NJIT
New Jersey Institute of Technology

2023 RESEARCH INSTITUTES, CENTERS AND LABORATORIES SHOWCASE

THURSDAY
MARCH 30, 2023

NJIT
Makerspace

Welcome to the 2023 Research Institutes, Centers and Laboratories Showcase, an annual celebration of NJIT's most potent and promising engines of innovation. The approximately 150 institutes, centers and labs represented today reflect the steady, strategic growth in the university's research enterprise. Over the past five years, more than 90 of these labs have been created, while total external research and development awards have increased by more than 114% and expenditures have nearly doubled.

We come together today, however, because these nodes of expertise do not exist in isolation. NJIT strongly believes that as researchers, we are most innovative and productive when we join together across disciplines to solve complex challenges that defy simple answers and niche know-how. Our research clusters encompass Bioscience and Bioengineering, Data Science and Management, the Environment and Sustainability, Materials Science and Engineering and Robotics and Machine, Intelligence. These clusters invite multidisciplinary collaborations on campus, at peer institutions and with partners in industry, government and business that advance innovations in research that are effectively translated into high-impact, real-world applications.

Our four research institutes — the Institute of Brain and Neuroscience Research, the Institute of Space Weather Sciences, the Leir Institute for Business, Technology and Society and the Institute for Data Science — take up system-wide challenges in their sectors. State-of-the art equipment at the York Center for Environmental Sciences, the Life Sciences and Engineering Center and, most recently, the renovated Microfabrication Innovation Center, a state-of-the-art nanoelectronics fabrication facility with the highest-level cleanroom, allow us to characterize and process novel materials and to fabricate devices and sensors for a broad spectrum of environmental, energy, water remediation and medical applications.

We continue to focus on three grand challenges inspired by "big ideas" in science and technology identified by federal agencies such as the National Science Foundation, the National Institutes of Health, the U.S. Department of Defense and other major organizations and foundations, including the World Health Organization, the Gates Foundation and the United Nations Foundation's sustainable development goals.

Within the health care arena, we focus on physiology-based innovations that include wearable health-monitoring technologies; cellular and tissue engineering-based therapeutic technologies; traumatic brain injury, brain health and improvements to neurological functions; human-robotic assistive devices; women's health; smart drug delivery systems; and smart health care information management systems.

Our diverse approaches to sustainability include system optimizations across sectors, technologies to protect and clean the environment and the development of next-generation infrastructure that is durable and green. Our devices and processes include novel energy materials and delivery systems; water treatment and waste management; environment and climate resilience; new knowledge of space weather; intelligent adaptive transportation; smart buildings and cities; and additive manufacturing.

Our third major emphasis is on high-performance computing, quantum computing and information systems, artificial intelligence and cyber-infrastructure technologies, including system architectures for complex high-performance data analytics; cybersecurity and secured adaptive networking; co-evolution and augmentation of machine and human intelligence; smart robotics in technological and societal applications, such as assisted living; and robust data management.

Atam P. Dhawan

Interim Provost and Senior Executive Vice President
Senior Vice Provost for Research

National Academy of Inventors-NJIT Chapter Forum

Collaborative Research and Technology Innovation Partnerships

In conjunction with

NJIT's 2023 Research Institutes, Centers and Laboratory Showcase

March 30, 2023
Ballroom, Campus Center, NJIT

YouTube Live Streaming at

https://www.youtube.com/live/D_VwZ5Lsr-w?feature=share

Technology innovations are driving profound societal changes, while creating new pathways to address the world's grand challenges, improve our quality of life and grow the economy. It is clear, however, that advances in translational research and market validation methods, as well as in smart manufacturing and distribution optimization strategies, are needed to truly harness the power of our vast knowledge base and unprecedented investments in basic and applied research. Synergistic partnerships among the research, industry, business and infrastructure sectors, as well as government and non-government stakeholder communities, are critical to our success. As the world's technology innovation leader, the U.S. must continue to focus on building healthier and more prosperous communities, while ensuring they are also sustainable.

To achieve our research and educational goals, the university's strategic plan calls for multidisciplinary research collaborations and technology innovation-based entrepreneurship among faculty, staff and students, all of whom have a central part to play in advancing science, engineering and technology to fuel societal progress. We have organized our research into five principal areas.

BIOSCIENCE AND BIOENGINEERING

This cluster includes research in the areas of biomedical devices, sensors and instrumentation, brain health and neuroscience, tissue engineering, biological sciences and behavior, molecular biology, evolutionary sciences, and gene therapy and phenotype related research. Researchers at NJIT are advancing our understanding of the functions of the brain and spinal cord under normal, injured and diseased states at molecular, cellular and functional levels through experimental, theoretical and computational methods. Imaging experts, computer scientists and biomedical engineers are working together, for example, to devise therapies and devices that will improve motor, cognitive and organ functions. To this end, our tissue engineers focus on replacing dysfunctional cells with regenerated cells and tissues. The Bioscience and Bioengineering cluster intersects with other research clusters to develop health care technologies and systems such as point-of-care medical sensors, devices and rehabilitation systems, as well as health care information systems and management involving primary care, hospitals and emergency care resources and protocols.

DATA SCIENCE AND MANAGEMENT

This cluster includes the study and practice of data science and analytics and the extraction of information and knowledge from data that can be used for medical, financial, business management, scientific and engineering applications. Researchers in these groups focus on bioinformatics, medical informatics, image processing, data mining, solar-terrestrial physics, transportation, financial management, business administration and management, life sciences and health care.

The cybersecurity group designs secure cyber systems and improves cyber information and communications technology (ICT). ICT is shaping many aspects of society as the economy evolves rapidly, providing access to unprecedented amounts of information, anytime and anywhere, from any type of device. By 2025, the number of global IoT (Internet of Things) connections will increase to more than 30 billion from 12 billion in 2020, according to an estimate by IoT Analytics. Global spending on security hardware, software and services is estimated to reach about $175 billion by 2024, according to Statista.

The Data Science and Management cluster, with its broad transdisciplinary scope, also includes research centers focused on mathematical sciences, transportation systems, additive manufacturing, wireless communications technology and industry and business management, as well as a focus on the societal impacts of science and technology. Working across disciplines, its researchers develop data-driven approaches in applications ranging from health care information systems, to industry automation, to finance and business management.

ENVIRONMENT AND SUSTAINABILITY

This cluster conducts research on urban ecology, solar physics and space weather, environmental sensors, sustainable infrastructure, intelligent transportation systems, global climate change, biodiversity and conservation, clean water, waste management, renewable energy, smart grid systems and additive/advanced manufacturing systems. The urban ecology and sustainability area emphasizes sustainable infrastructure, smart transportation, ecological communities and urban modeling and simulation. We study the connection between space weather and evolutionary changes in the solar system for direct impacts on our ecosystems and climate changes globally.

This area also focuses on the water-energy nexus and the impact of ocean levels on the environment, as well as the development of technologies to clean water and to provide green energy, such as biofuel cells and powerful, long-lasting batteries. Research in the manufacturing systems group involves new methods and technologies in design innovation and process automation. A specific emphasis is the creation of new processes and tools for pharmaceutical manufacturing. The Environment and Sustainability cluster intersects with other clusters to develop smart and green buildings and sustainable communities, to understand space weather and climate changes, and to devise intelligent adaptative and data-driven automations in additive manufacturing systems.

MATERIALS SCIENCE AND ENGINEERING

This cluster focuses on advanced materials, including smart energetic and composite materials,quantum materials, biomaterials, polymers, membrane technologies and nanotechnologies. The scope of nanotechnology research includes scientific and engineering phenomena at the minutest and most fundamental levels in order to develop technologies for environmental and pharmaceutical applications. The interdisciplinary group focused on engineered materials and particulates develops technologies to prepare, process and use engineered-particulate materials and their composites for a spectrum of applications.

The Materials Science and Engineering group works on environmental and medical sensors and devices, tissue engineering, intelligent robotics and rehabilitation systems, additive and pharmaceutical manufacturing, smart buildings and sustainable communities, as well as data-driven modeling and simulation for the development and characterization of smart materials.

ROBOTICS AND MACHINE INTELLIGENCE

This cluster explores the human-machine interface, cyber-human systems, robotics — including bioinspired, medical, social and industrial autonomous systems — intelligent infrastructure, artificial intelligence, machine learning and augmented and virtual reality. Robotics and bioinspired autonomous systems are making a significant impact in areas such as rehabilitation, manufacturing, navigation and transportation, and medical and home-based care. Artificial intelligence and augmented/virtual reality applications have evolved rapidly, bringing new modes of automation, social networking and the co-evolution of machine and human intelligence to make important decisions in our daily life from finance to health care. The Robotics and Machine Intelligence cluster also develops smart automation and navigation systems, smart health care information systems and intelligent systems for applications in education and learning for smart cities and living-assistance systems.

BIOSCIENCE AND BIOENGINEERING

Institute for Brain and Neuroscience Research

Farzan Nadim, Director

The Institute for Brain and Neuroscience Research (IBNR) takes a multipronged approach toward understanding neural circuits and their disruption. IBNR neurobiologists examine the simple nervous systems of animals such as crustaceans and worms, while mathematicians develop models of neuronal patterns. IBNR biochemists conduct laboratory analyses of the biochemical building blocks of internal mechanisms such as the circadian clock. The Institute is equally committed to mitigating the effects of disabling neurological disorders and injuries by designing devices and therapies that help people function to their full potential. In these efforts, neurorehabilitation and biomechanics engineers work closely with imaging experts who have devised ways to map the brains of people affected by diseases such as Alzheimer's and developmental conditions such as ADHD and dyslexia, as well as changes in brain patterns in response to visual and hearing disorder treatments that our researchers develop. IBNR researchers work closely with clinicians in the region and throughout the country on a variety of therapies. Our biomedical engineers partner with the Kessler Institute and hospital-based rehabilitation centers to develop exoskeletons and other devices that will help people with neurological disorders participate in classrooms and in workplaces; our traumatic brain injury specialists collaborate with New Jersey-based physicians and medical researchers on their work for the U.S. Department of Defense and with clinicians and researchers at pediatric hospitals from Pennsylvania, to Alabama, to California.

BioSensor Materials for Advanced Research & Technology Center

Omowunmi Sadik, Director

The mission of the BioSensor Materials for Advanced Research & Technology (BioSMART) Center is to understand how biological systems communicate with their surroundings by gathering data with sensors on their internal states and environments, measuring the information, and then using that knowledge to develop innovative sensing technologies that employ sustainable materials and greener environmental processes. BioSMART seeks to meet society's need for fully autonomous, self-aware and resilient intelligent chemical and biological sensor systems by learning – and designing – from nature. Biological systems, without exception, are SMART sensors. Their behavior is the result of a complex web of interactions between sensory inputs and physiological processes that implements cognitive functions to allow the organism to perform efficiently. The BioSMART team has developed innovative biosensors for ultrasensitive detection of Staphylococci Enterotoxin B, the microorganisms that compose biofilms, nucleic acid mutations, E. coli, Bacillus globigii and numerous environmental pollutants: chromium VI; lead; polychlorinated biphenyls; microcystins; organophosphates; nitrobenzenes; and endocrine disrupting chemicals. One of our technologies has been translated to a portable, fully autonomous, remotely operated sensing device known as an Ultra-Sensitive Portable Capillary Sensor, or U-PAC. Some of our earlier sensors have been used for the detection of trace uranium and vanadium. Current projects include environmental sensors for COVID-19, pain biosensors, sustainable nanomaterials, biodegradable polymers, and new diagnostic tools and detection devices for medical, environmental and military applications. The wide range of intelligent sensor systems that can become commercial realities through advances pioneered by BioSMART will benefit society in antibiotic resistance monitoring, environmental analysis, wireless sensor networks, robotic sensors, bioremediation and point-of-use 'smart' systems.

Center for Brain Imaging

Bharat Biswal, Director

The long-term goal of the Center for Brain Imaging is to better understand human brain functioning using integrative neuroimaging and statistical and computational modeling methods. We believe it is essential to understand the complexity of brain function and its development in order to develop effective treatments. We have four research themes: human brain functional patterns and their development; reliable neuroimaging measures; functional patterns in animal models; the links between specific psychological processes and brain function and the means by which mental and neurodegenerative diseases disrupt brain function. We use modern neuroimaging techniques (MRI, fMRI, PET, fNRIS) to map the three levels of intrinsic functional brain architecture – regions; subnetworks; and the entire brain. We then direct our investigations to brain development within different stages of life, to computational simulation of the brain's neural connections and to clinical psychology and psychiatry guided by our neuroimaging results. We are working on several disease models, including Alzheimer's, schizophrenia and autism, as well as on the effects of aging and spinal cord injury. Our research is currently funded by the National Institute on Aging and the National Institute of Biomedical Imaging and Bioengineering, the National Science Foundation, the New Jersey Commission on Spinal Cord Research and the N.J. Governor's Council for Medical Research and Treatment of Autism.

Center for Injury Biomechanics, Materials and Medicine

Bryan Pfister, Director

The Center for Injury Biomechanics, Materials and Medicine (CIBM3) is a multi- and interdisciplinary research center focused on understanding, diagnosing and treating brain injuries and concussions using experimental and computational methods. The CIBM3 is involved in both traumatic brain injury (TBI), a major concern among U.S. soldiers and veterans, and mild TBI and concussion in sports injuries, which also raise serious health concerns. Specifically, through novel blast-tube and drop-tower facilities, we examine what type of helmets, pads and configurations offer the right protection for soldiers and players. We study when and how concussions are caused and if there are simple diagnostic methods to identify concussions. We use animal models and mechanical surrogates to examine the role of blast pressures and the height of falls to relate injury to medical outcomes. Some of our recently funded efforts include examining the effect of blast overpressures on the dose-response curve of animal models and research into the mechanisms of blast-induced brain injury. In yet another project, we use experimental methods to study the effect of eyewear and hearing protection on the TBI susceptibility of warfighters. Bryan Pfister and James Haorah, along with other colleagues from NJIT, medical schools and Veterans Administration facilities take a holistic approach to offer new measurement techniques, diagnostics and prognostic tools to address sports injuries and military medicine.

Advanced Biomaterials Translation Laboratory

Vivek Kumar, Director

The Advanced Biomaterials Translation Laboratory develops novel peptide-based hydrogels that are injected and then self-reassemble in situ in tissue spaces. These constructs can be designed to deliver drugs and other small cargo over day, week or month-long periods. Facile modification of the base peptide allows for the development of novel drugs that can specifically target angiogenesis, neurogenesis, osteogenesis and even the delivery of antigenic sequences for vaccine development. Motivated by translational goals, the lab engages in academic science, biopharmaceutical development, medical device prototyping, drug design and delivery and entrepreneurship. Our current work has led to the establishment of platforms for the treatment of maladaptive angiogenesis, ischemic tissue disease, diabetic ulcer wound healing and dental pulp regeneration, among other therapies.

BioDynamics Laboratory

Xianlian Alex Zhou, Director

The BioDynamics Laboratory focuses on computational biomechanics and bioengineering, robotics and human-robot interaction, injury prevention and personalized medicine. The lab aims to develop advanced computational methods and software to simulate and understand the dynamics and neuromuscular control of human locomotion; to analyze biomechanical loadings in different biosystems (such as musculoskeletal, vascular, and respiratory systems) under normal, extreme or injurious conditions. We also design and evaluate wearable assistive devices such as exoskeletons for human performance augmentation or rehabilitation and to develop protective or preventive measures and treatment options against injuries or diseases.

Cardiovascular Tissue Engineering and Stem Cell Laboratory

Eun Jung Lee, Director

The Cardiovascular Tissue Engineering and Stem Cell Laboratory focuses on understanding and developing therapeutic strategies to repair cardiovascular diseases. The lab develops various in vitro cardiovascular tissue models that involve integrated use of stem cells, biomaterials and biomimetic bioreactors. These tissue models are used to investigate the biophysical cues needed for heart and microvascular development. Moreover, diseased tissue models allow us to understand the mechanisms and the interaction between cells and their extracellular environment during pathological conditions, providing a novel means for evaluating new treatments for diseased or damaged cardiac tissue.

Circadian Clock Laboratory

Yong-Ick Kim, Director

The Circadian Clock Laboratory researches the detailed biomolecular mechanisms of the circadian clock, the bodily and behavioral changes tied to the 24-hour daily cycle that synchronize to daylight and darkness. Increasingly, these patterns are disrupted by modern urban culture, including the omnipresence of artificial light and frequent travel across time zones. To explore the biochemical mechanisms that underlie these daily rhythms, we study the reconstituted in vitro circadian clock from a cyanobacteria, Synecochoccus elongates. The bacteria's central oscillator is encoded by three genes, KaiA, KaiB, and KaiC, whose protein products function together to generate a 24-hour rhythm of KaiC phosphorylation. The 24-hour KaiC phosphorylation rhythm is generated by the timely association and dissociation of these three Kai proteins. The laboratory works with biophysicists and mathematical biologists to examine hypotheses about the circadian clock's molecular mechanisms. By exploring them at this level, we expect to obtain critical clues for the treatment of medical problems related to the clock's disruption, including sleep deprivation and jet lag.

Computational Biofluid Dynamics Lab

Peter Balogh, Director

The Computational Biofluid Dynamics Lab focuses on the simulation of bio-inspired fluid dynamics using high-performance computing. We use an in-house, state-of-the-art method which couples fluid mechanics and solid mechanics models in 3D to enable new scientific discoveries. Our high-resolution simulations can capture biological cells, such as red blood cells or cancer cells, deforming and flowing in dense suspensions through complex 3D networks of blood vessels. Our recent projects include new method development and modeling in the area of angiogenesis, or the growth of new blood vessels. Through collaboration with experiment-based researchers we are developing new technology to enable predictions of microvascular growth in 3D. Potential impacts include helping to predict tumor growth patterns and informing new treatment approaches; improving blood flow in heart disease through re-vascularization; and aiding in the healing process following injury. We are also working to build a new understanding of cancer cell transport through complex blood vessels, as well as blood rheology and the influences of disease and aging.

Computational Neuroanatomy and Neuroinformatics Laboratory

Xiaobo Li, Director

The Computational Neuroanatomy and Neuroinformatics Laboratory aims to fill the gaps in the fields of neurobiology and neuroimaging, especially the need for systematically constructed models of quantitative neurobiological criteria that can aid in clinical diagnoses of cognitive deficits associated with severe brain disorders. The lab focuses on the development and implementation of analytical and statistical models for providing quantitative biological criteria that help identify cognitive deficits by integrating high-dimensional, multi-modal magnetic resonance neuroimaging, clinical and behavioral data and refined imaging analysis and machine learning techniques.

Computational Orthopaedics and Rehabilitation Engineering Laboratory

Saikat Pal, Director

The Computational Orthopaedics and Rehabilitation Engineering (CORE) Laboratory works on decoding the complexities of human movement through experiments and computational methods. In our experiments, we study three-dimensional kinematics, kinetics and electromyography from muscles during movement. Experimental methods alone cannot decode all of the musculoskeletal system's complexities, however, so we also develop and validate computational models of human movement during daily activities. Our insights are used to understand the onset, progression and treatment of musculoskeletal disorders. Current projects include: understanding joint loads during rehabilitation for bone health after spinal cord injury; changes in neuromuscular control strategies with aging; movement patterns in children with cerebral palsy; and building assistive devices for children with cerebral palsy.

Ecohydrology Lab

Xiaonan Tai, Director

Interdisciplinary research at the Ecohydrology Lab encompasses ecology, hydrology, geographic information science, remote sensing and computer science. We seek mechanistic understandings underlying the geospatial patterns of vegetation dynamics and how they might influence the future of ecosystems and water resources in the context of new and emerging environmental conditions. More specifically, the lab seeks to answer the following questions: What are the mechanisms underlying ecosystem response to anticipated warming and drought? How do biotic diversity and abiotic heterogeneity influence ecosystem resilience and resource sustainability in changing climates? How do we increase ecosystem resilience through effective management strategies? To explore these questions, we use advanced, mechanistic modeling, statistical analysis, in situ and remote sensing observations and parallel computation to synthesize various data sources and to advance knowledge.

Endocrine Disruption and Chemical Biology Laboratory

Genoa Warner, Director

The Endocrine Disruption and Chemical Biology Laboratory uses chemical tools to investigate the toxicity and mechanisms of endocrine disrupting chemicals in the female reproductive system. These chemicals interfere with the production, distribution and action of hormones in the body. Human are exposed during daily life to endocrine disrupting chemicals, which include ingredients in pesticides, personal care products, pharmaceuticals and other consumer products. Understanding how these chemicals act is important for the development of safer chemicals and novel therapeutics to prevent damage to sensitive reproductive organs. Current research projects include identifying the transcriptional and genomic targets of phthalates, a class of plasticizers, and investigating the ovarian toxicity of phthalate-alternative chemicals and novel mixtures representing environmental exposures.

Laboratory of Evolutionary Pattern and Process

Phillip Barden, Director

Work in the Laboratory of Evolutionary Pattern and Process is comparative in nature. We analyze phenotypic and genomic variation across multiple species and lineages to understand the evolutionary history of life and the mechanisms responsible for maintaining biodiversity. Part of this work is historical. We estimate the phylogenetic relationships of living and extinct organisms in a temporal context, quantify ecological change over time, and reconstruct patterns of biogeography and trait evolution. We also work to uncover broad trends in evolution by analyzing behavioral or morphological traits at the lineage or ecosystem level. Because they are ecologically impactful and phenotypically diverse, we primarily use eusocial insects, especially ants, as model systems for asking core questions. Our approach is multidisciplinary and combines paleontology; imaging methodology, such as micro CT-scanning and confocal microscopy; comparative genomics; and systematics. The lab is currently focused on identifying convergent trends in genome evolution related to advanced social behavior; quantifying links among phenotype, ecology, and extinction; and maximizing data collection from fossil amber.

Fluid Locomotion Laboratory

Brooke Flammang, Director

In the Fluid Locomotion Laboratory, we take a multidisciplinary approach, integrating comparative anatomy and physiology, biomechanics, fluid dynamics, and biologically-inspired robotic devices to investigate the ways in which organisms interact with their environment and drive the evolutionary selection of morphology and function. By combining these different areas, we are able to approach broad-impact ecological and evolutionary questions from an experimental perspective and directly test the effective relationship between an organism and its environment. We use both live animal and robotic models to investigate several ongoing research projects in our lab. One major initiative focuses on the functional morphology of the remora's adhesive apparatus with applications in defense, health care, and technologies and devices requiring long-term reversible attachment in wet conditions. Other projects include studying the swimming behaviors of sharks, reptiles and robotic models to interpret the functional morphology of extinct ichthyosaurs; modeling the passive high-throughput flow dynamics of chondrichthyan egg cases; and investigating the adaptive morphology and comparative biomechanics of fishes that can walk on land.

The Horax BioDataNamics Lab

Horacio Rotstein, Director

The goal of our research group is to understand how biological networks generate patterns of activity with an emphasis on oscillatory networks, how these networks process information and perform computations, and how all of this depends on the dynamic properties of the participating nodes, the connectivity and the network topology. We particularly focus on oscillatory networks of the nervous system, which play important roles in cognition and motor behavior both in health and disease. We develop and use mathematical modeling, numerical simulations, dynamical systems tools, parameter estimation and inference algorithms, and we have a well-developed network of collaborations with experimental scientists carrying out research both in vitro and in vivo. Our research includes the investigation of the mechanisms of selection of frequencies, amplitudes and additional activity attributes of the experimentally observed patterns, and the network response to external, often oscillatory signals, that are subject to background noise inputs (e.g., resonances, entrainment, correlations) as the result of the interplay of nonlinearities, time scales and the levels of neuronal organization (cellular, synaptic, micro-, meso- and macrocircuit). This research extends to biological networks in the context of chemistry and systems biology (e.g., biochemical, genetic). Our efforts also include the investigation of the relationship between experimental and observable data to models in collaboration with statistical neuroscientists and data scientists. These projects include of identification of degeneracy (multiple biological scenarios producing the same observable patterns) and the resolution of the associated problem of unidentifiability in models and data (the lack of ability to uniquely estimate model parameters from observable data). They also include the determination of dynamic scenarios underlying correlations and causal rules in neuroscience data.

Interdisciplinary Forensic and Biomedical Sciences Lab

Sara C. Zapico, Director

The Interdisciplinary Forensics and Biomedical Sciences Lab (ForenBioS) focuses on the use of biochemical techniques for forensic science applications, such as age-at-death estimation, post-mortem interval determination to establish how long ago a person died, body fluid identification and DNA extraction from tough substrates, with implications in biomedical sciences and cell biology. Current research projects include the development of the first epigenetic clock in tooth tissues to understand tooth aging; improvements to facial approximation by a combination of anthropological findings; DNA phenotyping and digital facial reconstruction; the development of a predictive model for post-mortem interval estimation based on metagenomics (the analysis of bacterial genetic material), and transcriptomics (the analysis of gene expression), and the identification of specific markers to detect sweat at crime scenes as a source of DNA.

Keck Laboratory for Topological Materials

Camelia Prodan, Director

The Keck Laboratory for Topological Materials uses interdisciplinary research to investigate the existence of what are known as topological phonons in microtubules (MTs), a naturally occurring biological material. Our theoretical evidence suggests that topological phonons are integral to the function of MTs – a cytoskeletal component in all eukaryotic cells that is essential for many fundamental cellular processes, including cell division and movement. Inspired by the mechanical properties of the microtubules, we work on laying the theoretical and experimental foundation for a new class of engineered materials that exhibit the unique vibrational and thermal properties of topological phonon edgemodes. Such materials may find application in sound deadening and amplification, and the management of heat flow.

Mechanobiology Lab

Farid Alisafaei, Director

The Mechanobiology Lab focuses on developing integrated computational and experimental tools to understand and harness the role of mechanics in physiological processes such as wound healing and stem cell migration, as well as in pathological processes such as fibrosis, surgical adhesions, scar formation, dry eye disease and cancer progression. Changes in the physical properties of the extracellular environment, due to aging, obesity and diseases such as fibrosis and diabetes, affect many important cellular functions such as migration, proliferation, differentiation and gene expression. Understanding the mechanisms through which cells sense and respond to these physical changes can lead to novel therapeutic modalities and pathways against diseases.

Neural Prosthetics Laboratory

Mesut Sahin, Director

The primary research focus of the Neural Prosthetics Laboratory (NPL) is to develop novel and translational neural prosthetic approaches and implantable devices in order to restore function in people with neurological disabilities resulting from injuries to the central nervous system, as in spinal cord and brain injuries, and strokes. In parallel, we aim to increase our knowledge about the role of the spinal cord and the cerebellum in motor coordination and sensory-motor integration. One of our recent projects involves modulation of the cerebellar activity using focused ultrasound and low frequency sinusoidal currents (transcranial alternating current stimulation) in animal models as a potential treatment modality in disorders of the motor system. We are also developing novel electrode arrays for multi-channel recordings of cerebellar activity using carbon microwires in animals during behavioral tasks. In previous years, the lab has developed microdevices that are activated by a near-infrared light beams for wireless neural stimulation of the spinal cord where tethered electrodes cannot be implanted.

Laboratory of Neurobiology and Behavior

Eric Fortune, Director

Research in the Laboratory for Neurobiology and Behavior examines the interactions between sensory and motor systems that are used to generate and control animal behavior. Experiments in the lab focus on two main questions: how sensory representations of movement are encoded by sensory systems and translated into motor commands, and how pairs of animals integrate social cues in the control of cooperative behaviors. We use methodologies that encompass varying levels of biological organization, from the computational consequences of transmembrane molecules to the behavior of multispecies flocks. Our work includes field studies of natural behavior in Amazon basin habitats, highly controlled behavioral studies in the laboratory, and a variety of neurophysiological approaches to central nervous system neurons in animals, pharmacological studies and mathematical modeling.

Neuroecology of Unusual Animals Laboratory

Daphne Soares, Director

How do nervous systems evolve and adapt to extreme environments? Evolution through natural selection has shaped nervous systems to generate behaviors. However, there are very few opportunities to study neural-circuit evolution where the ancestral and derived forms, as well as the adaptive environment, are all known and accessible. The Neuroecology of Unusual Animals Laboratory studies the synthesis of neuroethological and ecological principles to understand the evolution of neural adaptation. In our research, we have a three-pronged approach that examines the evolution of circuitries, molecular mechanisms of behavior, and sensory novelty. This integrative approach links a detailed characterization of the environment with the anatomy and function of neural systems within a phylogenetic context.

Laboratory of Neuroethology of Locomotion

Gal Haspel, Director

The Laboratory of Neuroethology of Locomotion studies the neurobiology of locomotion: How do nervous systems generate coherent muscle activity to propel animals in their environment? In particular, we focus on the levels of neuronalcircuits coordination in the locomotion of the nematode, C. elegans. This 1-millimeter-long roundworm moves through its environment by counteracting muscle contractions activated by a nervous system, as do all other animals, while also using the same molecular and cellular mechanisms, such as neurotransmitters and neuromodulators. Moreover, it offers several advantages as a research model: its nervous system is compact and includes only 302 neurons; it is small and transparent and fits under a microscope; and it is the only animal whose genome and nervous system have been completely mapped. This allows us to use a combination of optical methods to record and control neuronal activity together with transgenic methods to direct these tools to their targets. We use focused laser light to precisely dissect neuronal processes to study the circuit response to injury and regeneration and high-resolution techniques to map neuronal connectivity. More broadly, our research goal is to determine rules that govern the connectivity, activity and robustness of neuronal networks that generate behavior.

Sensorimotor Quantification and Rehabilitation Laboratory

Chang Yaramothu, Director

The Sensorimotor Quantification and Rehabilitation Laboratory (SQRL) researches various methods of concussion diagnosis and rehabilitation to return people to their baseline. Concussions or mild traumatic brain injuries can severely affect a person's quality of life or even prevent them from routine actions. Symptoms include headache, light sensitivity, nausea and fogginess, among others, which are caused in part by defects in the oculomotor (eye movement) and vestibular (balance) systems. Diagnosis is currently based on patient symptoms and there are few accurate and reliable objective assessments. At SQRL, we utilize portable technology, such as virtual reality (VR) headsets, to obtain objective, quantifiable metrics to detect concussions. In future work, we will use the same VR headsets to aid in the rehabilitation process. We are currently conducting preliminary research on children, NJIT athletes and veterans.

Structural Ecology Lab

Gareth Russell, Director

Members of the Structural Ecology Lab are interested in how the distribution and movement of organisms is affected by the physical and social structure of their environment. Within this arena, we gravitate towards applied conservation questions, such as how landscape alterations caused by humans impact the ability of animals to survive and prosper. After earlier work looking at how the spatial structure of islands and habitat fragmentation impact extinction risk, we have been focusing on animal movement. In particular, we are trying to understand why group-living animals follow particular movement paths in landscapes that have both physical structure, such as vegetation patches, and social structure, meaning the presence of other individuals. For example, a current question is whether social networks can be discovered from group movement patterns, and in turn how the social networks determine those movements. For this, we are using GPS-collared African elephants as our study system. We are also interested in the use of emerging tracking and identification technology for ecology and conservation.

Swarm Lab

Simon Garnier, Director

The Swarm Lab is an interdisciplinary research unit that explores the mechanisms of swarm intelligence. We study how information is exchanged and transformed during interactions between members of a group and how this leads to "intelligent" group behaviors. We focus on the coordination of large animal groups, such as ant colonies, ungulate herds, baboon troops and human crowds. We use this knowledge to develop applications to problems such as the organization of pedestrian traffic and the control of miniature robotic swarms. We collaborate with biologists, social scientists, physicists, mathematicians and computer scientists around the world to elucidate the principles that underlie collective behavior across levels of biological and social organization. Current projects include research into the decision-making abilities of neuron-less organisms such as the slime mold; the organization of traffic and supply chains in leaf-cutting ants; the dynamic construction behavior of nomadic army ants; the role of vocal communication in the coordination of activities in mammal groups; the impact of poaching on movement decisions and social structure in African elephant herds; and the application of swarm intelligence principles to predictive policing software.

Urban Ecology Lab

Daniel Bunker, Director, and Gareth Russell, Maria Stanko & Caroline DeVan, Co-Directors

TThe Urban Ecology Lab at NJIT aims to understand how species, ecological communities and ecosystems respond to the forces of global change. These forces include changes in temperature, precipitation and seasonality driven by increasing atmospheric CO2, as well as increasing pollution, invasive species, habitat fragmentation and urbanization. We use a combination of field, laboratory and modeling experiments to understand and predict these responses to global change. An example of ongoing research includes understanding how cockroaches spread through urban areas and vector human disease pathogens. Here we are using high throughput DNA sequencing to build population and dispersal models of cockroaches, and to quantify the microbiome found on cockroaches. Another example of ongoing research is an effort to understand how plants evolve adaptations to urban environments. Here we are studying Shepherd's Purse (Capsella bursa-pastoris), a common weed in urban environments around the globe. Our approach uses field and lab experiments coupled with real-time RNA expression to quantify local adaptations to polluted soils.

Vision and Neural Engineering Laboratory

Tara Alvarez, Director

Convergence Insufficiency (CI) is a prevalent binocular vision disorder that disrupts coordination of the eyes as they turn inward to focus on a near object. Symptoms, which include double and blurred vision, eyestrain and headaches during reading or other close work, negatively impact activities of daily living and can significantly impair a child's ability to focus and learn, for example. CI is present in about 5 percent of the population; just over a quarter of these patients do not improve even with validated therapy. While office-based therapy is effective in about 75 percent of patients with CI, home-based therapies are no more effective than a placebo. Our National Institutes of Health-funded project studies two potential mechanisms that may cause CI that we believe could be improved through therapy. This knowledge could lead to targeted therapeutic interventions, improved treatment success rates, reduction in the time to remediation and reduced health care costs. The laboratory is also funded by a life-science focused venture capital fund and through an IEEE EPICS grant to develop a virtual reality-game therapy device with NJIT's Computer Gaming Program, Salus University and The Children's Hospital of Philadelphia.

Zebrafish Neural Circuits and Behavior Laboratory

Kristen Severi, Director

The Zebrafish Neural Circuits and Behavior Laboratory researches the neural circuits underlying locomotor behavior in the larval zebrafish. These tiny fish with transparent bodies are ideal for studying in real time how the brain and spinal cord work together to produce everyday movements the fish needs to swim around its environment. The techniques we employ are multidisciplinary, including high-speed behavioral recordings and analysis, dynamic imaging of calcium activity within populations of neurons and electrophysiology. Using these techniques, we try to understand what specific circuits are essential for performing different motor actions and how those circuits are wired together.

DATA SCIENCE AND MANAGEMENT

Institute for Data Science

David Bader, Director

The Institute for Data Science (IDS) focuses on interdisciplinary research and development in all areas pertinent to solving real-world problems using data, including health care, financial management, cybersecurity, food safety, manufacturing and smart cities, to name a few. The institute is composed of research centers in data analytics and artificial intelligence, big data, medical informatics and cybersecurity; the centers conduct both basic and applied research that cut across all NJIT colleges and schools. Beyond academic research, the institute interacts closely with the outside world to identify and solve important problems in the modern data-driven economy. In collaboration with NVIDIA, a leading technology company that makes accelerators for real-world applications, for example, IDS is contributing to RAPIDS.ai, an open GPU data science framework for accelerating end-to-end data science and analytics pipelines entirely on GPUs. These new analytics pipelines are more energy-efficient and run significantly faster, which is critical for making swift, data-driven decisions. The Institute also collaborates with Accenture, a leading technology consulting firm, with protecting the open source software supply chain. The institute also emphasizes multidisciplinary research and workforce skills training to develop technology leaders who will solve global challenges involving data and high-performance computing. The Institute for Data Science's Advisory Board includes Accenture Labs, the Alfred P. Sloan Foundation, Amazon, Bayer Corporation, BlackRock, Cherre Inc., Citi, Google Research, the IBM T.J. Watson Research Center, NEC Laboratories America, The New York Times, NVIDIA, Prudential Financial, Stanley Black & Decker, UPS and Yahoo Research.

Henry J. and Edna D. Leir Research Institute for Business, Technology and Society

Michael Ehrlich, Director

The Henry J. and Edna D. Leir Research Institute for Business, Technology and Society (LRI) focuses on some of the most critical global challenges facing business and society today: the impacts of climate change and other disruptive societal and operational events on corporate sustainability and business continuity. LRI has an integrated, dual mission of innovative business research and targeted outreach necessary to realize the institute's overarching goal of helping business and industry to become more eco-efficient, resilient and sustainable. The LRI's research builds upon and leverages decades of NJIT experience and intellectual capital in the fields of sustainability and industrial ecology, environmental science, operations management and decision analytics, organizational behavior and business data science. In addition to conducting business and management research, the LRI works closely on problems with academic and business communities, regional economic leaders and government agencies. New cognitive business and machine learning methodologies, designed to help companies collect, visualize and analyze data from wide-ranging sources, are viewed as central to these efforts.

New Jersey Innovation Institute

The New Jersey Innovation Institute (NJII), an NJIT corporation, was founded in 2014 and helps turn ideas into workable solutions across four divisions: healthcare; strategic partnerships and entrepreneurship; defense and homeland security; and professional and corporate education. NJII combines the vast resources of NJIT, strong and far-reaching industry and government relationships, and proven methods for building industry-centric ecosystems to help drive innovation and deliver solutions that make a direct impact on the economy and the health and welfare of its participants. Our industry-centric divisions are:

- **Defense and Homeland Security (SVP and GM, General William Marshall):** The Defense division creates integrated product teams that include representatives from academia, industry and government. These teams develop solutions for the U.S. Department of Defense, such as rapid fabrication of parts on the battlefield and software that determines what parts can be 3D printed. The group recently opened an advanced manufacturing and innovation space in Landing, N.J., known as COMET, which builds on decades of collaboration between NJIT, NJII and the U.S. Army Picatinny Arsenal. (www.njii.com/defense)
- **Strategic Partnerships and Entrepreneurship (VP, Kathy Naasz):** The team inside the Strategic Partnerships and Entrepreneurship division runs an incubator called VentureLink, which is also the name of a building that is located on the NJIT campus and offers flexible private and co-working office space. The division is also tasked with commercializing intellectual property that comes from NJIT and with expanding NJII entrepreneurship programs and services across New Jersey. (www.njii.com/entrepreneurship)
- **Healthcare (SVP and GM, Jennifer D'Angelo):** Our Healthcare division is the state-designated entity responsible for developing and managing the New Jersey Health Information Network (NJHIN) on behalf of the New Jersey Department of Health. They are also a certified registry for the Centers for Medicare & Medicaid Services' Merit-based Incentive Payment System, which is a quality improvement program for Medicare providers that meet a certain threshold of Medicare billing annually. As of 2023, the division has accomplished HITRUST Risk-based, two-year certified status for NJII's key implemented systems, along with CMS Medicaid Enterprise System certification for New Jersey and the NJHIN. (www.njii.com/healthcare)
- **Healthcare Innovation Solutions (HCIS) (SVP and GM, Jennifer D'Angelo):** In 2018, NJII launched Healthcare Innovation Solutions, Inc., its for-profit subsidiary, to help our clients find new and innovative ways to optimize healthcare delivery and lower costs, improve patient outcomes and advance technology. (www.healthcareinnovationsolutions.com)
- **Professional & Corporate Education (Interim VP, Kathy Naasz):** The Professional & Corporate Education division at NJII is focused on helping employers make the most of their most valuable asset: their people. We believe strongly in protecting the value of investments made in the workforce and are dedicated to providing programming and support that meet the needs of industries and businesses. We also offer pre-apprenticeship programs, professional development and executive education, and continuing education programs that provide opportunities for individuals to sharpen their skills and keep up with the latest advances. (www.njii.com/pce)

Center for Applied Mathematics and Statistics

Michael Siegel, Director, and David Shirokoff, Associate Director

The Center for Applied Mathematics and Statistics (CAMS) is an interdisciplinary research center dedicated to supporting research in the mathematical sciences. CAMS researchers work on the modeling and simulation of complex systems with applications to fluids and materials, biological systems and electromagnetic phenomena. There are also significant efforts in nonlinear partial differential equations, optimization, statistics and data science. Research techniques involve developing new models, as well as novel numerical algorithms. Our research approach is interdisciplinary and involves collaborations with colleagues from a variety of disciplines at NJIT, as well as nationally and internationally. CAMS brings researchers from academia, industry and government to NJIT by organizing the annual "Frontiers in Applied and Computational Mathematics" meeting and other workshops. The center maintains a high-performance computer cluster for the use of its members, and runs a weekly colloquium on applied mathematics and statistics. We also organize a seminar series in mathematical biology, fluid dynamics and wave propagation, and applied statistics. CAMS supports the submission of interdisciplinary research proposals and a summer program for graduate students.

Center for Big Data

Chase Wu and Dantong Yu, Co-Directors

The mission of the Center for Big Data is to synergize expertise in various disciplines across the NJIT campus and build a unified platform that embodies a rich set of big data-enabling technologies and services with optimized performance to facilitate research collaboration and scientific discovery. Current research projects at the center focus on the development of high-performance networking and computing technologies to support big data applications. We are building fast, reliable data-transfer systems to help users in a wide spectrum of scientific domains move big data over long distances for collaborative data analytics. We are also developing high-performance workflow processes to manage the execution and optimize the performance of large-scale scientific workflows in various big data computing environments, including Hadoop/MapReduce and Spark. Furthermore, we are developing new machine learning, data mining and data management techniques to address volume, variety, velocity, variability and veracity challenges to enable big data analytics and predictive modeling in real-life applications. For example, we are developing a platform for analyzing user-contributed social media data to discover adverse drug effects, a leading cause of death. We are also developing data-driven methods to analyze web page browsing behaviors to better understand user needs, as well as the economics that sustain the free Web. These projects have been supported by the Leir Charitable Foundations, the National Science Foundation and Google.

Center for Computational Heliophysics

Alexander Kosovichev, Director

The primary goal of the Center for Computational Heliophysics is to develop data analysis and modeling tools in the area of heliophysics – the study and prediction of the Sun's magnetic activity – by combining expertise from computer scientists in the Ying Wu College of Computing with that of physicists and mathematicians in the College of Science and Liberal Arts. We work in partnership with NASA's Advanced Supercomputing Division at the NASA Ames Research Center. The Center is involved in the NSF EarthCube initiative to transform geoscience research by developing cyberinfrastructure to improve access, sharing, visualization and analysis of all forms of geosciences data and related resources. The center's work is focused on novel, innovative approaches, including the development of intelligent databases, automatic feature identification and classification, machine-learning, realistic numeric simulations based on first-physics principles and observational data modeling. The center develops synergies among these approaches to make substantial advances in heliophysics and computer science. Our new methods and tools can be used in broader scientific and engineering applications for developing new approaches to intelligent big data databases, as well as for image recognition and characterization methodologies

Cybersecurity Research Center

Reza Curtmola and Kurt Rohloff, Co-Directors

Cyber technologies are critical in modern society and include communication networks, hand-held computers, cloud computing environments and embedded computing technologies that are integrated into all modern automobiles, airplanes and military systems. The Cybersecurity Research Center seeks to address ongoing and long-term future cybersecurity needs for protection and further economic development across the State of New Jersey, nationally and internationally. The center develops new methods for understanding how modern cyber systems can be compromised and fail, for designing cyber systems so they are secure, and for improving or fixing the cyber infrastructure that has already been deployed. Current areas of investigation to address these challenges include developing and applying new approaches to software supply chain security; web security and privacy; smartphone and mobile security; database security; trustworthy machine learning and AI; and homomorphic encryption. The center is primarily affiliated with the Ying Wu College of Computing, but is intended to be highly collaborative and inclusive, with the goal of including and supporting collaborations with researchers outside of the college and with researchers and practitioners outside of the university. The center has been externally funded by agencies such as the National Science Foundation (NSF), Defense Advanced Research Projects Agency (DARPA) and the National Security Agency; its members are recipients of two NSF CAREER awards and one DARPA Young Faculty Award. Faculty affiliated with the center aim to publish their research in top security and related venues, such as Usenix Security Symposium, IEEE Security and Privacy Symposium, ACM Mobicom and ACM SIGMOD.

National Science Foundation I-Corps Program Center

Michael Ehrlich, Principal Investigator

NJIT is a partner institution of the NSF I-Corps Northeast Hub, a nationwide NSF-funded network of universities formed to accelerate the economic impact of federally funded research in health care, the environment and technology, among other areas, while building skills and opportunities among researchers from all backgrounds, including those historically underrepresented in entrepreneurship. Princeton University is the principal institution in the hub, along with nine partner institutions, including the University of Delaware; Rutgers University; Lehigh University; Temple University in Pennsylvania; New Jersey Institute of Technology (NJIT), Rowan University in New Jersey; Delaware State University; Drexel University; and Yale University. The hub will expand by adding new partner institutions each year.

With $15 million in funding from NSF over five years, the hub provides entrepreneurial training, mentoring, and resources to enable researchers to form startup companies that translate laboratory discoveries into breakthrough products and services. The hub employs the NSF I-Corps entrepreneurship training approach, which focuses on understanding the needs of potential customers, exploring industrial processes and practices first-hand, and confronting the challenges of creating successful ventures based on scientific discoveries. This approach employs a “lean startup” methodology in which innovators rapidly iterate on their products and business plans based on customer feedback and market needs. Ultimately, the goal of the NSF I-Corps program is to grow the societal and economic benefits arising from NSF-funded research in science and engineering

New Jersey Innovation Acceleration Center

Michael Ehrlich, Director

The New Jersey Innovation Acceleration Center (NJIAC) is a resource for entrepreneurs and innovators from throughout the region, with a focus on students and faculty at NJIT, as well as members of the Newark and, more broadly, North Jersey communities. Partnering with VentureLink, we offer a full range of services, from business incubation to new business training, among other resources. Our mission is to help innovators accelerate their time to market and to revenue metrics. Among other activities, the NJIAC sponsors the NJIT Entrepreneurs Society, TEDxNJIT and the New Business Model Competition (with support from Capital One Bank, Synchrony Bank, Edison Foundation and others), which is open to both students and community members from throughout North Jersey. This year’s 12th annual competition was held virtually and attracted the largest attendance ever. The winners and finalists of the NBMC are invited to participate in the 10-week NJIT Lean Startup Summer Accelerator Program, in which we help new companies launch and quickly achieve their first revenues.

Structural Analysis of Biomedical Ontologies Center

Yehoshua Perl and James Geller, Co-Directors

The Structural Analysis of Biomedical Ontologies Center (SABOC) is an interdisciplinary research center linking computer science and medicine. It deals with medical terminologies and ontologies, a subject of study that is a sub-field of medical informatics. Many biomedical terminologies are measured in the tens of thousands to hundreds of thousands of terms, including drug names and their chemical ingredients, symptoms, diagnoses, body parts, medical procedures, medical devices, infectious agents and accidents, among others. Understanding these terms and finding inconsistencies with textual representations is difficult, and we therefore use graphical representations: biomedical terminologies appear as networks in which the terms are symbolized as boxes and the relationships between pairs of terms are symbolized as arrows. Without a sophisticated approach, visualizing these networks on a computer screen can lead to failure. The core research efforts of SABOC are to develop small abstraction networks that summarize large biomedical terminologies; to visualize abstraction networks on a computer screen in a manner that is easier to comprehend than the original terminologies; and to perform quality assurance on the original terminologies by using the abstraction networks to find and remove inconsistencies. As biomedical terminologies are increasingly used in applications such as electronic health records, ensuring that terminologies are free of inconsistencies helps ensure the correctness of these applications. SABOC is currently funded by a three-year, $1.75 million grant from the National Institutes of Health.

The Elisha Yegal Barn-Ness Center for Wireless Information Processing

Alexander Haimovich, Director

The Elisha Yegal Bar-Ness Center for Wireless Information Processing (CWiP) engages in a broad range of research in diverse areas of wireless communications, signal processing and radar. The center serves as a collaboration hub of faculty, visiting scholars, post-doctoral fellows, graduate and undergraduate students. Current main areas of research include 5G wireless mobile networks, cloud radio access networks, sensor networks, information theory cooperative networks, machine learning radar and acoustics communications

Advanced Networking Laboratory

Nirwan Ansari, Director

The Advanced Networking Laboratory (ANL) engages in research to improve the performance and dependability of telecommunications networks. The ANL's goals are to identify, model, simulate and demonstrate next-generation networking technologies; to add to the knowledge base for next-generation networks; to train tomorrow's network engineering innovators; and to foster industrial collaboration and international partnerships. ANL worked with NEC America and FutureWei, for example, to improve passive optical networks. The National Science Foundation (NSF) has supported the lab's investigations into new ways to provide services to a growing set of traffic classes in next-generation networks. Other recent projects that have been funded by NSF include: SoarNet, which leverages free space optics – the use of light in free space to wirelessly transmit data – as a backhaul and energizer for drone-assisted networking; FreeNet, Cognitive Wireless Networking Powered by Green Energy, which liberates wireless access networks from spectral and energy constraints; Greening at the Edges, which creates mechanisms for making the access portion of communications infrastructure more energy-efficient; REPWiNet (Renewable Energy Powered Wireless Networks), which aims to efficiently power future wireless networks with renewable energy; and Fast Autonomic Traffic Congestion Monitoring and Incident Detection, which seeks to provide real-time traffic monitoring through advanced networking, edge computing and video analytics.

Big Data Analytics Lab

Senjuti Basu Roy, Director

The Big Data Analytics Lab (BDaL) is an interdisciplinary research laboratory with a focus on large-scale data analytics problems that arise in different application domains and disciplines. One of the primary goals of our lab is to investigate an alternative computational paradigm that involves "humans-in-the-loop" for large-scale analytics problems. These problems come up at different stages in a traditional data science pipeline, including data cleaning, query answering, ad-hoc data exploration and predictive modeling, while also presenting in emerging applications. We study optimization opportunities that can be exploited in these unique man-machine collaborations, and address data management and computational challenges to enable large scale-analytics with humans-in-the-loop. Our focus domains are social networks, health care, climate science, retail and business and spatial data. The research projects at BDaL are funded by the National Science Foundation, the Office of Naval Research, the National Institutes of Health and Microsoft Research

Collective Intelligence Lab

Niccolo Pescetelli, Director

The Collective Intelligence Lab investigates group decision-making and collective performance in humans and machines. As people interact more and more online, their interaction is often mediated by algorithms, machines and artificial intelligence. The lab investigates the mechanisms behind high-performing teams and defines the boundaries of collective intelligence in the digital age.

Design Computation Lab

Taro Narahara, Director

The Design Computation Lab pursues creative solutions to reshape built environments and cities through emerging technologies, including multimedia big data analytics, advanced AI, immersive VR and innovative UX/UI. We aim to create a multidisciplinary research community to develop innovative, human-centered computational design solutions. Design is an open-ended process directed toward what is often the subjective and the qualitative. Our recent work on subjective functionality and comfort prediction for apartment floor plans through the use of deep neural networks was awarded the Human Communication Award by IEICE in Japan and the Excellence Award at the Informatics Research Data Repository User Forum by the National Institute of Informatics in Japan. Our generative design application for housing complexes employing an intuitive sketching interface received National Science Foundation funding and a national student award from the Architectural Research Centers Consortium. Our goal is to scientifically understand the professional decisions made by architects, real estate planners and urban designers that influence the quality of their spatial designs through multidisciplinary investigations.

Digital Spatial History Lab

Louis Hamilton and Burcak Ozludil, Co-Directors

The Digital Spatial History Lab (DSHL) provides tools for researchers and students to conduct temporospatial analysis of historical and contemporary environments. Researchers address questions about society, culture, religion and medicine by using digital historical methods to examine the built environment. DSHL projects use 3D simulation, virtual reality, ontological modeling, mapping and agent-based modeling to allow users to move in scale from one building to an entire city and from one minute to several centuries. Current projects focus on the Mediterranean capitals of Rome and Istanbul from the thirteenth century to the twenty-first. The Rome project examines street shrines as an expression of vernacular devotion, revealing hidden communities and exploring forces that shape individual devotion—from politics, to urban infrastructure, to tourism. The Istanbul project analyzes and maps medical spaces to uncover the history of Ottoman/Turkish psychiatry, reconstructing the daily life and medical routines within mental hospitals

Laboratory for Discrete Event Systems

MengChu Zhou, Director

The Laboratory for Discrete Event Systems explores the theory and application of such formal methods as Petri nets and automata to model, analyze, control, evaluate and simulate complex engineering systems. By combining them with mathematical optimization theory, the Internet of Things, big data analytics, artificial intelligence, machine learning and intelligent optimization methods, the lab offers many powerful methodologies and tools to advance a wide range of systems and processes. They include wafer fabrication, flexible manufacturing, intelligent transportation, oil refinery, water processing, steel production, electronics manufacturing, high-speed rail transportation, disassembly, and demanufacturing. Over the past three decades, the lab has produced more than 900 papers, including more than 500 IEEE Transactions journal papers, 28 patents, 29 book chapters and 12 books. They have been used by industrial firms, leading to significant economic and societal impact.

FinTech Lab

Grace Wang, Director

Rapid technology advances and innovations in machine learning, data mining, blockchain and mobile computing, among other technical fields, are reshaping the financial industry and the way financial services are delivered. Crowdfunding, cryptocurrency, mobile banking and e-payment are examples of new processes and products in the new FinTech era. The FinTech Lab pursues interdisciplinary research involving data science, computer science and finance to provide insights into financial data, improve the efficiency of financial operations and deliver innovative financial services. The lab also provides students training in FinTech to prepare them to enter the financial industry with an exceptional skill set.

Geriatric Engineering Technology Lab

David Lubliner, Director

The Geriatric Engineering Technology Lab engages School of Applied Engineering and Technology students in handson research projects that involve designing intelligent living environments to support independent living by individuals over the age of sixty-five. The lab contains both Arduino micro controllers and quad-core Linux Raspberry Pi systems to interface with and program sensors, motors and cameras, among other devices. In addition, students work on advanced design projects in gait analysis, facial recognition and proactive AI software to assist individuals as they age. Advisory group members in this age group interact with students to ensure their designs meet the needs of the target community, while internships with companies such as CISCO and Johnson & Johnson help refine their design projects. Students teams have the opportunity to commercialize their designs through the National Science Foundation I-Corps program based on NJIT's campus.

Gidget Lab – (G)ender-(I)nclusive (D)esign, (G)ame and (E)ducational (T)echnology Lab

Michael Lee, Director

The Gidget Lab examines various ways in which technology can better inform, engage and teach diverse learners a range of STEM topics. We build tools and study new technologies to attract more people and increase diversity in STEM. Our free computing education game, Gidget (helpgidget.org) has helped thousands of people across the globe to learn introductory programming concepts; nearly half the users are girls and women. The lab runs Newark Kids Code (newarkkidscode.org), a weekly program that assists middle school students in Newark, N.J. in learning programming and website design. We also work with local high schools to teach chemistry using virtual reality headsets. Our lab (gidgetlab.com) is funded by the National Science Foundation, the N.J. Department of Education and Oculus Research.

GIScience and Remote Sensing Laboratory

Huiran Jin, Director

The GIScience and Remote Sensing Laboratory focuses on the advancement of geospatial analysis and quantitative modeling of environmental changes at local, regional and global scales. Remotely sensed data acquired by various airborne and spaceborne sensing systems, such as multi- and hyperspectral sensors, synthetic aperture radar, light detection and ranging, and unmanned aerial vehicles are used in conjunction with geographic information system techniques and quantitative analytics to address a range of social and environmental issues. Research topics include land-cover and land-use mapping, urban growth detection, natural disaster management and the monitoring of wetland inundation dynamics for methane flux estimation. The methodologies we use include big data processing, spatiotemporal analysis, land-surface modeling and decision-support algorithm development for an improved understanding of the Earth.

High-Performance Computing Lab

Qing Gary Liu, Director

The overarching goal of the High-Performance Computing Lab (HPCL) is to research and develop methodologies and software tools to accelerate discovery on large scientific instruments, such as supercomputers, and at experimental and observational facilities. Our mission is to not only develop new ideas and advance knowledge, but to also work with computing facilities to develop hardened solutions that can benefit various science and engineering disciplines. HPCL researchers have successfully deployed software into various production environments, such as the U.S. Department of Energy's computing systems, National Science Foundation computing centers and U.S. Department of Defense computing centers. An estimated usage of software developed by HPCL researchers is 1 billion computing hours each year. The HPCL lab provides research and educational opportunities involving computer science and engineering, applied math, and computational engineering. Research activities are focused in the broad areas of parallel and distributed computing, data analytics and high-speed networking.

Laboratory for High-Performance Data Signal Processors & Data Engineering Research

Ali Akansu, Director

Data-intensive scientific discovery offers new opportunities to better understand, model and design complex systems and services. This endeavor requires cutting-edge, high-performance data processing and computing and internet and data engineering expertise, strongly coupled with mathematics. Many industries and businesses have already built state-of-the-art data and information processing infrastructure for their operations. The Laboratory for High Performance DSP & Data Engineering Research (HPDER) is a research and technology development laboratory that strives to advance the theory and implementation of analytically oriented high-performance DSP (digital signal processing), machine learning and data engineering methods to address big data and signal processing problems in various domains, ranging from quantitative finance to data networks. Current projects include explainable machine learning methods and algorithmic trading for U.S. equities.

Networked Controls and Intelligent Diagnostics Laboratory

Mohsen Azizi, Director

The Networked Controls and Intelligent Diagnostics (NCID) Laboratory focuses on the design and development of controllers and fault diagnosis algorithms that target the optimal and robust performance of industrial and dynamic systems. Decentralized control techniques are specifically designed for large-scale dynamic systems in which computation resources are distributed and communication bandwidth is limited. Moreover, hybrid diagnostics algorithms are designed based on a combination of classical and artificial intelligence-based fault diagnosis techniques that aim at the resilient and reconfigurable performance of dynamic systems in the presence of faults and failures. These control and fault diagnosis algorithms are developed for microgrids and renewable energy systems, and will be applied in the future to other applications, including autonomous vehicles, robotics and aerospace systems.

Networking Research Laboratory

Roberto Rojas-Cessa, Director

The goals of the Networking Research Laboratory are to perform world-class research on computer networking, intelligent systems, energy and security, and to develop novel approaches for data and information dissemination using theoretical, mathematical and practical approaches. This research aims to identify applications in communications and cyberphysical systems to benefit the community. The laboratory has contributed with models to measure different network parameters, the design of security tunneling of packets using autoencoders and protection to privacy-using machine learning and the development of new wireless and wired technologies. More recently, the laboratory has developed methodologies based on the modeling and evaluation of drone-oriented applications, models of COVID-19 spread and evaluations of the use of blockchain in control and prevention measures. The laboratory is deeply involved in supporting STEM education to students affiliated with the university and those interested in learning new challenges in computer networking, intelligent systems and sustainability. Recent sponsored research includes the digitization of energy; communications based on free-space optics; light-communication technologies for high-speed trains; and energy use in maritime ports.

Operations Management Laboratory

Wenbo Selina Cai, Director

The Operations Management Laboratory seeks to advance understanding of the impact of key players' decision-making processes on the design, pricing and management of products and services in supply-chain management. Theories and methodologies in both operations research and microeconomics, such as stochastic processes, optimization and game theory, are used. Research topics include fostering private-public collaborations to reduce the impact on ash trees from invasive species, such as the emerald ash borer, through a cost-sharing program; accelerating the implementation of carbon-capture and storage (CCS) technology through the design of economic incentives and optimal service contracts among participants of CCS networks; improving the performance of primary health care services through stochastic scheduling and optimal capacity allocation among pre-scheduled and urgent patients; and examining the economic and environmental implications of adopting additive manufacturing technology in the retail and supply chain.

Optimized Networking Laboratory

Abdallah Khreishah, Director

The Optimized Networking Laboratory engages in research to improve the performance of wireless and wireline networks and to utilize these networks in emerging applications. The goals of the lab are to identify, model, simulate and demonstrate proof-of-concept setups for next-generation networking technologies and to add to the knowledge base for next-generation networks, to train tomorrow's network-engineering innovators and to foster industrial collaboration and international partnerships. One future networking technology the lab investigates is Visible-light Communications (VLC), in which indoor light fixtures are used to jointly perform communications and illumination. We spend 90 percent of our time indoors, where 80 percent of Internet traffic is generated. The lab was the first to demonstrate a proof-of-concept setup that designs a cognitive Internet access system to leverage hybrid Radio Frequency (RF) access points or WiFi and VLC, an emerging concept. VLC has been extended to use very low-power Internet access for small Internet of Things (IoT) devices. With respect to the vehicular networks used by intelligent transportation systems, the lab is exploring the emerging concept of edge computing to enhance wireless networks in order to solve several problems related to traffic monitoring systems and congestion control on the highways of New Jersey. The lab is also investigating several wireless technologies for unmanned aerial vehicles and drones to help in situations such as emergency-response and recovery from natural disasters.

Social Interaction Laboratory

Donghee Yvette Wohn, Director

The Social Interaction Lab is an interdisciplinary research hub that combines psychology, communication, computing, and design to understand how people interact with technology, a field known as human-computer interaction (HCI). Some of our projects include understanding online harassment and content moderation on social media, examining new digital economies, studying remote communication/collaboration, and developing applications for health and well-being.

The Sound Interaction and Computing Lab

Mark Cartwright, Director

The Sound Interaction and Computing (SInC) Lab pursues research at the intersection of human-computer interaction and machine learning with the aim of building tools to aid in the understanding and the creative expression of sound. To do so, the lab studies peoples' needs and practices, researches new technologies to meet those needs, and then studies how they use the technology. Topics of interest include interactive machine listening, human-centered audio production tools and music information retrieval. One goal, for example, is to enable novices to use complex audio tools for creative expression that typically require significant knowledge and experience to employ effectively. SInC tools would allow them to communicate their sound choices in descriptive language, the way they might describe them to a friend, or by making the sound with their own voice.

Visual Perception Laboratory

Yelda Semizer, Director

The Visual Perception Laboratory studies human visual perception using a computational-experimental framework, involving computational modeling, behavioral psychophysics and eye-tracking. Our research focuses on determining how the human visual system integrates sensory information to make perceptual judgments while accounting for uncertainty and statistical variability within the visual world. These perceptual judgments can be as simple as locating a cursor on a webpage or as complex as detecting a tumor in an X-ray image. Our research investigates what limits the visual system, and how and when it overcomes these limitations to maximize its performance. Our work with radiology experts focuses on the development of visual expertise in medical image perception.

ENVIRONMENT AND SUSTAINABILITY

Institute for Space Weather Science

Haimin Wang, Director

The Institute for Space Weather Science (ISWS) promotes multi-disciplinary research and education on space science, with a focus on the powerful bursts of electromagnetic radiation, energetic charged particles and magnetized plasma known as space weather. To understand and predict the physics of solar activities and their effects on space weather, the institute combines the strengths of three NJIT research centers: the Center for Solar-Terrestrial Research, the Center for Computational Heliophysics and the Center for Big Data. At the institute's core is the Center for Solar-Terrestrial Research (CSTR). With its array of unique instruments on land and in space – the 1.6-meter Goode Solar Telescope, a newly expanded radio array with 15 antennas, instruments aboard NASA's Van Allen Probes spacecraft and devices deployed across Antarctica, to name a few – the center is uniquely poised to advance understanding of the genesis, acceleration and impact of solar storms, as well as to provide a comprehensive view of solar activity over months and years. Joining the CSTR are modeling and big data analytics experts at the Center for Computational Heliophysics, who partner with NASA's Advanced Supercomputing division at the NASA Ames Research Center, and researchers at the Center for Big Data. The latter's mission is to synergize expertise in various disciplines across the NJIT campus and to build a unified platform that embodies a rich set of big data-enabling technologies and services with optimized performance. ISWS has obtained NSF funding through various multi-disciplinary grants, such as EARTHCUBE, ANSWERS and SHINE. Since 2022, it has hosted a National Science Foundation Research Experiences for Undergraduates program site.

NJIT Center for Building Knowledge

Deane Evans, Director

The Center for Building Knowledge (CBK) is a 31-year-old research, training and technical assistance institute affiliated with the Hillier College of Architecture and Design. The center is dedicated to generating new knowledge to improve the built environment and enhance the planning, design, construction and operation of facilities. CBK's mission is to help individuals and communities make better-informed decisions about the performance, sustainability and resilience of buildings and communities. The center created and currently manages the New Jersey Clean Energy Learning Center, a unique online energy-efficiency training and resource platform for the New Jersey Clean Energy Program. CBK also manages and is currently updating a national online training platform funded by the U.S. Department of Energy (DOE) and focused on training building owners and operators on how to use the DOE's Asset Score energy optimization tool. The tool evaluates the energy efficiency of key physical assets within a facility – its building envelope, lighting and HVAC systems – and tabulates an "asset score." In addition, CBK recently received a three-year grant from the DOE's Building America program. The Re-Side Right project will test and validate a new, two-component insulation/air/water barrier system that can be used to significantly improve the energy efficiency of typical re-siding jobs in the U.S.

Center for Community Systems

Colette Santasieri, Executive Director

The Center for Community Systems is a resource and conduit for creating thriving, sustainable and resilient communities. It is a strategic platform that connects innovative planners, engineers, environmental scientists, social scientists, architects and economists with government, industry and community organizations in order to solve complex problems. Communities exist within the context of varying and ever-evolving social, economic, political and cultural conditions. The pressures they experience include increasing or decreasing populations; aging infrastructure; fiscal constraints; climate change; contaminated lands; and natural and human-made disasters. These complexities and constraints may hinder a community's ability to grow and prosper in a sustainable and resilient manner. The Center for Community Systems engages in cross-disciplinary collaborations designed to stimulate intellectual curiosity and foster innovative solutions to the challenges communities face. The center's multi-disciplinary staff of professionals design, develop and deploy technical assistance, as well as tools and resources, such as infographics on state regulatory rules; how-to videos and case studies on brownfields redevelopment; and educational and engagement programs for communities to improve environmental conditions, spur economic development and advance social equity. The center's focus areas include brownfields redevelopment; community revitalization; transportation planning; land-use planning; transit-oriented development; port city relationships; and natural resources.

Center for Energy Efficiency, Resilience and Innovation

Haim Grebel, Director

The Center for Energy Efficiency, Resilience and Innovation (CEERI) conducts research and development, provides technical and educational assistance for the deployment of sustainable technologies and applications to manage energy and water resources, and promotes public awareness of energy resources. The activities of CEERI are interdisciplinary. With support from state, federal and business partners, CEERI's main focus is identifying and implementing cost-effective measures that reduce operating costs, environmental impacts in the deployment of sustainable technologies, and applications related to energy and water. The center is a collaboration between industry and NJIT.

Center for Ethics and Responsible Research

Britt Holbrook, Director

To foster the core values of integrity and social responsibility outlined in the NJIT 2025 strategic plan, NJIT has established the new Center for Ethics and Responsible Research (CER2). At the cutting edge of research in ethics and ethics education, CER2 promotes experiential learning via experimental pedagogical approaches and helps develop the means to evaluate those approaches. With grants from the National Science Foundation and the New Venture Fund, and in collaborative projects with colleagues at the University of Florida, Harvard University, Stanford University, the University of South Florida, Rowan University and the University of Connecticut, CER2 is working to instill a culture of ethics in both NJIT faculty and students. Faculty teach students about ethical and responsible research not only through standalone ethics courses, but also by modeling ethical behavior in their own research and practice. Students are our future researchers, professionals and practicing engineers, and educating them in ethical and responsible research – via both direct and indirect instruction – will have broad impacts on society.

Polar Engineering Development Center

Andrew Gerrard, Director

The Polar Engineering Development Center (PEDC), housed within NJIT's Center for Solar-Terrestrial Research, consists of a highly skilled group of professors, research scientists, electrical and mechanical engineers and technicians who bring decades of experience in instrument and hardware design for deployment at high latitudes and Polar regions. The group was formed in the 1980s as part of the National Science Foundation-supported Automatic Geophysical Observatory (AGO) program, which operates to this day on projects active across the Antarctic ice shelf. Today, the PEDC is reaching out to serve the broader astrophysical and geospace scientific communities conducting research in Polar environments by providing support in the areas of sustainable "green" power generation in the 10-W to 100-W range; power conditioning and control; robust engineering for Polar climates; data acquisition techniques, units, and transmission services; and general Polar field support. As an NSF-sponsored facility, the PEDC manages instruments at South Pole Station, McMurdo Station, Palmer Station and across the Antarctic ice shelf.

NJIT Center for Resilient Design

Deane Evans, Director

The Center for Resilient Design (CRD) is a seven-year-old research, training and technical assistance institute affiliated with the Hillier College of Architecture and Design. Established in the immediate aftermath of Super Storm Sandy, CRD's founding mission was to serve as a resource to help New Jersey communities recover from the effects of Sandy – first as a special program within the College of Architecture and Design (COAD) and then as a full-fledged center within the university. These activities soon evolved into broader explorations of how these same communities could become more resilient in the face of future events. Building on lessons learned in New Jersey, the center has become a research, technical assistance and training institution focused on improving the resilience of buildings and communities in the face of natural disasters and other stresses to inform and support disaster-resilience initiatives in other jurisdictions across the U.S. and beyond. CRD recently completed and launched a new, online educational platform – the Community Microgrids Planning Academy – to help jurisdictions across New Jersey create microgrid development plans to improve the energy performance and resilience of their communities. The project – funded by the U.S. Department of Housing and Urban Development and managed by the N.J. Department of Community Affairs – was designed to constitute the first component of a comprehensive educational program that addresses first the planning and then the technical feasibility and financing/procurement phases of a microgrid development project. Funding for these activities has recently been secured from the New Jersey Clean Energy Program for the technical feasibility module and from the U.S. Department of Energy (through the New Jersey Board of Public Utilities) for the financing/procurement module. The Planning Academy also received a prestigious Award of Merit for "Innovations for High-Performance Buildings and Communities" from the National Institute of Building Sciences' 2018 Beyond Green Awards program.

Center for Solar-Terrestrial Research

Andrew Gerrard, Director

The Center for Solar-Terrestrial Research (CSTR) is an international leader in ground- and space-based solar and terrestrial physics, with a particular interest in understanding the effects of the Sun on the geospace environment. CSTR operates the Big Bear Solar Observatory and Owens Valley Solar Array in California, the Jeffer Observatory at Jenny Jump State Forrest in New Jersey and the Automated Geophysical Observatories distributed across the Antarctic ice shelf. The CSTR also manages a large number of instruments at South Pole Station, McMurdo Station and across South America and the United States. CSTR is one of the principal investigators in NASA's Van Allen Probes mission, which explores the radiation and plasma environment around Earth, and houses the Space Weather Research Laboratory, which conducts scientific research in the area of space weather with the mission to understand and forecast the magnetic activity of the Sun and its impact on Earth. Such instrumentation and data resources enable scientific studies ranging from the Sun's surface to its extended atmosphere, and into Earth's atmosphere.

Center for Solar-Terrestrial Research–Big Bear Solar Observatory

Wenda Cao, Director

The Center for Solar-Terrestrial Research (CSTR) operates Big Bear Solar Observatory (BBSO) in California, which houses the high-resolution 1.6-meter Goode Solar Telescope (GST), the only optical telescope in the world that can observe the Sun continuously for several hours with high spatial resolution (~ 65 kilometers on the solar surface). With its state-of-the-art adaptive optics and scientific instrumentation, the telescope obtains high-resolution views of the Sun's surface features, such as sunspots, granulation, filaments, flares, spicules and jets. Its instruments measure the magnetic fields and motions of these features to understand the basic physics of solar activity that affect the Earth and near-Earth technological systems. Current GST users are distributed over 61 universities, institutes and observatories in 21 countries. Since GST started its regular observations in 2010, more than 200 science and instrumentation papers have been published using its data, including one in Science and six in Nature journals. Through the BBSO telescope, NJIT scientists have explored how twisted magnetic fields interact to produce the sudden release of energy that powers solar flares and unveiled ground-breaking insights into the generation mechanism of many spicules and their possible contribution to coronal heating. Using data from multiple NASA solar spacecraft and advanced computer modeling, we are developing an understanding of fundamental processes that improves our ability to predict the occurrence and impact of such solar activity on the Earth.

Center for Solar-Terrestrial Research–Expanded Owens Valley Solar Array

Dale Gary, Director

The Center for Solar-Terrestrial Research (CSTR) operates the Expanded Owens Valley Solar Array in California, a recently completed major expansion operating as one of the most capable solar-dedicated radio arrays in the world. The array consists of 14 antennas and is used to image solar flares at hundreds of frequencies over the frequency range 1-18 GHz within one second. Its ability to follow evolving radio emissions with such high frequency and time resolution allows us to capture and quantify the energy release, acceleration and transport of energy in flares. In addition, the array images the slower timescale emissions of sunspot regions on 30-minute timescales, and the full disk of the Sun on 6-12-hour timescales. Among other advantages, such data provide dynamic measurements of the coronal magnetic field in flares and maps of magnetic field strength 30,000 miles above the Sun's surface. This has opened a new window on the processes of solar activity. Our research has included the discovery that radio emissions from the Sun can directly and adversely affect cellular communications and navigation systems, such as GPS and radar.

Otto H. York Center for Environmental Engineering and Science

Somenath Mitra, Director

The Otto H. York Center for Environmental Engineering and Science offers core research facilities as a resource for many interdisciplinary research programs and initiatives. The center was the first building in the nation specifically constructed for cooperative public and private research in hazardous waste management. Today, it has diversified into many other areas, with research projects in nanotechnology, drug-delivery systems, particle engineering, microfluidics, membrane science, environmental science and engineering and biomedical engineering. Researchers from a range of disciplines — chemistry, environmental science, chemical engineering, biomedical engineering, mechanical engineering, material science and pharmaceutical engineering — have laboratories in the center with extensive facilities in microscopy, mass spectrometry and material characterization. York Center research projects are funded with faculty grants from agencies such as the National Science Foundation, the National Institutes of Health, the National Institute of Environmental Health Sciences and the U.S. Department of Defense, as well as from leading industries. The new Life Sciences and Engineering Center associated with the York Center provides additional shared laboratory space for interdisciplinary projects. The York Center supplies Faculty Instrument Usage Seed Grants (FIUSG) for the use of core laboratories in order to support faculty and to promote research across campus by providing free instrument time to pursue preliminary findings that will lead to the development of new ideas and grant proposals. The FIUSG initiative aims to support the launch of new initiatives in core and emerging interdisciplinary areas aligned with NJIT's strategic interests.

Advanced Circuit-to-Architecture Design Laboratory

Shaahin Angizi, Director

The Advanced Circuit-to-Architecture Design Laboratory (ACAD Lab) conducts research on the cross-layer software/hardware co-design of energy-efficient and high-performance systems to address the ongoing and long-term future needs of big data processing. To this end, we combine innovations at the device-, circuit-, and architecture-level through a synergistic study. Our mission is to advance application-specific integrated circuits, which are customized chips, processing-in-memory technologies and processing-in-sensor accelerators to enhance complex artificial intelligence and machine learning tasks, bioinformatics (computation), data encryption and graph processing, among other areas. Our developed platforms can be widely applied in a variety of critical application domains, including medical monitoring and in industrial and environmental sensors. The ACAD lab offers research and educational opportunities to electrical and computer engineering students.

Advanced Energy Systems and Microdevices Laboratory

Eon Soo Lee, Director

The Advanced Energy Systems and Microdevices Laboratory is dedicated to research on new nanomaterials for advanced energy systems and new microdevices for disease detection and diagnosis for biomedical applications. The lab's energy research focuses on the non-platinum group of metal (non-PGM) catalysts to replace PGM catalysts for electrochemical energy systems, such as fuel cells and batteries, and industrial applications such as filtering systems and petroleum processing systems. Principal research includes synthesizing and characterizing new, high-performance non-PGM catalysts from carbon materials such as graphene, and understanding the fundamental mechanisms of the reaction. The lab's microdevices research concentrates on applying micro- and nanotechnology to diagnose complex diseases, such as cancers, at their early stages using a nano-biochip. The biochip incorporates microchannels with a self-driven flow mechanism of biofluid and nanocircuits to sense the existence and the level of severity of a disease with high sensitivity and selectivity. Our research has been supported by the National Science Foundation, the New Jersey Health Foundation, NJIT and a private company, Abonics, Inc.; we work in collaboration with and support from the John Theurer Cancer Center at Hackensack University Medical Center, Brookhaven National Laboratory-Center for Functional Nanomaterials, CUNY's Advanced Science Research Center, Rutgers University and Montclair State University. We have obtained several patents for our technology innovations.

Analytical Chemistry and Nanotechnology Laboratory

Somenath Mitra, Director

The Analytical Chemistry and Nanotechnology Laboratory is located in the Department of Chemistry and Environmental Science. Our research focuses on the fields of analytical chemistry, nanotechnology and water treatment. In analytical chemistry, we develop instrumentation for online and real-time monitoring analysis, environmental monitoring, fieldportable instruments and microfluidic devices. In nanotechnology, we work on nanoparticles, particularly nanocarbons such as carbon nanotubes and graphene, with applications in the energy and environmental technologies sectors. In the area of energy, we focus mainly on batteries and supercapacitors, with prior work on solar cells. To improve water quality, we develop novel sorbents and membranes, for which our main thrust is desalination and water treatment. Our work on nanocarbon-based membranes focuses on various associated applications, such as membrane distillation. And lastly, to improve drug-delivery systems, we use nanotechnology to make hydrophobic drugs dissolve more effectively.

Atmospheric Chemistry Laboratory

Alexei Khalizov, Director

The Atmospheric Chemistry Laboratory investigates the origins of atmospheric pollution and evaluates its environmental impacts. We work at the junction of chemistry, physics and engineering, using laboratory experiments and computations, to understand the processes that produce, modify and remove pollutants. We also develop new pollutant detection methods. The lab's two major research projects focus on aerosols and mercury in the atmosphere. In the aerosol project, we study how soot nanoparticles evolve during their atmospheric lifetime and evaluate their impacts on climate and air quality. The goal of the mercury project is to understand the broader atmospheric chemistry of this persistent, bioaccumulative pollutant emitted to the atmosphere by various activities, from coal combustion to artisanal gold mining. We study gas-phase and gas-surface mercury reactions and we develop highly sensitive mass spectrometry-based techniques for atmospheric oxidized mercury detection. Additionally, we collaborate with NJIT's Computational Laboratory for Porous Materials on the propagation of ultrasound in fluid-saturated nanoporous media to probe the effects of confinement on the elastic properties of fluids, with implications for both fundamental science and technology.

Building Dynamics Lab

Vera Parlac, Director

In the Building Dynamics Lab, we are interested in creating dynamic, adaptive and responsive architectural systems that lead to a more sustainable built environment. Our work is premised on the notion that buildings exist in a constantly changing context, yet, by being static and inactive, they don't fully respond to such dynamics. For example, if building envelopes can react dynamically to changes in the sun's location, outside temperature and humidity levels, they could reduce substantially the amount of energy used for heating and cooling. If the size of building spaces, their internal configuration and environmental conditions can be adjusted in real time, we could have buildings that better meet the needs of users and require even less energy for their operation. To enable buildings to effectively engage with the dynamics of their surroundings and changes in their use, we experiment with novel responsive systems that integrate shape-changing materials and soft inflatable components. We design and build prototypes of dynamic assemblies by taking advantage of contemporary advances in material, robotic, interactive and computation technologies.

Building Energy and Built Environment Laboratory

Hyojin Kim, Director

The Building Energy and Built Environment Laboratory, or (BE)2 Lab, was founded in 2013 to offer advanced learning and research opportunities and an environment for architecture and engineering students and others who wish to improve building energy efficiency and indoor environmental quality for occupant comfort and well-being through active involvement in research. The lab conducts research to create new knowledge and to advance measurement science in order to enable an integrative and rigorous assessment of whole-building performance using both computer simulation and field measurements. The lab aims to strike a balance between theoretical knowledge and practical applications. Our research has been funded by the National Institute of Standards and Technology, the U.S. Department of Energy, the U.S. Department of the Interior, Samsung Electronics and the American Society of Heating, Refrigerating and Air Conditioning Engineers.

Clean Water Infrastructure Lab

William Pennock, Director

The Clear Water Infrastructure Lab focuses on applied physical and chemical processes for drinking water treatment with an emphasis on experiments and the development and refinement of analytical models. Current research is focused on improving the operation of fluidized bed clarifiers which use an efficient upflow sedimentation process that is not described by existing models for drinking water treatment; detecting, analyzing and removing lead in drinking water distribution systems; and optimizing the use of ferric coagulants to efficiently remove suspended and dissolved solids while minimizing lead release. A major motivation is the provision of clean drinking water for low-resource settings. Our lab is partnering with AguaClara Reach to conduct research that advances the ability of small communities to obtain safe drinking water.

Laboratory of Environmental Microbiology and Biotechnology

Mengyan Li, Director

The Laboratory of Environmental Microbiology and Biotechnology seeks to make advances in the fields of applied microbiology and molecular biotechnology, and to develop innovative techniques to mitigate and address environmental issues related to water and energy. We develop water remediation techniques that deploy microorganisms to biodegrade organic pollutants of emerging global concern. We further research interdisciplinary methods to improve urban water treatment technologies, including the application of nanotechnology to disinfect supplies contaminated with pathogens, and we use biomass-derived charcoal to remove metal toxins. We employ surrogate and indicator microorganisms to investigate the potential impacts of engineered nanomaterials and disinfection byproducts once they are released into the environment. To examine the microbial processes in natural and engineered systems, we integrate conventional culture-dependent approaches with state-of-the-art high-throughput molecular technologies, such as cloning, microarray, metagenomics and next-generation sequencing. We design innovative and inexpensive genetic forensic tools for the rapid quantification of microbial populations and functions in the environment. Other projects include mitigation of biofouling in membrane-treatment facilities, the control of microbe-induced corrosion, and the identification of microbial enzymes for biofuel production.

Environmental Systems Lab

Lisa Axe, Director

The Environmental Systems Lab focuses on chemical and physical processes in environmental systems. Researchers in the group use a suite of analyses to study the effects of surface chemistry on contaminant transport and attenuation. Recent projects include work with the water company SUEZ North America on converting filters and adsorbents used in water treatment plants into biologically active filters for the additional purpose of treating emerging contaminants that involve pharmaceuticals, personal health care products and pesticides. The lab studies biologically active filters with equipment that includes a TOC analyzer, nutrient analyses and ATP analysis. Additionally, Chemours Company is supporting the lab's research into reactive mineral phases using core samples preserved for redox integrity. A primary goal is to advance understanding of interfacial processes, the interaction between minerals and chlorinated solvents, and their impact on water quality and contaminant mobility and bioavailability. The lab has been funded by the National Science Foundation, the U.S. Army, SUEZ North America, Chemours Company and the state transportation agencies of both New Jersey and New York.

Green Technology Research and Training Laboratory

Philip Pong, Director

The Green Technology Research and Training Laboratory focuses on research and training in green technologies. Our research programs endeavor to achieve condition monitoring, predictive maintenance and anomaly detection to safeguard the uninterrupted and efficient operations of critical infrastructures, such as power grids, offshore wind farms and HVAC systems in buildings. The laboratory also provides training to nurture future engineers, scientists and researchers for the Age of Clean Energy. It provides comprehensive training in engineering knowledge and design in green technologies through hands-on design projects and experiential learning experiences on a research team. We welcome Ph.D., master's, undergraduate and high school students to pursue cutting-edge research and receive advanced training for the blooming clean energy industries, particularly the offshore wind industry in New Jersey.

Music Lab

David Rothenberg, Director

The Music Lab conducts research on music and bioacoustics, with a particular focus on the sounds of birds, insects and whole environments.

Newark Design Collaborative

Anthony Schuman, Darius Sollohub and Georgeen Theodore, Co-Directors

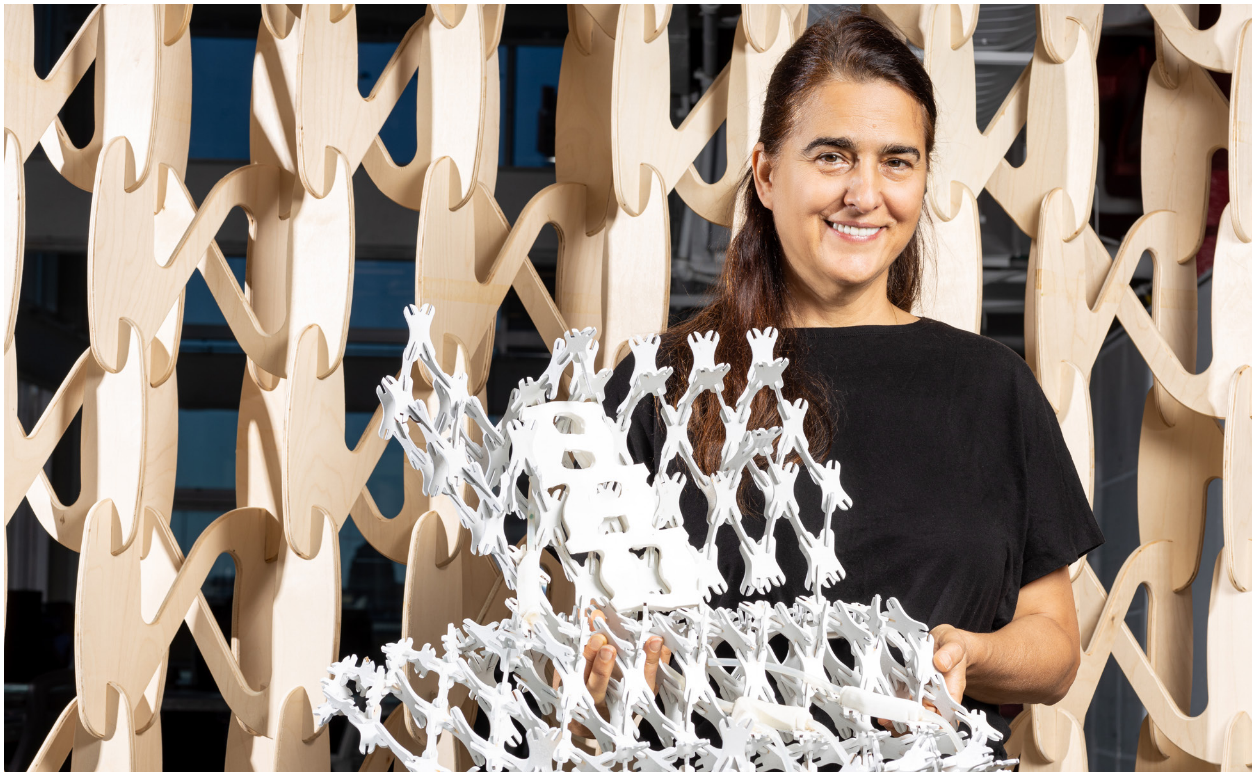
The Newark Design Collaborative (NDC) at the Hillier College of Architecture and Design brings together NJIT faculty and students, city agencies, and community and industry stakeholders in the planning and design for an equitable, sustainable and prosperous city. The purpose of the collaborative is to engage community perspectives and contribute our collective expertise to Newark's development, while educating future designers and planners. We offer our students rich real-world learning through direct collaboration with the Newark community, providing them with the experiences needed to address the design challenges facing dense urban areas in the 21st century. The collaborative implements this mission through design studios, seminar classes, independent projects, reports and pro bono assistance. Through project documentation and the Digital Archive of Newark Architecture (DANA) in the Littman Library at Hillier College, the NDC serves as a resource for faculty, students, city agencies and developers. The long-term vision includes the establishment of a downtown facility for community engagement operated by Hillier College.

Photochemistry and Catalysis Laboratory
Michael Eberhart, Director

The Photochemistry and Catalysis Laboratory is a multidisciplinary laboratory that uses inorganic chemistry, organometallic chemistry, materials chemistry and photochemistry to solve energy-related problems and catalysis. Problems of interest include understanding how to couple photon absorption events to energetically demanding multi-step chemical reactions; understanding the mechanisms of metal-metal interactions in catalysis; and mimicking the biological processes of photosynthesis which occur in photosynthetic organisms. Applications include producing fuels from water, carbon dioxide and sunlight; designing catalysts that can enable previously impossible or inefficient chemical reactions; and mimicking biochemical reaction pathways in the laboratory for economical and environmentally sustainable chemical synthesis. The laboratory's research involves a balance between synthesis and the use of physical methods to investigate the species that are synthesized. Techniques and areas of interest include synthesis, electrochemistry, transient absorption spectroscopy, synchrotron X-ray methods and other spectroscopic techniques.

The Sensor Research Laboratory
Philip Pong, Director

The Sensor Research Laboratory works on sensors and smart grid and smart city applications. We endeavor to advance the science and technology of sensors and to innovate sensor applications in power grids and critical infrastructures. To do this, we apply sensors and sensor fusion (the process of merging data from multiple sensors) together with machine learning, IoT and data analytics to establish intelligent sensing platforms that act as key parts of cyber-physical systems, such as power grids and autonomous systems. Our research will enable critical infrastructure such as power grids, transportation systems, health care services and the pharmaceutical industry to achieve predictive maintenance and anomaly detection in order to ensure uninterrupted operations. By continuously monitoring and analyzing available machinery data to detect early signs of degradation or failures, our technology can effectively avoid damaging malfunctions, reduce downtime, increase efficiency and enhance competitiveness. The core activities of the laboratory include fundamental scientific studies, practical engineering projects, technology commercialization, community outreach and STEM education for K-12 students and under-represented students.



MATERIALS SCIENCE AND ENGINEERING

Electronic Imaging Center

Haim Grebel, Director

The Electronic Imaging Center is an interdisciplinary center focused on nanotechnology and spectral analysis with subwavelength structures and energy. Nanotechnology is a field dealing with phenomena at the nanoscale, including diverse phenomena that encompass molecular and biological interactions and interfacial science, as well as bulk and surface properties. The field is fast expanding into the agricultural, energy and pharmaceutical sectors. Spectroscopy with subwavelength structures is a field important to pollution detection, remote sensing and imaging at resolutions surpassing the diffraction limit. It is related to nanoscale phenomena, but can also find applications in the infrared and the THz frequency range. Energy is fast becoming a crucial commodity: its transmission, delivery and storage are key to the development of the U.S. economy and to the safeguarding of national security. Ongoing projects that focus on one or several aspects of the above include graphene-coated nano-optical antennas for molecular detection, tunable supercapacitors for energy storage, digital energy for efficient energy management and white light sources.

New Jersey Center for Engineered Particulates

Rajesh Davé, Director

The creation of advanced particulate materials and products through particle engineering is a major research focus of the New Jersey Center for Engineered Particulates (NJCEP). The center's research combines experimental, computational and theoretical studies to achieve an understanding of particle properties at the individual particle scale to predict particle and product behavior at the macro-scale. NJCEP research has applications in the pharmaceutical, food, cosmetics, ceramics, defense, electronics and specialty chemicals industries. Center researchers have more than a dozen granted patents. An example of a noteworthy licensed technology is a solvent-free particle coating process with applications in taste-masking and the controlled release of drugs. NJCEP is funded by federal and industry sources, including through its participation in the National Science Foundation (NSF) – Engineering Research Center, which is focused on improving pharmaceutical manufacturing processes. NJCEP has developed several pharmaceutical technology platforms, including a thin stripfilm real-time release methodology, funded by NSF and the U.S. Food and Drug Administration, for delivering nano and micron-sized poorly water-soluble active ingredients for enhanced therapeutic effects. Currently, NJCEP is developing patient-compliant drug-delivery vehicles for pediatric and geriatric care, with commercial applications.

Center of Materials for Advanced Energetics

Edward Dreizin, Director

Powders of metals are better fuels than hydrocarbons based on their volumetric and gravimetric combustion energy. They are used primarily in propellants, explosives and pyrotechnics. In this center, new metal-based reactive materials are developed, characterized and tested. Correlations between material synthesis processes and the powder characteristics are established and their reaction mechanisms are elucidated. The center includes laboratories for mechanochemistry and metal combustion and a state-of-the-art thermo-analytical facility. The center also conducts research in materials characterization facilities in the York Center. Our work is supported by the Office of Naval Research, the Defense Threat Reduction Agency and the U.S. Army, among other sponsors. We invite students with backgrounds in chemical and mechanical engineering, physics, and materials science and engineering to explore research opportunities with us.

Membrane Science, Engineering and Technology Center

Kamalesh K. Sirkar and Boris Khusid, Co-Directors

The Membrane Science, Engineering and Technology Center, a National Science Foundation Industry/University Cooperative Research Center, conducts basic research and related development on innovative materials and processes that facilitate the use of membrane technology. The center also provides timely and effective technology transfers between the center's researchers and its sponsors, from private industry and U.S. government laboratories. With the research performed primarily by graduate students, the center promotes education in membrane science and technology. The research topics are decided by corporate members of the Industrial Advisory Board. This center is located at four university research sites: NJIT, Pennsylvania State University, the University of Colorado at Boulder and the University of Arkansas at Fayetteville. NJIT faculty members from the following departments are active in the center: chemical and materials engineering; chemistry and environmental science; civil and environmental engineering; biomedical engineering; and electrical and computer engineering.

Center for Membrane Technologies

Kamalesh K. Sirkar, Director

The Center for Membrane Technologies investigates problems across multiple industrial sectors that use membrane technologies to separate and purify water, air, industrial-fluid streams, solvents, pharmaceuticals, proteins, biopharmaceuticals, cells, particles and nanoparticles. Membrane synthesis, membrane modification and the development of novel membrane-based separation techniques are of particular interest. The problems we are researching include solvent resistant nanofiltration with pharmaceutical applications, the separation of organic solvent mixtures by a membrane, continuous production of nanocrystals via hollow-fiber membranes and the development of ultrathin membranes for use in gas separation. The organic synthesis of drugs involves many steps requiring frequent exchanges of solvents, recovery of catalysts, concentration of active pharmaceutical ingredients and their final purification by crystallization. Nanofiltration membranes capable of resisting solvents are of great value for such operations, as they allow solvents to pass through while retaining solutes with greater molecular weights. We are studying the behavior of novel, inert polymeric membranes for nanofiltration that permit solvent flow, but reject the solutes. We are also investigating the possibility of separating organic solvent mixtures by a membrane. We have already succeeded in obtaining a pure solvent in permeate from a few varieties of binary solvent mixtures which is unprecedented in membrane separations. We are also exploring novel techniques for making ultrathin films with considerable separation potential for various gas separations, such as carbon capture from power plant emissions.

Center for Natural Resources

Michel Boufadel, Director

The Center for Natural Resources (CNR) was founded in 2012 to foster sensible approaches to environmental and energy resource utilization. The center's specialties include assessment and remediation studies of pollution in natural settings and the evaluation of natural resources for the potential production of energy, especially the production of renewable energy. The center conducts studies ranging from the microscopic scale to the landscape scale and utilizes advanced networks of sensors to gather data. center staff integrate comprehensive field measurements with powerful computational models. The center is internationally known for its long-term studies of the Exxon Valdez oil spill in Alaska and the Deepwater Horizon spill in the Gulf of Mexico, as well as its efforts in dealing with repercussions from Hurricane Sandy. The Center's publications have been in renowned journals, such as NATURE Geosciences and Environmental Science and Technology. The center collaborates with a broad range of constituents, including federal, industrial and regional foundations, to create sustainable approaches that adequately balance the diversity of public and private interests. CNR's long-term vision is the development and adoption of minimally intrusive technology for dealing with environmental and energy challenges. It aims to produce the next generation of scientists that are well informed of societal needs, and to foster environmental education and best methods for the stewardship of natural resources.

Additive Manufacturing Laboratory

John Federici and Ian Gatley, Co-Directors

The Additive Manufacturing Laboratory (AddLab) specializes in innovations using modern additive manufacturing techniques, including 2D and 3D printing in conjunction with embedded electronics. Additive manufacturing has revolutionized manufacturing production, bringing down the cost of prototyping, while allowing for novel designs and devices never before possible. In-situ, non-destructive evaluation methodologies that monitor the fabrication process and efficiently qualify fabricated components are under development. The AddLab works with industrial partners to transition research and development from the laboratory into industrial scale production. Our extensive 2D and 3D fabrication tools, in combination with expertise with simulations and modeling, enables the lab to develop and optimize manufacturable components for U.S. Department of Defense customers as well. The AddLab faculty, staff and students take pride in developing the workforce of the future. Many opportunities are available for undergraduate internships during the academic year and over the summer, as well as graduate student research.

Advanced Materials and Engineered Surfaces in Extreme Environments

Kerri-lee Chintersingh, Director

The Advanced Materials and Engineered Surfaces in Extreme Environments (AMEE) lab focuses on developing, characterizing and testing metals, alloys, oxides and composites as powders for energy and combustion applications. The engineered materials are designed to either generate or withstand high temperatures and pressures and can be tailored to produce gas or condensed phase products, including halogenated products for destroying harmful microorganisms, such as anthrax, and specific oxides for use as catalysts in degradation. The lab uses principles of mechanical milling-mechanochemistry and wet chemistry to tune material surfaces and microstructures. It combines experimental data with computation models to describe material behavior and reaction mechanisms under extreme conditions. It also utilizes artificial intelligence, particularly machine learning, to help extract data, such as anomalies and trends, from complex experimental scenarios, such as burning metal particles above 2000 Kelvin captured from high speed optical and x-ray phase contrast imaging videos. One goal of the lab is to be able to accelerate material design in the field by establishing structure-function-property relationships from our experiments and to optimize material preparation parameters toward a desired morphology, structure and performance.

Applied Electrohydrodynamics Laboratory

Boris Khusid, Director

The Applied Electrohydrodynamics Laboratory explores electric and magnetic field-driven phenomena in multiphase systems. They are ubiquitous in our daily life —paints, blood, milk, inks and emulsions — and in a wide variety of terrestrial and space systems. The lab's emphasis is on understanding how the electric and magnetic interactions between different species, such as colloidal particles, droplets, gas bubbles and polymer molecules, affect their arrangement and motion, and thereby, the multiphase system behavior. Practical applications are related to the development of electromagnetic methods utilizing the difference between species for the precise control and manipulation of a multiphase system, such as particle and bubble suspensions and emulsions. These methods do not require moving parts and employ electrical or magnetic forces acting on individual species. Supported by NASA and the National Science Foundation, the lab conducts the following microgravity experiments on the International Space Station: Phase Transitions in Colloids, Flow Boiling and Condensation, and Thermal Stability of Cryogenic Fluids.

Biophotonics and Bioimaging Laboratory

Kevin D. Belfield and Yuanwei Zhang, Co-Directors

The Biophotonics and Bioimaging Laboratory combines diverse chemical and biological approaches to develop novel biomaterials and techniques to explore and sense pathological processes. The lab investigates fundamental principles and develops new methods for the interaction of light with biological organisms, tissues, cells and molecules, an area that is regarded as key science for the next generation of clinical tools and biomedical research instruments. We develop novel organic linear and nonlinear optical probes and bioconjugates that can be used to detect subcellular events and for deep tissue in vivo imaging via fluorescence microscopy and light-activated drug delivery and photodynamic therapy. We collaborate with other scientists and clinicians to optimize and apply these technologies to solve problems in biological and biomedical research. Early disease detection and subsequent treatment, viewed as central to disease management, require technologies that combine sensing, targeting and treating. To achieve this goal, the lab develops fluorescent probes for two-photon-based deep tissue tumor and angiogenesis imaging for cancer diagnosis and imaging-guided surgery, as one example. Functional organic, polymer, inorganic and hybrid nanoparticles are central to our efforts in the development of sensors, photoactive medicines, and materials for emerging quantum data computing.

Biophotonics Sensing and Imaging Laboratory

Xuan Liu, Director

The Biophotonics Sensing and Imaging Laboratory investigates advanced biophotonics technologies with a focus on optical coherence tomography (OCT). We have in-house capabilities to develop novel optical imaging systems for a variety of applications, including the design of optical imaging systems, optical component alignment, algorithm development and real-time signal processing. In one of our funded research projects, we investigate dual-modality OCT imaging that performs structural and mechanical characterization of breast tissue to achieve higher accuracy in breast cancer diagnoses. We also collaborate with industrial partners to develop OCT sensor-guided surgical instruments and an ultrafast 3D imaging technology.

Complex Flows and Soft Matter Group

Linda Cummings, Director

The focus of the Complex Flows and Soft Matter Group is on fluid systems that are complex due to rheological properties, complicated flow geometry, complex multiphysics aspects of the forces governing the flows, or a combination of these factors. We carry out modeling and simulations of such problems, as well as developing appropriate computational methods. Current projects include mathematical modeling and simulation of membrane filtration, schooling and flocking models (for fish and bird locomotion), "quantum" behavior of walking droplets, flow of granular media, and wetting and de-wetting of thin liquid films under the action of a range of external forces. In some cases, we also carry out physical experiments in our Undergraduate Capstone Laboratory in coordination with the capstone course taken by our applied mathematics majors. Our work, in which we collaborate with scientists from a number of different institutions, is supported by the Center for Applied Mathematics and Statistics, the Department of Mathematical Sciences, and by grants from a number of federal research agencies. See cfsm.njit.edu.

Computational Biophysics Laboratory

Cristiano Dias, Director

Research in the Computational Biophysics Laboratory concentrates on the development of computational tools to answer complex questions at the interface of physics, biology and chemistry for medical and industrial purposes. We focus on three areas: designing new biomaterials with superior properties emerging from the aggregation of proteins into fibrillike structures that are biodegradable and biocompatible; investigating the cell toxicity of amyloid proteins responsible for degenerative diseases like Alzheimer's and Parkinson's; and predicting the effect of solvents on protein and lipid membrane structures. We use multiscale approaches to provide atomic resolution of macroscopic structures in order to understand and control systems, by self-organization or by design, from nanometer to mesoscopic scales. Experimental methods used to validate our simulations include, but are not limited to, cell and single-molecule imaging techniques.

Computational Laboratory for Porous Materials

Gennady Gor, Director

The main focus of the Computational Laboratory for Porous Materials is nanoporous materials, solids with pores of 100 nanometers and below. Such materials play a significant role in both nature and technology. Synthetic nanoporous materials are widely used in the chemical industry as adsorbents, catalysts and separation membranes, among other uses. Naturally occurring nanoporous materials include coal and shale, key fuels in the production of energy. Another research focus is soot agglomerates, which are not porous, but rather nanostructured materials with features on the same scale as nanoporous solids. We work on the wide spectrum of phenomena related to the interfaces between these nanoporous or nanostructured solids and fluids: fluids adsorption, fluids transport and the propagation of ultrasound in fluid-saturated porous media, to name a few. Our approaches are purely theoretical; we use various modeling techniques to represent phenomena at the nanoscale: Monte Carlo simulations, molecular dynamics, density functional theory and finite element analysis.

Computational Nanomechanics and Materials Science Laboratory

Dibakar Datta, Director

The Computational Nanomechanics and Materials Science Laboratory (CNMSL) promulgates a fundamental understanding at the atomic and molecular level of the chemical-electrical-mechanical phenomena of nanomaterials used for real-life applications such as energy storage devices (rechargeable batteries, fuel cells), electronic devices (smartphones, laptops) and health care (targeted drug delivery, medical nanodevices), among other areas. The lab investigates various nanomaterials, including crystalline solids such as silicon and germanium; atomically thin two-dimensional materials such as graphene and transition metal dichalcogenides; and their heterostructures, which include the combination of different nanomaterials. Novel theories and methodologies are developed for modeling the interplay between mechanical, electronic, thermodynamic and kinetic aspects of nanostructures. The computational results provide the guidelines for the experimentalists for the most efficient experimental design of nanomaterials-based structures that are used in everyday life.

Computer-Assisted Tissue Engineering and Blood System Biology Laboratory

Roman Voronov, Director

The Computer-Assisted Tissue Engineering and Blood System Biology Laboratory focuses on high-performance, imagebased modeling of complex flows with applications ranging from bone tissue engineering, to blood systems biology, to drug delivery. The lab is currently involved in two major projects. First, we are developing computer-assisted tissue engineering technologies through predictive modeling of stem cell behavior and the control of single-cell migration. Second, we are looking closely at the mechanisms of blood clot formation, which is relevant to thrombotic disorders such as strokes, heart attacks and hemophilia. The tools used for this work involve soft lithography, hardware automation, super-resolution microscopy, computer vision and machine learning.

The Functional Materials and Biomedical Devices Laboratory

Lin Dong, Director

The Functional Materials and Biomedical Devices Laboratory focuses on designing and synthesizing functional nanomaterials and applying novel engineering knowledge and principles toward important innovations in biomedical applications. Principal applications of the lab's research include energy harvesting/sensing systems, soft robots, and smart tactile devices. Currently, the laboratory is working on transduction mechanisms (foundational research); smart materials and structures (design); energy harvesting/sensing systems (implementation); machine learning (integrations); and biomedical devices (applications). The multidisciplinary nature of the lab transcends disciplinary boundaries to explore mechanical engineering fundamentals in materials, biomedical and data science that will lead to innovations in medical treatment.

Geomechanics for Geo-Engineering and Sustainability Lab

Oladoyin Kolawole, Director

The Geomechanics for Geo-Engineering and Sustainability (GGES) Lab is an integrated research lab focused on rock mechanics and geo-engineering. The lab conducts fundamental studies on the deformation and breakdown of underground geomaterials, such as rocks and soil, in response to distinct changes in stress, pressure and temperature. Additionally, we research rock-fluid interactions and their implications for thermo-hydro-chemo-mechanical processes encountered in extracting, exchanging, storing and protecting underground georesources, such as groundwater, minerals, petroleum and natural gas, as well as for underground spaces for construction, tunnels, wellbores and disposal facilities. The goal is to mitigate global climate change and prevent geotechnical-related hazards. Currently, we are developing new knowledge in biogeomechanics, geologic carbon sequestration, slope instability and the cracking and breakdown of geomaterials caused by underground drilling and excavation, among other geotechnical-related hazards.

Heat and Fluid Transport Engineering Research Laboratory

Angelantonio Tafuni, Director

The mission of the Heat and Fluid Transport Engineering Research (HaFTER) Laboratory is to investigate state-of-theart problems in the field of fluid mechanics and heat transfer within complex engineering systems. Problems of interest include multiphase flow and fluid-structure interactions in aerospace and ocean engineering applications, free-surface flow in river and coastal environments, and the optimization of industrial processes involving fluid dynamics. Computational fluid dynamics techniques are developed and validated to address challenging problems in engineering. These include threedimensional highly nonlinear flow with one or more phases, such as the bubbly flow and spray generated by ships. The laboratory is also home to a mechanical platform for the experimental investigation of various liquid sloshing phenomena.

High-Performance Concrete and Structures Laboratory

Methi Wecharatana, Director

Critical innovations in the area of high-performance concrete in recent years include the development of highly durable concrete, impact-resistant concrete, microdefect-free concrete, fiber-reinforced concrete, fly-ash concrete, high-performance carbon fiber-reinforced concrete and high-strength fiber-reinforced plastics, among others. With funding from the National Science Foundation (NSF), we have installed six closed-loop hydraulic MTS and Instron testing machines with capacity ranging from 25,000 to 1 million pounds in our state-of-the-art laboratory and testing facility. In our highbay structural concrete lab, we test full-scale, 12-footlong columns with automated closed-loop hydraulic testing machines; our reaction walls enable us to simulate lateral loads from both wind and earthquakes. Past and ongoing funding for our research comes from government agencies such as the NSF, the U.S. Department of Energy and the National Oceanic and Atmospheric Administration, as well as from private partners such as Public Service Electric and Gas and SCG of Thailand.

Instructive Biomaterials and Additive Manufacturing Laboratory

Murat Guvendiren, Director

A major bottleneck in medicine is the lack of organs for transplantation, as well as tissue models for drug testing. Although 3D bioprinting is at the forefront of innovative research and biomanufacturing, the selection of available bioinks – bioprintable formulations of living cells without or supported with hydrogels – is extremely limited. Currently used bioinks offer limited control over bioactivity, degradation and stiffness, which are required to control cellular behavior. Moreover, biological processes, such as tissue development and disease, are dynamic in nature, yet the majority of the bioprinted constructs offer static properties. Bioinks enabling the spatiotemporal control of properties are needed to advance bioprinted tissues into clinical applications. The main focus of the IBAM-Lab is to design "cell-instructive" printable biomaterials – that will "tell cells what to do." To this end, IBAM-Lab: (i) develops novel printable biomaterials and hydrogels with tunable mechanics, degradation and bioactivity to control stem cell differentiation, (ii) focuses on 3D bioprinting of living tissues and organs, as well as medical devices, with a current focus on bone, cartilage and the osteochondral interface), (iii) fabricates in vitro disease models for fundamental studies and drug screening for liver fibrosis, breast cancer and cardiac models. The lab is currently funded by federal agencies, private foundations and industry.

Mass Spectrometry Center

Hao Chen, Director

Mass spectrometry (MS) is a fascinating technology with a growing impact on chemical measurement and imaging for a variety of areas, such as analytical chemistry, environmental chemistry, forensic chemistry and life science research. The Mass Spectrometry Center studies proteomics, or comprehensive sets of proteins, and structural biology: the identification, sequencing and quantifying of proteins, as well as their characterization following translational modifications, the elucidation of their 3D structures, and the exploration of protein-protein interactions. Our goal is to couple novel instrumentation with new chemistry to solve analytical challenges. We use MS techniques to study the mechanisms of electrochemical and organometallic reactions and to develop innovative methods for biological analysis, as well as environmental and forensic investigation. The center collaborates with Merck, Johnson & Johnson and Colgate-Palmolive, as well as with scientists at Stanford, Harvard, Purdue, the University of South Florida, Ohio University and Ohio State University.

Material Analysis in Biological Systems Laboratory

Kathleen McEnnis, Director

The Material Analysis in Biological Systems Laboratory investigates the interaction of polymer drug delivery vehicles with the biological environment, including cells, blood, proteins and physiological temperature, using physical chemistry techniques in novel ways to design successful particles for drug delivery. Drug delivery vehicles are an ideal treatment for many diseases. In practice, however, their design is challenging, and few are currently used clinically. The interaction of the biological environment with drug delivery vehicles is not well understood, and by addressing this gap, better and more successful models can be designed. The Material Analysis in Biological Systems Laboratory investigates novel techniques to analyze nanoparticles in blood, nanoparticle aggregation and protein corona formation in blood, particle glass transition temperature in biological conditions and the cellular uptake of particles.

Materials and Structures Laboratory

Matthew P. Adams and Matthew J. Bandelt, Co-Directors

The Materials and Structures Laboratory (MatSLab) is focused on improving the knowledge base of materials and structures in the built environment and reengineering them for the future. The laboratory consists of experimental and computational facilities capable of evaluating the performance of existing and emerging construction materials and structures from the nanometer to the meter scale. Recent research has focused on the behavior of sustainable materials, such as recycled concrete aggregates (RCA) and low-embodied carbon concrete systems, and resilient and damage-tolerant materials, such as high-performance fiber-reinforced cementitious composites (HPFRCCs). RCA materials are being used in pavement design to increase sustainability and reduce cost; HPFRCCs are being deployed in bridge structures to decrease construction time and in earthquake-resistant structures to increase ductility and damage tolerance. Recent research at the MatSLab has been funded by the National Science Foundation, the Federal Highway Administration, the U.S. Department of Transportation, the New Jersey Department of Transportation, the Port Authority of New York and New Jersey, the American Concrete Institute and private industry sponsors.

Material Dynamics Lab

Martina Decker, Director

The Material Dynamics Lab was founded in 2008 to create a research space for faculty, students and industry members from the fields of architecture and biomedical engineering. Since 2012, the interdisciplinary research hub has expanded upon the collaborative mission and now additionally fosters relationships among team members from numerous areas: the Department of Physics; the Department of Mechanical and Industrial Engineering; the Department of Chemistry and Environmental Science; the Department of Biology; the Department of Civil and Environmental Engineering; the Department of Electrical and Computer Engineering; and the Department of Computer Science. The Material Dynamics Lab serves as a vital junction for interdisciplinary innovation and undergraduate research through the application of the design thinking methodology. Projects that emerge from the lab are as diverse as its collaborators. They include the reconstruction of prehistoric “hell ants;” the fabrication of a collaborative robotic fleet of sensor bots; smart material-driven building “skins” for environmental control; and a multispectral camera that takes laboratory-bound tabletop inventions to a handheld design stage that can be tested in the field.

Mixing Laboratory

Piero M. Armenante, Director

The Mixing Laboratory is dedicated to the study of single- and multi-phase mixing phenomena, such as those occurring in industrial stirred tanks and reactors, involving single fluids – primarily liquids with different rheological properties – in the presence or absence of one or more additional phases, such as fine solid particles, a dispersed gas or an immiscible liquid. Mixing phenomena are extremely common in industry, taking place in very small systems, such as tablet dissolution in testing units used in the pharmaceutical industry, and in large production units, such as drug solid suspensions in a carrier liquid for pharmaceutical product manufacturing. The outcome in each case is significantly affected by the hydrodynamics established by a moving component, typically an impeller. Understanding the fluid dynamic characteristics of these systems is critical. For this purpose, the lab is equipped with state-of-the-art equipment, such as particle image velocimetry, to non-intrusively measure the fluid velocities anywhere in the system. Additionally, numerical tools, including computational fluid dynamics and theoretical process modeling, such as mass transfer models, are used to determine how mixing affects processes of real industrial interest – often in collaboration with industrial partners – and how it can be modified to improve outcomes.

Laboratory for the Mechanics of Advanced Materials

Shawn A. Chester, Director

The primary research goal of the Laboratory for the Mechanics of Advanced Materials is to understand interesting and exciting phenomena in solid mechanics, particularly multiphysics material behavior. Multiphysics behavior occurs when multiple physical phenomena are present in a material's response, beyond deformation. For example, temperature can have a profound impact on the stiffness of materials and some oils degrade the strength of a material over time. Research includes experimental, theoretical and computational solid mechanics. The laboratory works on continuum level descriptions of polymeric behavior of materials, including polymer gels, dielectric elastomers and shape-memory polymers, among others. The lab's general procedure is to conduct experiments to obtain a material's behavior over a wide range of environmental conditions; to develop constitutive models to capture that behavior; to design and implement numerical procedures for use in finite element simulations; and lastly, to validate the constitutive model and its numerical implementation in exciting representative applications.

Micro and Nano Analytical Laboratory

Sagnik Basuray, Director

The Micro and Nano Analytical Laboratory establishes synergies among novel nano-structures, microfluidics, biology, materials, chemistry, advanced manufacturing and analytical techniques to develop disruptive and cost-effective technologies in areas such as sensors, rapid diagnostics, drug delivery systems and biofilms. The lab also advances knowledge of interfaces and surface physics in novel materials, including metal-organic frameworks, covalent organic frameworks and III-V compound semiconductors. Current research includes the development of a modular and adaptive electrochemical biosensor platform (ESSENCE) that meets the "ASSURED" criteria set by the World Health Organization for point-of-care devices used, for example, to detect bio-threats like COVID-19 and other infectious diseases and for liquid biopsies. A point-of-use sensor has been developed for industrial contaminants such as PFAS (per- and polyfluoroalkyl substances) in collaboration with the Pacific Northwest National Lab. In partnership with an international analytical testing laboratory, the lab is also developing a device for the rapid, multiplexed detection of cyanotoxins as a methodology to measure and address climate change. The Micro and Nano Analytical Laboratory works with researchers and companies to create new technologies for batteries, super-capacitors, electrical field-assisted separations, biologics and electro-catalysts. Our facilities include a wet lab to design, develop and test microfluidics, advanced manufacturing capabilities, cell work using lab-on-a-chip devices and the electrochemical characterization of devices and materials.

Nanoelectronics and Energy Conversion Laboratory

Dong-Kyun Ko, Director

The Nanoelectronics and Energy Conversion Laboratory is an interdisciplinary research group that studies nanoelectronic devices made from colloidal quantum dots (QDs). Colloidal QDs are nanometer-sized semiconductor crystals suspended in a solution that offer exciting opportunities for scientists and engineers to develop ultra-cheap, pervasive devices for the emerging ubiquitous electronics era, in which electronic devices are embedded into many of the objects we touch and the environments we live in. One of our principal goals is the development of QD sensors that can detect thermal infrared, or heat. Our aim is to reduce the size, weight and power consumption of these devices to enable their wide-spread utilization in first-responder and search-and-rescue missions, night driving, machine vision, industrial process controls, environmental monitoring of hazardous spills and non-invasive measurements of tumors and blood flow, as well as in optical communications. Other projects include the development of thermoelectric QDs that can produce electrical power directly from waste heat, which is widely available in both natural and man-made environments. The goal is to scavenge energy from the environment to continuously power embedded electronics devices, ultimately enabling them to achieve power autonomy.

Nanomaterials for Energy and Environment Laboratory

Xianqin Wang, Director

The goals of the Nanomaterials for Energy and Environment Laboratory (NEEL) are to develop advanced functional nanomaterials for sustainable energy production and environmental protection, and to investigate the structure and reactivity of catalytic systems under operational conditions such as high pressure and temperature. Research topics include, but are not limited to: hydrogen production from bio-alcohols on a series of transition metal oxide nanoparticles; bioalcohols or biofuel production from biomass over novel catalytic materials; completely green catalytic materials for solar water splitting and oxygen reduction reactions; fuels production and purification for solid-oxide fuel cells and protonexchange fuel cells, among others; water treatment with catalytic nanoparticles encapsulated in a hierarchical framework; nitrogen and sulfur removal from crude oil and other organics; structural and electronic properties of various materials using synchrotron-based in situ time-resolved techniques, such as catalytic, pharmaceutical and energetic materials. Our aim is to contribute to a cleaner, healthier environment for current and future generations.

Laboratory of Nanomedicine and Healthcare Biomaterials

Xiaoyang Xu, Director

The Laboratory of Nanomedicine and Healthcare Biomaterials aims to develop new biomaterials and nanotechnologies for a variety of medical applications, including diagnosis, bioimaging, controlled drug delivery and regenerative medicine. We look at both fundamental and applied questions in the cross-disciplinary fields of biomaterials, nanomaterials and medicine in order to develop novel therapeutic methods for the treatment of cancer, obesity, cardiovascular disease and many other conditions and diseases. One specific goal is to develop multifunctional nanoparticles for medical applications, including drug-delivery mechanisms and regenerative medicine, such as the development of targeted nanoparticles to deliver therapies to the brain. We are also developing mRNA-based nanoparticle vaccines to protect against COVID-19. Another major area of focus is the development of synthetic biomaterials and processing techniques to fabricate hydrogels and scaffolds with degradable and biocompatible properties for use in drug delivery and tissue engineering.

Nano-Optoelectronic Materials and Devices Laboratory

Hieu P. Nguyen, Director

The Nano-Optoelectronic Materials and Devices Laboratory develops high-performance nanophotonic and nanoelectronic devices for lighting and energy storage applications. Such devices are fabricated from gallium nitride (III-nitride)-based semiconductors in the form of nanostructures devised through a state-of-the-art epitaxial growth technique called molecular beam epitaxy. III-nitride nanostructures have emerged as a powerful platform to effectively scale down the dimensions of future devices and systems. The research group aims to develop superior quality III-nitride nanostructures wherein we will investigate their epitaxial growth, characterization and applications. We believe this will provide an enhanced materials system and device structure for applications in biological sensors, solid-state lighting, digital displays, electronic textiles, water purification systems and solar cells, as well as hydrogen generation and carbon-dioxide reduction for clean, storable and renewable sources of energy.

Laboratory for Numerical Turbulence

Simone Marras, Director

The Laboratory for Numerical Turbulence aims to understand the ties between the numerical approximation of the equations of fluid dynamics and the physical parameterization of the sub-grid scale mechanisms at the core of turbulence. Specifically, the lab concentrates on the development of efficient algorithms for the direct and large-eddy simulation of turbulence with the goal of minimizing the numerical error introduced by the discretization of governing equations onto the modeling of the sub-grid scale mechanisms. Our research is used in the fields of atmospheric turbulence, aeroacoustics and aerodynamics, among other areas of engineering and science; applications range from managing turbulence in free surface flows to the aeroacoustics of wind turbines and large wind farms in the atmospheric boundary layer.

Organic Reactions and Mechanisms Laboratory

Pier Alexandre Champagne, Director

The Organic Reactions and Mechanisms Laboratory focuses on the development of novel approaches toward organic molecules and the study of how chemical reactions happen at the molecular level. To this end, we combine experimental and computational tools to invent, understand and improve transformations for organic synthesis. Our research focuses on two main areas related to the synthesis of complex molecules targeted for pharmaceutical research. Ongoing projects include the synthesis of complex alkanes, which are useful in cancer treatment, using boron-containing reagents; the valorization of sulfur for the synthesis of medicinally-relevant heterocycles, a class of organic chemical compounds; the investigation of organic mechanisms using physical organic chemistry tools; and the study of important catalyzed reactions using theoretical calculations based on density functional theory.

Particle Engineering and Pharmaceutical Nanotechnology Laboratory

Ecevit Bilgili, Director

The Particle Engineering and Pharmaceutical Nanotechnology Laboratory (PEPNAL) designs advanced particulate formulations and processes for various high-value-added product industries, such as the pharmaceutical, flavors and fragrances, nutraceuticals and cement industries. With an array of characterization and processing equipment, the Laboratory has made significant advances on the bioavailability enhancement of poorly water-soluble drugs via three platform approaches: nanosuspensions; nanocomposites; and amorphous solid dispersions. Highlights from recent research include the preparation of sterile-filterable drug nanosuspensions for long-acting injectable drugs; fast-dissolving surfactant-free drug nanocomposites with colloidal superdisintegrants for bioavailability enhancement; and hybrid nanocrystal–amorphous solid dispersions for enhanced drug solubilization. The laboratory also examines mechanisms such as particle breakage, aggregation and growth during the formation of nanoparticles and microparticles. We couple experimentation with population balance modeling, discrete element modeling and computational fluid dynamics to elucidate complex non-linear rate processes that occur in pharmaceutical manufacturing operations. Our goal is to develop engineering science for delivering and manufacturing poorly soluble drugs cheaper, faster and more efficaciously.

Soft Matter Research Laboratory

David C. Venerus, Director

The focus of the Soft Matter Research Laboratory is the characterization of soft matter, such as synthetic polymers, biomaterials, gels, foams and emulsions, with the goal of establishing relationships between microstructure and material properties. The experiments carried out in the lab advance development of new processes and materials for applications ranging from plastics packaging to biomedical devices. The laboratory includes both commercial and custom-made instruments to perform novel rheological experiments in both shear and elongational flows. Also included in the laboratory is a custom-made optics setup that allows for novel light scattering to investigate non-classical thermal and mass transport in soft matter.

Sustainable Environmental Nanotechnology and Nanointerfaces Laboratory

Wen Zhang, Director

The Sustainable Agricultural Irrigation and Food Disinfection Laboratory has two major missions: mitigating the impacts of climate change through sustainable agricultural irrigation and food disinfection; and developing nanotechnology-based materials and processes for sustainable pollution mitigation and resource recovery. The lab specializes in colloidal science and interfaces, nanomaterial synthesis and characterization, catalytic processes and engineering. Team members research the chemical and mechanical interactions between pollution targets, such as microplastics and microbes, and engineered micro- and nanobubbles and other nanomaterials. Additionally, the lab develops reactive membrane filtration systems for desalination and contaminant removal, as well as microalgal removal and harvesting methods using magnetophoretic separation and reactive membrane filtration. Recent applications include novel uses of nanobubbles in agriculture; the recovery of lithium and cobalt from spent lithium-ion batteries; induction-heating membrane distillation; and microwave-enabled water and air purification.

Terahertz Spectroscopy, Imaging and Wireless Communication Laboratory

John Federici and Ian Gatley, Co-Directors

The Terahertz Spectroscopy, Imaging and Wireless Communication (THz SPICE) Laboratory specializes in the development and application of terahertz (THz) technology to spectroscopy, imaging and wireless communication. The THz frequency ranges from about 0.1-3 THz corresponds to the far-infrared spectral range. The laboratory's research in spectroscopy and imaging focuses on the non-destructive evaluation of materials, including THz Computed Tomography, additively manufactured components and plastic welding. The laboratory has expertise in terahertz wireless communication. Research efforts include evaluating the effects of atmospheric weather on THz communications, as well as THz reflectors and antenna arrays for indoor THz communications.

Tissue Engineering and Applied Biomaterials Laboratory

Treena Livingston Arinzeh, Director

The Tissue Engineering and Applied Biomaterials Laboratory develops functional biomaterials for regenerative medicine applications. Recent discoveries in the tissue-engineering field have shown that the microenvironment can influence stem cell self-renewal and differentiation, which has had a tremendous impact on identifying potential strategies for using these cells effectively in the body. This laboratory develops functional biomaterials that impart cues to stem cells, either already present within the body or implanted, to affect their behavior. These biological cues stimulate growth in bone and spinal cord tissue, for example. Our laboratory has pioneered the use of bioactive ceramics and composites for use in bone-tissue engineering. Novel bioinspired materials such as glycosaminoglycan (GAG) mimetics and piezoelectric materials also are being developed for bone, cartilage and neural applications. GAG mimetics combine with growth factors to stimulate tissue growth and piezoelectric materials provide electrical stimulation to cells. Current funding is from federal, state and private agencies.

Tissue Innervation and Muscle Mimetics Laboratory
Jonathan Grasman, Director

The Tissue Innervation and Muscle Mimetics Laboratory develops biomaterials and tissue-engineered strategies to understand the mechanisms and processes by which tissue innervation occurs, and how to leverage these data to improve skeletal muscle repair outcomes. Neural and vascular networks are critical components of each of the tissues within our bodies, and yet many tissue engineering strategies rely on their passive incorporation into nascent tissue. In fact, the failure to generate both of these structures is a significant limitation in regenerative medicine, especially in skeletal muscle, which has a high density of both of these structures to maintain proper function. Specifically, we focus on fabricating tissue systems from a variety of biopolymers to generate neurovascular and skeletal muscle tissue mimetics to enhance regeneration and innervation in incidents of traumatic injury, neuropathy and genetic disorders both in in vitro and in vivo.

ROBOTICS AND MACHINE INTELLIGENCE

Center for AI Research
Grace Wang, Director

Artificial intelligence (AI) has advanced tremendously, promising improved transportation, enhanced national security and more intelligent cities, to name a few benefits. AI holds the potential to be the driving force of emerging technologies and transform lives across the nation. The Center for AI Research aims to provide an intellectual environment and primary home for AI research initiatives at NJIT. Its mission includes:

- Promoting cutting-edge and high-quality research and cultivating publications and patents in AI and machine learning
- Fostering collaborations among professors who pursue foundational AI research and professors who use AI methods to solve domain problems and develop synergies among research groups across different departments and colleges
- Training postdoctoral researchers, graduate students and undergraduate students in AI and preparing them to be skilled and capable AI workers
- Improving the visibility of NJIT on AI research at the national and international levels
- Facilitating collaborations among NJIT and other institutions in integrated and complex AI projects

Intelligent Transportation Systems Resource Center
Lazar Spasovic, Director

The Intelligent Transportation Systems Resource Center (ITS) was established as a research and technology resource for the New Jersey Department of Transportation's Division of Traffic Operations and Division of Mobility and Systems Engineering. ITS utilizes roadside sensing, information and communication technologies and integrates them into traffic engineering and management practices with the goal of reducing congestion and improving the mobility, safety and efficiency of the transportation system in support of sustainable regional growth and economic development. The main purpose of the center is to conduct research studies of innovative ITS technologies and optimize strategies for their deployment in the regional transportation system. This is accomplished through technology assessment, the evaluation of strategies and deployment scenarios, concept-development studies and technology transfer and training. The center and its laboratory also serve as a test bed for innovative and promising new ITS technologies. They include vehicle sensing and traffic-flow monitoring, automated traffic-incident detection and emergency response, active traffic management using traffic sensors and wireless communication, traffic and transportation data analytics, ITS system integration, and the introduction of connected and autonomous (driverless) vehicle technologies on our roadways. From a teaching and learning standpoint, the center builds on and further strengthens NJIT's competencies and national stature in the research areas of information and communication technology and sustainable systems and infrastructure. The center also serves as the nexus among federal and state transportation agencies, the regional academic research community and the private sector engaged in the development and implementation of innovative transportation-intelligence technology and services.

Center for Rehabilitation Robotics

Sergei Adamovich, Director

The Center for Rehabilitation Robotics is comprised of multiple projects applying robotics, virtual reality, brain imaging and non-invasive brain stimulation to improve the lives of individuals with disabilities. The largest of these, funded by the National Institutes of Health, employs a unique combination of robotics and virtual reality for neurorehabilitation of people with limited arm capability resulting from a recent stroke. Five smaller projects on wearable robots, supported by a multi-year grant from the National Institute on Disability, Independent Living, and Rehabilitation Research, address lower-extremity exoskeletons to restore walking in individuals with stroke; use epidural electrical stimulation to increase spinal cord transmission and improve the use of exoskeletons by people with spinal cord injury; and research new robotic technology for stroke therapy to be used in the home. In two development projects, center researchers are designing new human-robot interfaces allowing people to control exoskeletons in a biologically natural way. The Kessler Foundation and the Department of Rehabilitation and Movement Science at Rutgers University are major collaborators.

AI for Social Good Lab

Hai Phan, Director

The AI for Social Good Lab (AI4G) focuses on diverse applications involving AI, big data and machine learning. They include exploring novel techniques that advance privacy, security and trustworthiness in AI and machine learning; the application of AI for social good in areas such as health informatics, human sensing and modeling, and network analysis; and transferring technology for practical applications through industry partners. Projects include drug-abuse monitoring on social networks and modeling human behaviors and mental health during the COVID-19 pandemic using a machine learning technique called Federated Learning on smart phones. We are currently building a mobile app to monitor students' mental and physical wellness. The AI4G Lab has long been committed to broadening participation in computing and education. The lab is supported by research funding agencies and industry partners, including the National Science Foundation, Wells Fargo, Qualcomm and Adobe.

Controls, Automation and Robotics Laboratory

Cong Wang, Director

The Controls, Automation and Robotics Laboratory (CAR) focuses on the development of control theories and their applications to automation and robotics. With a strong tie to the community of dynamic systems and controls, we continue to push frontiers in the field, especially in the direction of machine learning-based methods and data-oriented and statistical methods. We emphasize the use of computational intelligence and data science. Our work enables us to develop advanced automation and robotics technologies. In particular, we are challenging the limits of high-performance control for advanced manufacturing and automation, as well as developing intelligent and ultra-high-maneuverability motion systems for human-robot interactive and collaborative operations and extreme robotic manipulations. This technology is targeted at sectors ranging from advanced manufacturing, to household automation, to health care.

Face Recognition and Video Processing Laboratory

Chengjun Liu, Director

The Face Recognition and Video Processing Laboratory investigates advanced pattern recognition and video analytics methods and develops novel technologies to solve challenging problems, such as automated traffic incident detection and monitoring, facial recognition, image search, video retrieval, big-data analytics and visualization. Our video analytics system, which achieves next to a one order of magnitude improvement over RADAR for vehicle counting, has outperformed commercial systems for automated traffic incident detection and monitoring in challenging environments. Our facial recognition technology is able to reliably verify face images at a very low false-accept rate. Our patented face detection technology, iris detection and recognition technologies, and image-search technologies are additional focuses of the lab's research and development work.

Intelligent Transportation Systems Laboratory

Jo Young Lee, Director

The Intelligent Transportation Systems Laboratory (ITSL) is a multidisciplinary research hub for the development and deployment of cutting-edge ITS and connected and automated vehicles (CAV) technologies to improve the mobility, safety and environmental performance of the transportation system. The lab houses state-of-the-art traffic sensors employing radar, lidar, computer vision and machine learning technologies. As a live laboratory, the NCC test bed is equipped with state-of-the-art traffic detection and cellular vehicle-to-everything(C-V2X) communication technology at 13 signalized intersections along a 2-mile section of Raymond Boulevard and Warren Street in Newark, N.J. The test bed leverages the C-V2X and information technologies to improve mobility, air quality and traffic safety, especially the safety of vulnerable road users. The test bed is designed to collect and process traffic signal control and air quality data, and then broadcast this data to road users. It also allows the road users, including motorists, bicyclists, and pedestrians, to communicate service requests to the traffic signal controllers.

Intelligible Information Visualization Lab

Aritra Dasgupta, Director

In the Intelligible Information Visualization Lab, we are a group of data toolsmiths who develop visualization techniques to serve as a transparent lens between what is computed and what is communicated to the human mind. As the playwright George Bernard Shaw observed, "The single biggest problem in communication is the illusion that it has taken place." This is evident in today's age, in which information, if communicated properly, can cure diseases and fuel discoveries, but if miscommunicated, can lead to an "infodemic." To solve this conundrum, the NiiV team pursues intelligibility as the foundational principle for making information more accessible, meaningful and actionable for experts and nonexperts alike. We operationalize this principle by visualizing data, big or small, with the ultimate goal of letting human observers see, understand and trust the information that is often generated by black box models. By embracing a human-centered data science approach resulting in interactive visual interfaces, we preserve the best of both worlds: the power of computational methods and that of human reasoning for data-driven decision-making.

Interactive Cross-Reality Lab

Margarita Vinnikov, Director

The Interactive Cross-Reality Lab (iXR) addresses the general areas of interactive mix reality (XR) applications and serious game development. The lab investigates specific topics in virtual and augmented reality and cross-model (visual, audio and haptic) user experiences in the context of driving simulations and military mission planning. Another critical focus in the lab is the design of gaze-contingent displays for gaming and social interaction applications. The lab work is split between simulating and visualizing complex phenomena, such as different weather conditions and complex data formations, and user studies looking at the impact of spatial displacement in the context of navigation and learning.

Media Interface and Network Design Lab

Frank Biocca and Hannah Kum-Biocca, Co-Directors

The Media Interface and Network Design (M.I.N.D.) Lab is a center for the research and design of interactive augmented reality computer interfaces, dynamic data visualizations and human-computer interaction. The M.I.N.D. Lab also conducts human-computer interaction studies assessing the effectiveness of new interactive hardware and software on user performance, learning, cognition and aesthetic experience. Current M.I.N.D. Lab interface design projects include human-scale, near-space magnetic field visualization; interactive AR visualization of artists in museums and displays; AR visualization of biochemical structures: and library visualization and navigation. The museum AR project has won two international awards for augmented reality design. The M.I.N.D. Lab is the local site of a network of three collaborative human-computer interaction labs that over time have spanned the United States, Europe and Asia, including more than 50 computer scientists, neuroscientists, artists and human-computer interaction specialists. Recent M.I.N.D. Lab network projects have been funded by the U.S. Air Force, the National Science Foundation and the European Union, and by clients such as HP, Korea Telecom, Amazon and Samsung.

Robotics and Data Laboratory

Pramod V. Abichandani, Director

The Robotics and Data Laboratory works on problems centered on optimal, multi-dimensional, data-driven decisionmaking for systems involving multiple aerial, terrestrial, underwater and manipulator robots. Techniques from mathematical programming, linear and nonlinear systems theory, statistics and machine learning are leveraged to create theoretical frameworks and associated real-time embedded systems to solve these problems. Past and current research sponsors include the National Science Foundation, the National Institutes of Health, the Office of Naval Research, Lockheed Martin and Mathworks.

The Smart Construction and Intelligent Infrastructure Systems Lab

Rayan H. Assaad, Director

The Smart Construction and Intelligent Infrastructure Systems (SCIIS) Lab focuses on the sustainability, resiliency and environmental impacts of infrastructure systems, as well as infrastructure asset management of above and underground structures, such as bridges, dams and tunnels, and transportation, utility, energy and water infrastructure. The lab works on computational methods and applied machine learning to design and implement scalable solutions for next-generation projects and infrastructure, as well as on the modeling, simulation and optimization of infrastructure assets, construction operations, and human and community dynamics, including communications. The lab conducts fundamental, applied and translational research to develop systems of the future, such as a new generation of integrated infrastructure systems. The SCIIS lab advances the development and application of smart and intelligent technologies to inventory, manage and monitor the built environment and to manage high-performance and complex infrastructure systems through research, teaching and outreach. The lab's vision is to enable a safe, sustainable, resilient and productive environment.

Ubiquitous Networking and Intelligent Computing Systems Lab

Tao Han, Director

The Ubiquitous Networking and Intelligent Computing System (UNICS) Lab focuses on the design and development of new network algorithms, protocols and systems for next-generation wireless communication networks and edge computing systems. These technologies support a variety of applications, such as mobile mixed reality, ubiquitous machine vision, smart grid, wave energy, airborne computing and autonomous vehicles. The UNICS lab emphasizes both theoretical analysis, which provides rigorous performance evaluation, and practical system implementation to validate the viability of new networking solutions.

Virtual Technology Applications Lab for Human Simulation

Salam Daher and Frank Biocca, Co-Directors

The Virtual Technology Applications Lab for Human Simulation (ViTALHS, pronounced "Vitals") is a research lab in the College of Computing. The ViTALHS team consists of faculty researchers, software developers, artists, including 3D modelers and animators, Ph.D. students, undergraduate researchers and collaborators with subject matter expertise in areas such as nursing and medicine. Our aim is to design, develop and evaluate human simulations, such as 3D virtual patients, and to develop techniques that improve learning and training. Research areas include health care simulation, human-computer interaction, human surrogates, virtual avatars, 3D graphics, multimedia, augmented reality, virtual reality and mixed-reality experiences that are virtual and physical. Multi-sensory simulations with immersive elements are designed, developed, and used for health care, education and defense, among other domains. We develop remote health care simulators, digital assistants and 3D human representation by creating a realistic training replica that behaves, reacts and communicates like real patients to facilitate learning and practice in a safe environment for health care providers. We design studies to evaluate the technology and its effects on the users, including providers, patients, educators and students.

Visual Computing, Graphics and Artificial Intelligence Lab

Tomer Weiss, Director

The mission of the Visual Computing, Graphics and Artificial Intelligence (VGA) Lab is to solve challenging computational problems in social computing areas, including crowd and collective dynamics and artificial intelligence in computational design. More specifically, we are interested in understanding the dynamics underlying human motion in a space and devising computational approaches for designing better spaces for people. To that end, we utilize tools from a wide range of disciplines, from computer graphics, visualizations and physics-based simulations, to machine learning and computer vision. Current projects include the development of computational algorithms for the automatic synthesis of architectural spaces; computational approaches to select style-compatible furniture for rooms; interactive systems for the design of virtual spaces; and the creation of pedestrian and group dynamics models and their application to robots and swarms.

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of Higher Education
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162 Patents
and intellectual property
assets
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150
Research Institutes,
Centers and specialized
labs.

12 Fellows
of the
National Academy
of Inventors

$21 million
amount raised in
2022 by companies in
VentureLink@NJIT

Top 20
university in the United
States for graduating
Black engineers.

Top 100:
institutions globally in
addressing the United
Nations' Sustainable
Development Goals - 2022
Times Higher Education
impact Ratings

Student-founded
nonprofit, Minorities in Shark
Science, attracted 400 members
from 30 countries

SINCE 2013

107% increase
in external
research
funding

23 winners
of National Science
Foundation CAREER
Awards

$7.5 million
spent on
undergraduate student
research stipends

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180 3/23