many years for a pre-college program teaching students how to develop games while employing diverse technologies and programming languages. Her research has been published in journals such as the *International Journal of Human-Computer Studies* and *ACM Transactions on Computer-Human Interaction*.

Title: Gaze-Contingent Displays in Cross-Reality Applications

Cross-reality (XR) devices have been steadily conquering consumer markets all over the world, and experts predict a doubling of investment in them. With increasing demand, there is a growing need for new applications, interfaces and creative integration between devices, fields and data. This talk will present applications that address the fundamental issues and technological trends of Virtual, Augmented, and Mixed Reality (VR/AR/MR) domains. Specifically, the talk will showcase indoor and urban navigation, such as driving. For example, how the user experience changes based on light and weather conditions depending on whether the user is a virtual pedestrian or a virtual driver. Then the talk will address the significant impact of eye-tracking and gaze-contingent technologies in the context of these applications, as well as the different ways these types of technologies can be evaluated. It will conclude with future research directions and potential collaboration opportunities in the context of XR and cross-model (visual, audio and haptic) user experiences and gaze-contingent displays for gaming and social interaction applications.

Xinyue Ye

Associate Professor of Informatics

Xinyue Ye, director of NJIT's Urban Informatics and Spatial Computing Lab, integrates social science and computational science towards information visualization, urban informatics and spatial social network analysis – the mapping of relationships among individuals in networks, integrated with spatial and environmental factors. Ye has published over 200 refereed publications. He received a Doctoral Dissertation Research Improvement award from the National Science Foundation (NSF) 2008, won the national first-place research award from the University Economic Development Association in 2011 and received the Regional Development and Planning "emerging scholar" award from the American Association of Geographers in 2012. His works has been funded by the NSF, the National Institute of Justice, the U.S. Department of Commerce and the U.S. Department of Energy.

Title: Automating Parcel Classification for Land Management

Homeowners' Associations (HOAs) dictate landscape structure and management through legally enforceable land covenants at the neighborhood scale in the U.S. Determining the location and spatial extent of HOAs is critical for examining their influence. However, such analysis is confounded by the lack of spatial data at the appropriate unit for such analysis. The purpose of this research is to develop and realize an open source implementation to automate land parcel classification, which is an initial step towards the goal of determining the impact of HOAs on urban land management. Using Maricopa County, Arizona, as a testbed, we found that parcel-merging processes reduce the number of subdivisions from 26,042 to 17,269, so that boundaries better align with neighborhood units to which rule sets such as land covenants apply. Moreover, after an initial training period, this process was completed in just over seven hours. This research is an important first step toward enabling a number of key analyses, including determining the location and spatial extent of HOAs regionally and, eventually, nationally, and identifying links between HOAs and land management outcomes.

Baruch Schieber

Professor of Computer Science

Baruch Schieber is the chair of the Department of Computer Science. Prior to joining NJIT, he was a Distinguished Research Staff Member at IBM Research and a member of the IBM Academy of Technology. He managed the "Mathematics of AI" group at IBM Research with the mission of performing ground-breaking research in the mathematical foundations of AI, including the design of efficient and parallel algorithms for machine learning, the development of efficient algorithms for deep learning and the application of mathematical-programming techniques to obtain high-quality interpretable models. Schieber has led and participated in several ground-breaking AI and business analytics projects for over two decades, including a continual fleet optimization project that was featured in the New York Times, Business Week, Fast Company and Forbes and an integrated data analytics, simulation and optimization of airport-security resource allocation for the U.S. Transportation Security Administration. He has published more than 140 papers in leading scientific journals and conferences and is the co-inventor on five patents.

Title: Abstract Globally Optimal Symbolic Regression

Discovering mathematical models that explain the behavior of a system has a broad range of applications. Symbolic regression is an important field in machine learning whose goal is to find a symbolic mathematical expression that explains a dependent variable in terms of a number of independent variables for a given data set, most commonly as an explicit function of the independent variables. Unlike traditional (numerical) regression schemes, the functional form of the expression is not assumed to be known a priori. The utility of the approach has been established for a broad range of applications including the discovery of equations. We introduce a new technique for symbolic regression that guarantees global optimality. This is achieved by formulating a mixed integer non-linear program whose solution is a symbolic mathematical expression of minimum complexity that explains the observations. We demonstrate our approach by rediscovering Kepler's law on planetary motion using exoplanet data and Galileo's pendulum periodicity equation using experimental data. This research is conducted jointly with several collaborators at IBM and at Ecole Polytechnique.

Martin Tuchman School of Management

Xinyuan (Stacie) Tao
Assistant Professor of Finance

Xinyuan (Stacie) Tao joins NJIT from the State University of New York at Buffalo (SUNY – Buffalo), where she received a Ph.D. in finance in 2018. She researches empirical asset pricing with a current focus on the effects of frictions, the difficulty with which an asset is traded, and behavioral factors related to investors' cognitive biases in finance. Traditional asset pricing models typically assume that the market is frictionless, that investors are symmetrically informed and that their expectations are homogeneous. But in the real world, information is never perfect or evenly distributed. In a recent paper, Tao shows how to form optimal earnings forecasts in the presence of incomplete information, whereas past studies have focused on the sources of biased forecasts. Her research has been presented at prominent conferences such as the Society for Financial Studies Cavalcade, the Financial Management Association annual meeting and the China International Conference in Finance.

Title: Search Frictions, Market Quality and Equilibrium: Theory and Evidence
Treasury securities are auctioned periodically. A newly issued security is referred to as "on-the-run" and becomes "off-the-run" when another security with the same maturity is issued. When a Treasury security goes off-the-run, trading volume decreases by 90%. By exploiting this event, we are able to isolate the effects of *search frictions* (one type of difficulties to trade) and …find that search frictions significantly generate adverse impacts, such as increasing transaction costs and slowing the process of information reflected by prices. However, on- and off-the-run markets still interact with each other. All results show that search frictions play an important role in market quality.

College of Architecture and Design

Hannah Kum-Biocca

Assistant Professor of Digital Design

Hannah Kum-Biocca comes to NJIT from California State University, Long Beach where she was an assistant professor in User Experience Design and a research associate at the M.I.N.D. Lab at Syracuse University. She has been a faculty member at over 10 design research campuses after earning a master's degree from Goldsmiths, University of London. Kum-Biocca is an interactive media artist. Her research is in interaction design, including work on video mapping, virtual and augmented reality and interactive user experience design; it has been featured in more than 30 exhibitions in seven countries. Among her publications are three books, several research articles and numerous presentations. Prior to earning a Ph.D. in human-computer interaction, Kum-Biocca was the lead User Experience Designer at Hewlett-Packard Inc. Her professional portfolio includes designs for Samsung, LG and several other technology companies. Her research and design projects have been supported by grants and funding from more than 30 organizations, including the National Research Foundation, Korea Telecom, 2018 PyeongChang and the Winter Olympics.

Title: AR-Vis: Augmented Reality Interactive Visualization Environment for Exploring Dynamic Scientific Data

The AR-Vis Interactive project will demonstrate a new perspective on collaboration between design and science. An Augmented Reality (AR)-based platform will be presented for the visualization of scientific data, specifically magnetic fields around the observer. Through collaboration between interactive media artists and scientists, the new visualization platform will provide a more interactive and visible user experience toward understanding abstract ideas and less visible phenomena in the physical sciences. In this presentation, the ubiquitous and yet invisible forces of nature, magnetic fields, are visualized in AR with scientific data being externally provided in real time, allowing users to "see" such unseen fields in an interactive way as they move around the field and distort through their actions.

Faculty Seed Grant Recipients

Tara Alvarez
Professor of Biomedical Engineering

Chang Yaramothu
Postdoctoral Researcher

Title: OculoMotor Assessment Tool
The oculomotor assessment tool (OMAT) standardizes oculomotor assessments into one simple tool while performing a vestibular ocular motor screening, a concussion-screening protocol. Rather than clinicians holding their index fingers in front of a subject and assuming that the distance between the fingers does not change, this tool standardizes the procedure. The specialized markings on the OMAT also allow a medical professional to measure routine optometric parameters such as the near point of convergence and the amplitude of accommodation, which are measures commonly taken during concussions screenings. The tool will additionally provide patients with targets for vergence eye movements. The OMAT companion smartphone application (currently available on the Google Play Store, soon to be released for iOS products) allows an operator – doctor or other medical professional – to time and count eye movements, providing quantitative feedback on a person's oculomotor endurance and deterioration. An automated eye-tracking apparatus to accompany the OMAT is currently being designed by a biomedical engineering undergraduate Capstone team led by Alvarez and Yaramothu. This technology has been licensed and is being manufactured and sold by Guilden Ophthalmics, Inc.; it has a provisional patent in the process of being converted to a non-provisional patent. The OMAT protocol is being adopted by sports medicine physicians at Children's Hospital of Philadelphia.

Cesar Bandera
Associate Professor of Entrepreneurship

Peter Schmitt, Ph.D.
Cell Podium, Founding Partner

Title: mHealth for Social Isolation among the Elderly
Social isolation among the elderly affects half of the global elderly population, and the World Health Organization has identified it as a determinant of health and contributor to healthcare costs. Mobile health (mHealth) interventions have been effective in reducing social isolation among broader populations. However, the lower technical literacy and technology adoption rate of elderly populations pose unique challenges to mHealth interventions, including interoperability with legacy mobile devices, which impede traditional mHealth solutions and leave this vulnerable population unaided. The project goal is to develop an mHealth system that supports social isolation interventions among the elderly. Unlike traditional app-based mHealth solutions, the proposed system will operate natively with the devices, carriers and software already used by participants, thereby circumventing the impediments of technology adoption among the elderly. Project milestones include the development of a behavioral model of mHealth users to predict intervention benefits, system design and modeling, and empirical assessment of the impact on social isolation.

Phillip Barden
Assistant Professor of Biological Sciences

Title: An Interdisciplinary Approach in Data Extraction and Outreach: Terahertz Spectroscopy and Industrial Design with Fossil Amber
Fossil amber represents a data-rich window into the ancient evolutionary and environmental history of the planet. In addition, paleontological discoveries offer a significant opportunity to yield compelling examples for educational outreach. This project represents a collaborative approach toward paleontological data collection, as well as outreach spanning the Department of Physics, the Federated Department of Biological Sciences and the College of Architecture and Design. For the first time, terahertz (THz) spectroscopy is applied to amber specimens from around the world, ranging in age from ~20 to 130 million years old, with the aim of identifying unique chemical properties of each deposit and developing THz as a tool for identifying the composition of biotic and abiotic inclusions within ancient amber. With respect to outreach, design students are generating digital and physical models of newly described fossil species for dissemination.

Dibakar Datta
Assistant Professor of Mechanical Engineering

Title: The Chemomechanics of Two-Dimensional Materials-based Structures
Two-dimensional (2D) materials have enormous applications in energy storage systems and micro-electro-mechanical systems, among other areas. The failure of 2D materials during device applications involves a complex interaction of mechanics and chemistry. For example, if graphene is used as an anode material in lithium-ion batteries, lithiation/delithiation induces structural distortion leading to the fracture of graphene. 2D materials are also used as an interface in bulk materials-based structures. Therefore, we have developed the new Chemo-Atomistic Fracture Mechanics framework to study their chemomechanical failure. In addition, we studied interface mechanics to gain a fundamental understanding of the interface between 2D materials and bulk materials.

Edgardo T. Farinas
Associate Professor of Chemistry and Environmental Science

Yong-Ick Kim
Assistant Professor of Chemistry and Environmental Science

Title: Metabolic Engineering of Cyanobacteria: Circadian Clock Design for Biofuel Production and Environmental Pollution Control
The goal of this project is to engineer cyanobacteria for sustainable fuel production, while protecting the ecosystem from the harmful effects of greenhouse gases. Modern society has become addicted to fossil fuels, and many concerns arise from its use. First, it is not sustainable or renewable. Next, it yields greenhouse gases, primarily carbon dioxide (CO_2), when used for energy production. We can seek assistance from nature to address both economic and societal concerns. Photosynthetic organisms provide a means to produce a renewable fuel source that uses a cheap power source, sunlight, and a fuel derived from CO_2. Cyanobacteria is an excellent candidate for biofuel production as compared with other photosynthetic organisms, such as higher plants and eukaryotic algae. Cyanobacteria produce glycogen, a biofuel, in a process that depends on natural circadian rhythms that oscillate every 24 hours. Glycogen production occurs during the day and stops at night. Hence, biofuel synthesis is limited. In order to overcome this obstacle, a new metabolic pathway will be engineered into cyanobacteria to allow glycogen production at night; an on/

off switch will be designed to allow day functions at night. To attain this goal, KaiC, the primary protein involved in the regulation of the circadian clock, will be engineered to be active at night via directed evolution. A KaiC library (~108 members) will be created and screened to discover active night variants. Initially, a high-throughput assay will be developed to identify winners.

Brooke Flammang

Assistant Professor of Biological Sciences

Title: Long-term, Reversible, Surface-Indiscriminant, Biologically-Inspired Attachment in the Marine Environment

The remora's adhesive mechanism is a viable solution to a major challenge in ocean engineering – how to achieve reliable, reversible long-term attachment under high-drag conditions on any substrate. Using their unique adhesive disc evolved from dorsal fin elements, remoras can maintain long-term adhesion to natural and man-made surfaces of any roughness, compliance or curvature, attaching to both rigid and deforming bodies moving either at high-speed or while stationary. The objective of this work is to demonstrate a scalable, bioinspired attachment device capable of reliable, reversible adhesion to indiscriminate surfaces, particularly those with varying compliance and roughness. In the proposed work, findings from detailed remora adhesive disc structural, material-property, and functional analyses will lead to the design and integration of a self-contained attachment prototype device. The prototype model developed from this project could have a transformative impact on biosensing technology in both medical and scientific applications, animal tag development, dive computers and physiological monitoring, and defense strategies. Results achieved through research supported by this funding will fulfill the specific task of developing the soft tissue component of our bioinspired adhesive device, thus finalizing the basic research necessary to transition to the applied research task of producing a testable adhesive prototype.

Jorge Fresneda

Assistant Professor of Digital Marketing and Analytics

Alex Cohen

Assistant Professor of Marketing, West Chester University

Title: Left Behind by Inaccessibility: The Pursuit of Fairness and Equitable Recruiting and Hiring for Jobseekers with Disabilities

There are 30 million people with disabilities in the United States who continue to be challenged by the accessibility of the online environment. The unemployment rate among these citizens is the highest of any group in the country. Considering the means by which jobs are sought and applications submitted in today's market, the accessibility of this online mechanism could be exacerbating their unemployment problem. This study constitutes an effort to understand how these citizens are personally affected and how to bridge the gap between technological shortcomings, legislation, corporate needs and societal efforts seeking to promote greater diversity in the workplace.

Yong-Ick Kim

Assistant Professor of Chemistry and Environmental Science

Title: CikA Modulates the Effect of KaiA on the Period of Circadian Oscillation in KaiC Phosphorylation

Cyanobacteria contain a circadian oscillator that can be reconstituted in vitro. In the reconstituted circadian oscillator, the phosphorylation state of KaiC oscillates with a circadian period, spending about 12 hours in the phosphorylation phase and another 12 hours in the dephosphorylation phase. Although some entrainment studies have been performed using the reconstituted oscillator, they were insufficient to fully explain the entrainment mechanisms of the cyanobacterial circadian clock due to the lack of input pathway components in the in vitro oscillator. Here, we investigate how an input pathway component, CikA, affects the phosphorylation state of KaiC in vitro. Our findings give insight into how to reconstitute the cyanobacterial circadian clock in vitro by adding an input pathway component, which affects the circadian oscillation by directly interacting with the oscillator components.

Hannah Kum-Biocca

Assistant Professor of Design

Hyomin Kim

Assistant Professor of Physics

Title: AR-Vis: Augmented Reality Interactive Visualization Environment for Exploring Dynamic Scientific Data

The AR-Vis Interactive project will demonstrate a new perspective on collaboration between design and science. An augmented reality (AR)-based platform will be presented for the visualization of scientific data, specifically magnetic fields around the observer. Through collaboration between interactive media artists and scientists, the new visualization platform will provide a more interactive and visible user experience toward understanding abstract ideas and less visible phenomena in the physical sciences. In this presentation, ubiquitous and yet invisible forces of nature – magnetic fields – are visualized in AR with scientific data being externally provided in real time, allowing users to "see" such unseen fields in an interactive way as they move around the field and distort through their actions.

Ying Li

Assistant Research Professor of Biomedical Engineering

Bryan Pfister

Professor of Biomedical Engineering

Millie Swietek

Doctoral Candidate in Biomedical Engineering

Namas Chandra
Distinguished Professor of Biomedical Engineering

Title: Mild Stretch Injury Induces Inflammatory Pyroptosis In Vitro
Mild traumatic brain injury has been shown to lead to progressive cell death leading to long-term functional impairments, including cognitive and motor deficits. The mechanisms underlying these physiological changes that ensue after injury remain elusive. We have shown in a previous published study of neuronal injury using an in vitro stretch model and an in vivo model of fluid percussion injury that injury induces the activation of the Caspase-1 enzyme, which triggers neuroinflammatory cascades ultimately leading to neurodegeneration. Because Caspase-1 has been shown to lead to programmed inflammatory cell death, pyroptosis, we investigated whether neuronal cell death observed after injury was a consequence of the activation of a Caspase-1-induced inflammatory pathway. Neuronal injury was simulated using a custom stretch injury model. Stretch injury (40 percent at rate 20s-1) and LPS (1 ug/ml) induced increase of ASC, AIM2, Caspase-1, NLRP3 and Gasdermin D protein in cells by western analysis, immunohistology and IL-1b, IL18 in supernatant by ELISA. NLRP3 inhibitor CY-09 (5 uM) and Caspase-1 inhibitor VX-765 (10uM) significantly suppressed the increase of ASC, AIM2, Caspase-1, NLRP3 and Gasdermin D, as well as IL-18 and IL-1b after injury and LPS application, respectively. A live/dead cell assay indicated that CY-09 and VX-765 rescued neuronal cell death induced by stretch injury. Our results suggest that pyroptosis-inflammatory neuronal cell death is a possible mechanism of progressive cell death after mild traumatic brain injury.

Rongfang Liu
Professor of Civil and Environmental Engineering

Hindy Schachter
Professor of Management

Cristian Borcea
Professor of Computer Science

Liu Lv
Doctoral Candidate in Transportation Engineering

Title: Connecting Limited English Proficiency Communities in North Jersey via Smart Technologies
The research team conducted several focus group discussions in order to understand the issues and challenges faced by limited English proficiency (LEP) communities in North Jersey. The discussions took place in December at various locations, including in the Ironbound neighborhood of Newark and at a community center in Westfield. The LEP groups are made up of Spanish-, Portuguese- and Chinese-speaking individuals. Despite very different demographic, social and economic characteristics, it is apparent that participants in all of the focus groups are not satisfied with existing transportation services, especially transit services and methods for disseminating travel information. On the other hand, expectations and preferences differ among various LEP groups. For example, the LEP community in the Ironbound in Newark welcomes a new app that will provide travel information as long as it is free and easy to use. The LEP community in Westfield tends to resist new apps and does not want to share rides with strangers. The focus group discussions have confirmed some previous knowledge obtained by the research team. Meanwhile, certain new discoveries, such as not wanting a new app for travel information and a lack of interest in sharing rides, may suggest a shift in research and new challenges for the research team.

Xuan Liu

Assistant Professor of Electrical and Computer Engineering

Title: Optically Computed Optical Coherence Tomography for Neural Activity Recording

The goal of this project is to develop a highly innovative optically computed optical coherence tomography (OC-OCT) imaging platform that is coupled with optogenetics for all optical interrogation of neural activities. Microscopic mapping of neural activities is crucial to understand how the system-level neural processes, including action, thought and emotion, among others, are implemented at the cellular level. Electrophysiology, protein expression and animal behavior have been used as read-out technologies for neural activities. However, these technologies are invasive, indirect and non-specific. In particular, with the advent of optogenetics that uses light-responsive ion channels to regulate neural cells within intact, living brain tissue, there is an urgent need for a non-invasive read-out technology to monitor the activities of individual neurons in an interconnected network. To address this unmet need, we propose to develop OC-OCT technology to map neural activities, which will benefit the field of optogenetics and eventually promote the exploration of neuron circuits in relation to memory and emotion. In this study, we plan to construct a prototype OC-OCT system that has a 10µm spatial resolution, a 0.1ms temporal sampling interval and a 0.05nm displacement sensitivity. To validate its feasibility for mapping cellular activities, we will use visible light to excite the channelrhodopsin transfected hippocampal neuron cells and image the displacement of neural cells in synchronization with optogenetic excitation.

Enkeleida Lushi

Assistant Professor of Mathematical Sciences

Title: Bacterial Spread in Porous Media

While bacterial motility is well-studied for motion on flat surfaces and in unconfined liquid media, how bacteria migrate and spread through heterogenous media is still unclear. I will present a coarse-grained mathematical model of the dynamics of bacterial motion in a porous medium, the linear stability analysis, as well as numerical simulations of the system. I will discuss the spread of an initial drop of bacteria through a medium with varying porosity, and will compare the results against recent experiments.

Simone Marras

Assistant Professor of Mechanical and Industrial Engineering

Abhishek Mukherjee

Doctoral Candidate in Mechanical and Industrial Engineering

Title: Towards Efficient Numerics for the Direct Numerical Simulation of Aeroacoustics in Wind Energy and Aeronautics

The long-term rise of global temperatures poses an imminent threat, which is why countries are now leaning toward renewable energy sources; wind energy is one of them. But the addition of wind farms is not trivial due to aeroacoustic noise generation, which is the greatest concern for governments and communities, thus resulting in the adoption of more stringent noise regulations and severe limitations on wind farm installations. Hence, there is an urgent need to develop a sophisticated design tool to fulfill the requirement of low noise and high performance in the design of wind turbines. The objective of this study is to develop an efficient numerical tool, based on the spectral element Galerkin method, to capture aeroacoustic noise generation efficiently so that researchers and companies will be able to take proper action to mitigate aeroacoustic noise generation and propagation without sacrificing the efficiency of wind turbines. The spectral element Galerkin method is highly efficient in computational aeroacoustics, because it provides higher-order accuracy, hp-adaptivity and geometric flexibility; on the other hand, the element-based Galerkin method exhibits efficient parallelization, minimum numerical dissipation and dispersion error as compared to other discretization techniques.

Jay N. Meegoda
Professor of Civil and Environmental Engineering

Bruce Bukiet
Associate Professor of Mathematical Sciences

Title: Decontamination of Contaminated Sediments in the Passaic River Using Ultrasound and Sono-chemistry

This research is directed toward developing a sono-reactor that makes use of ultrasound, coupled with sono-chemistry, for in situ removal of pollutants in Passaic River sediments. The proposed technology will combine two different configurations to produce an intense ultrasonic field: a horn-type transducer operating around 20 kHz and a plate-type transducer operating at a higher frequency, between 200 kHz and 800 kHz. The horn-type transducer will stir up the sediments in the water, detaching contaminants from the sediments and bringing them into suspension. The plate-type transducers will induce acoustic cavitation, initiating sono-chemical oxidation due to free radicals and the destruction of contaminants in the suspension. This is an innovative approach using sonochemical degradation and oxidation.

Elizabeth Nowadnick
Assistant Professor of Physics

Title: High-Pressure Behavior of Hybrid Organic-Inorganic Halide Perovskites from First Principles

Solar cells based on hybrid organic-inorganic halide perovskite materials are a rapidly advancing next-generation photovoltaic technology. However, stability and toxicity issues are hindering the deployment of perovskite-based photovoltaics. This motivates the search for halide perovskites with alternative chemistries and/or structures which mitigate the problems while maintaining the excellent photovoltaic properties. Addressing this materials engineering challenge requires a detailed knowledge of the structure-property relationships at work in halide perovskites, which is currently lacking. In this research, we use a combination of group theoretic analysis and density functional theory calculations to elucidate the complex crystal structures of all-inorganic and hybrid halide perovskites, which will enable the subsequent formulation of structure-property relationships. In particular, by performing high-pressure calculations we investigate how the crystal structure accommodates pressure through a combination of bond contractions and metal-halide bond angle changes. In addition, we explore how these structural changes are conveyed into the electronic properties.

Vincent Oria
Professor of Computer Science

Title: Towards a Local Features Selection-Based Clustering

Cluster analysis is an important technique used to find natural groups in datasets. It aims at dividing data objects into meaningful groups, which is useful for several data-mining and machine-learning tasks. In several novel applications such as Multimedia and Recommender Systems, data is often represented as points in high-dimensional spaces. The high dimensionality often makes data-mining and machine-learning tasks, such as clustering, more challenging for state-of-the-art algorithms because of the so-called "curse of dimensionality." As the dimensionality increases, the discriminative ability of similarity measures diminishes to the point where methods such as clustering that depend on them lose their effectiveness. The usual approach to dealing with high-dimensionality is dimensionality reduction. Dimensionality reduction techniques comprise feature extraction techniques, which intend to derive new sets of features from the original ones, and feature selection techniques, which select important features directly from the original feature sets. Most existing dimensionality reduction techniques are global in the sense that the resulting feature set is the same for all the data points. Our goal in this research is to define a novel, scalable clustering approach that allies local features selection with clustering.

Paul Ranky
Professor of Mechanical and Industrial Engineering

Title: Human Error Prevention and Detection Methods and Tools, Focusing On Engineered Systems

Our research focuses on human error prevention and detection methods and tools in engineered systems. The significance of this project is huge, since human errors are extremely costly and can be fatal. A human error means a process that was executed that was not intended by the actor; not desired by a set of rules or an external observer; or that led the task or system to drive to outside its acceptable limits. In this proposal, a human error is a deviation from intention, expectation or desirability in engineered systems. Our core concepts are based on novel systems engineering, system analysis, design and scientific solutions to offer corrective and preventative actions / processes addressing non-conformances. The core concept is to deploy a novel 5D process modeling method with detailed object-oriented, layered process descriptions and a data dictionary, as one system, integrated with an AI machine-learning engine, process failure risk analysis and design methods. The fundamental goal of this research is to offer novel methods and tools to prevent, detect, reduce and eventually eliminate human errors. Also, a key part of this project is to perform and publish validated academic research in both the core, as well as the interdisciplinary areas.

Roberto Rojas-Cessa
Professor of Electrical and Computer Engineering

Jorge Chirinos
Doctoral Candidate in Electrical and Computer Engineering

Title: Evolutionary Selection of Congestion Window for Fast Transmission of Flows

The transmission of internet flows using the transport control protocol and derivatives is mostly based on a congestion window parameter set by the transmitter. This congestion window takes information from the congestion experience of the sent packets as they travel by network nodes and even the receiver host. Current approaches to manage network congestion are based on the additive increase multiplicative decrease principle. However, this principle is unable to speed up the transmission of flows and at the same time, avoid network congestion in an effective manner. As an example of evolutionary networking, we present a different approach to determine the congestion window, where this parameter experiences evolution through the transmission of the flow packets in the network to select an optimal value that satisfies these two requirements.

Dr. David Rothenberg
Distinguished Professor of Philosophy and Music

Camille Desjonquères
Postdoctoral Fellow in the Biological Sciences at the University of Wisconsin-Milwaukee

Benjamin Gottesman
Doctoral Candidate in Soundscape Ecology at Purdue University

Zach Poff
Sound Artist

Title: A Field Guide to Underwater Pond Sounds: Citizen Science Reveals the Unknown

The core of this project is teaching people to listen more carefully to the nuances of the underwater acoustic environment, and to learn simple software tools to identify the basic kinds of sounds one can hear there. So far, it seems these include insect stridulation and communication, plant respiration, insect chorusing and fish grumblings, of the kind studied by some of our biology faculty here at NJIT. Ben Gottesman proposes that aquatic insects and other underwater creatures can tell us much about the quality and status of freshwater systems. Sounds from aquatic insect communities have been shown to vary along with the degree of human disturbance, and also to be characteristic to certain habitat types. Through recording the sounds of threatened sources of drinking water and presenting them as compositions, we can raise public awareness of human health issues associated with water quality, and also connect people to their local habitats and recognize them as supporting diverse fauna. While humans and animals often have their differences, and so often seem pitted against each other in competition for the same resources, we are united in our preference for clean water. We are still just learning about the voices emanating from freshwater systems. This work will be part exploratory, and part social justice, as we will be using these voices to tell stories about water quality in the United States.

Kristen Severi
Assistant Professor of Biological Sciences

Zainab Tanvir
Doctoral Candidate in Biological Sciences

Title: A New Kind of Connectome: Revealing Functional Neural Circuits with Expansion Microscopy in Larval Zebrafish

The goal of this project is to demonstrate the effective use of a recently developed technique, expansion microscopy (ExM), in larval zebrafish for the purpose of pursuing targeted connectomics on neural circuits critical for locomotion.Command neurons in the hindbrain (reticulospinal or RS neurons) send the essential signals for activating and controlling spinal locomotor circuits. These RS cells are individually identifiable and combined with the genetic tractability and optical transparency of the zebrafish, provide a perfect opportunity to determine their spinal targets in a vertebrate model. Filling in this black box requires techniques where the axons can be traced throughout the animal and synapses can be resolved. This is why we turn to ExM, where we can accomplish this with greater efficiency and lower costs than electron microscopy and using standard confocal microscopy to image samples. In this project, we lay the groundwork to comprehensively map individually identifiable RS neurons to their spinal targets using transgenic lines to label various neurotransmitter and transcription factor classes of known types of spinal neurons. In synergy with the Haspel lab at NJIT, developing connectomics with ExM places NJIT among the world leaders in this emerging new methodology.

Junmin Shi

Associate Professor of Supply Chain Management and Finance

Title: Silver Economy: Elderly Wellness and Care Fragmentation

"Silver Economy," referring to all the economic activities relevant to the needs of older adults, such as healthcare and nutrition, leisure and wellbeing, is the third largest economy in the world, with an estimated value of $7 trillion per year, growing to $15 trillion by 2020. Care fragmentation has been one of the most critical threats faced by the Silver Economy. The absence of good care-coordination between the health care system and social services often causes the elderly to fall through the cracks, because neither side understands the full extent of the challenges faced by the elderly. Care fragmentation also frustrates the elderly and their caregivers, who find it challenging to navigate among the various providers and often feel that there is no one person who can help them get all essential services. The failure to provide the elderly with efficiently coordinated care can allow small problems to escalate into medical emergencies. This will likely result in unnecessary hospitalizations, increased mortality and higher health system costs. Blockchain will be introduced to help create next generation senior care, by tackling the problem of care fragmentation via the disruptive technical solution of blockchain. In particular, this project looks into the efficiency and effectiveness of blockchain in the Silver Economy, via a variety of methods, such as scheduling and planning, queuing and simulation.

Andrew Sohn

Associate Professor of Computer Science

Title: Building a Framework of Software and Hardware for Real-time Analytics on Social Networks

The goal of this project is to investigate the feasibility of using dynamic graph partitioning to enable real-time analytics on social networks. Social networks are graphs that change constantly to reflect the current state of the mindsets and behaviors of users, organizations, institutions and even countries. Capturing major changes is critical to the success of social networks, as analytics would allow them to predict what may come next and therefore be prepared with possible actions. Capturing major changes in real time, however, is a challenge. This project consists of both hardware and software to address the problem of capturing critical changes in social networks. In particular, a cluster of 16 PCs is currently being built to compute changes in real time, while spectral graph partitioning software will be designed and implemented for analytics on the cluster. The outcome of the project is a prototype framework that demonstrates that dynamic spectral graph partitioning on a cluster of machines can enable real-time analytics on large-scale social networks.

Hongtao Sun

Assistant Professor of Mechanical and Industrial Engineering

Title: Fabrication of Three-dimensional (3D) Hierarchical Architectures for Energy Applications

When the size of materials is reduced to the nanoscale dimension, various physical and chemical phenomena cause the material's properties and behaviors to dramatically differ from its bulk counterpart. These phenomena affect how nanoscale materials transport, store, convert and dissipate energy that is essential for a broad range of energy applications. However, key challenges exist in the assembly of these low-dimensional nanomaterials into three-dimensional (3D) macroscopic architectures. This process is usually accompanied by the loss of exceptional nanoscale properties and functionalities. In my research, the emphasis is being placed on the development of scalable nanomanufacturing approaches for the synthesis and hierarchical assembly of 3D hierarchical architectures which allow for the retention of novel features of their nanoscale building blocks. These 3D architectures enable novel innovations in energy storage devices, such as high-power batteries for electrical vehicles, thermal management such as thermal insulation for military and astronautical applications, as well as advanced sensing and detection.

Stephen Taylor

Assistant Professor of Finance

Title: Clustering Financial Return Distributions Using the Fisher Information Metric

Information geometry provides a correspondence between differential geometry and statistics through the Fisher information matrix. In particular, given two models from the same parametric family of distributions, one can define the distance between these models as the length of the geodesic connecting them in a Riemannian manifold whose metric is given by the model's Fisher information matrix. One limitation that has hindered the adoption of this similarity measure in practical applications is that the Fisher distance is typically difficult to compute in a robust manner. We review such complications and provide a general form for the distance function for one-parameter models. We next focus on higher dimensional extreme value models including the generalized Pareto and generalized extreme value distributions that will be used in financial risk applications. Specifically, we first develop a technique to identify the nearest neighbors of a target security in the sense that their best fit model distributions have minimal Fisher distance to the target. Second, we develop a hierarchical clustering technique that utilizes the Fisher distance. Specifically, we compare generalized extreme value distributions fit to block maxima of a set of equity loss distributions, and group together securities whose worst single-day yearly loss distributions exhibit similarities.

Roman Voronov

Assistant Professor of Chemical and Materials Engineering

Title: Image-Based Simulation of Transient PDGF-BB Gradient Explains How Fibroblasts Affect Each Other's Directional Decisions during Chemotaxis

Directed fibroblast migration is central to highly proliferative processes in regenerative medicine and developmental biology, such as wound healing and embryogenesis. Here, we use image-based multiscale modeling in order to explain an experimentally observed contradiction to the classical chemotaxis theory: fibroblasts alternating their directional decisions in microscopic tissue-sized confinement, instead of following the steepest chemotactic gradient. Overall, these finding support the conclusion that the presence of the individual cells in microconfinement can modify the external chemotactic cues via self-generation of local gradients. Consequently, accounting for such effects could lead to a better understanding of tissue generation in vivo, and result in more advanced engineered tissue products in vitro.

Haimin Wang
Distinguished Professor of Physics

Jason Wang
Professor of Computer Science

Title: Machine Learning for Space Weather Forecasting and Solar Data Mining

We present a suite of machine learning methods including random forests, multilayer perceptrons and extreme learning machines for performing multiclass predictions of solar flares using physical parameters provided by the Space-weather HMI Active Region Patches (SHARP) and related data products. We then describe the DeepSun project, which aims to provide machine learning as a service for space weather forecasting, and show how the machine learning methods work using DeepSun web services. Finally, we discuss our recent work of using deep learning to perform solar data mining, as well as future work on solar data and tool integration.

Xianqin Wang
Associate Professor of Chemical and Materials Engineering

Title: Synthesis of an Ideally Green Nanocrytalline Material – Cubic Gauche Polymeric Nitrogen

It is rare and challenging to synthesize cubic gauche polymeric nitrogen (cg-PN), especially in a nanocrytalline form. But PN attracts the scientific world due to its high energy storage capacity and other potential applications from its Lewis base property. A few theoretical calculations predicted the possible PN phases, structures and stabilities, but no experimental work has been found to synthesize cg-PN materials under practical manufacturing conditions. With the support of the SEED Grant, the long-sought cubic gauche phase of polymeric nitrogen (cg-PN) with nitrogen-nitrogen single bonds has been successfully synthesized together with a related phase by a radio frequency plasma reaction under near-ambient conditions. The successful synthesis of the cubic gauche allotrope of high-energy density polymeric nitrogen under near-ambient conditions will therefore enable its optimized production and applications, such as a "green" energetic material and a potential catalyst for a wide range of chemical reactions.

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