NEW YORK INSTITUTE OF TECHNOLOGY

College of Engineering
& Computing Sciences

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Research Labs

Do.
Make.
Innovate.
Reinvent the Future.

Message from the Dean

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PROGRESS – it has been our sharp focus since New York Institute of Technology was established in 1955. Our teaching and research have evolved to keep pace with an ever-changing world. Research at New York Institute of Technology's College of Engineering and Computing Sciences (CoECS) is increasingly cross-disciplinary, necessitating bold new thinking and ideas. Our research labs are seeding grounds for the next generation of technologies, algorithms, and materials that will push the world forward in the 21st century.

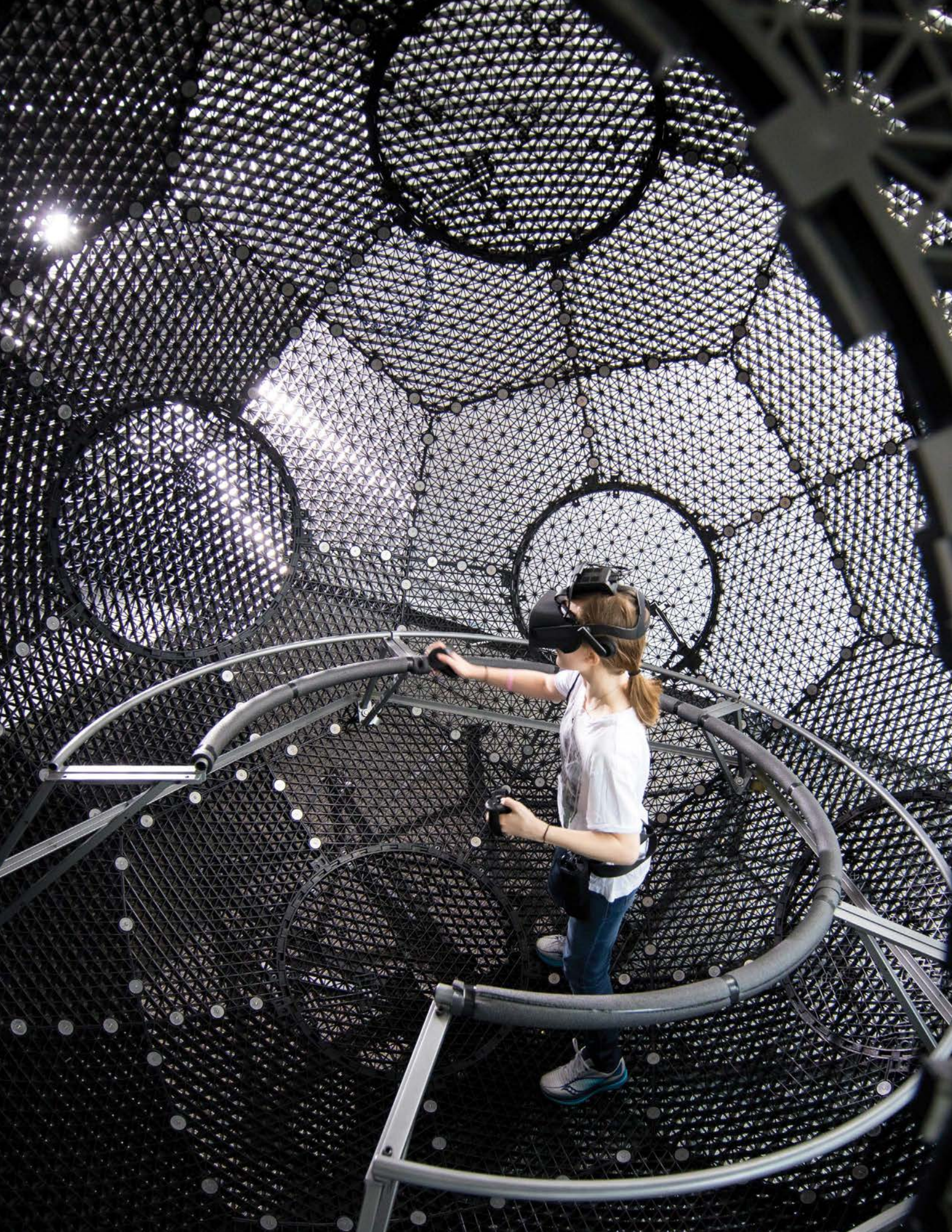
At the College of Engineering and Computing Sciences, you will find a community of learners dedicated to addressing some of the world's most complex engineering challenges. We pride ourselves on the success that comes from our top-notch faculty. Our researchers see the challenge of unlimited problems to solve as an opportunity to develop new and innovative solutions.

This booklet showcases the impressive array of research labs at the college, the exciting projects that are ongoing in these labs, and our star faculty who lead these labs. I am extremely proud of the doers, makers, innovators, and inventors who make up the College of Engineering and Computing Sciences. I am honored to be part of a team of people who aren't just about making something, but are about making the world better.

Sincerely,

Babak D. Beheshti, Ph.D.
Dean, College of Engineering and Computing Sciences
New York Institute of Technology

Contents



Biological Sciences and Bioengineering (BSB) Laboratory

The BSB laboratory is a living lab where our faculty train students while pursuing important interdisciplinary research that integrates engineering and biology. This integration offers tremendous opportunities for solving important problems in health sciences and medicine and enables a broad range of applications in diagnostics, sensing, therapeutics, and tissue engineering.

Long Island Campus,
Theobald Science Center

AREAS OF INTEREST

Disease Diagnostics and Structural Biomaterials for Bone Regeneration
Led by Azhar Ilyas, Ph.D.
Assistant Professor,
College of Engineering & Computing Sciences

Bacteriophages and Viruses' Therapeutic Effect to Treat Bacterial Infections
Led by Bryan Gibb, Ph.D.
Assistant Professor,
College of Arts & Sciences

Synthetic Biology Approaches: How Nervous Systems Encode Behaviors
Led by Navin Pokala, Ph.D.
Assistant Professor,
College of Arts & Sciences

Fate Analysis of Emerging Contaminants in Water and Soil
Led by David Nadler, Ph.D.
Assistant Professor,
College of Engineering & Computing Sciences

Bio-Nanotechnology and Biomaterials (BNB) Laboratory

The BNB laboratory specializes in applying micro- and nano-scale techniques to solve problems in medicine. Researchers focus on the general areas of biomedical engineering, nanoscience, and nanotechnology, particularly on two major themes: point-of-care disease diagnostics and structural biomaterials for bone-implant systems.

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AREAS OF INTEREST

Microfabrication and 3-D printing

Microfluidics and Cell Sorting

Electrophysical Analysis of Diseased Cells

Bioactive Coatings and Bioinks

Biomaterials and Tissue Engineering

ACTIVE PROJECTS

Microfluidic Devices for Tagless Identification/Quantification of Diseased Cells

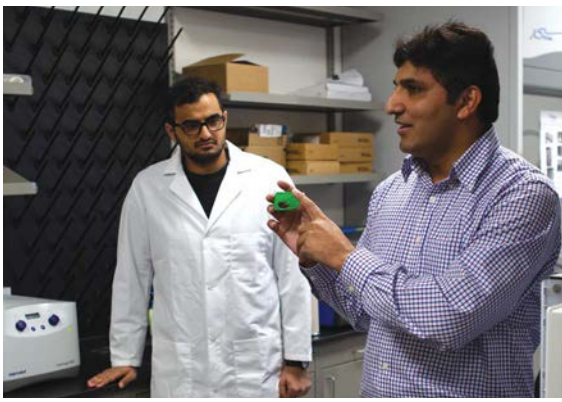
An accurate, quick, and inexpensive enumeration of blood cells, including lymphocytes, is critical for early diagnosis of various physiological disorders and has been the subject of much attention. Nanotechnology empowers us with tools to investigate fatal diseases like cancer and HIV at cellular/molecular scales. Several approaches have been used for cell sorting and identification, but most of these are limited by low throughput, need for fluorescent tags, or lack of quantitative analysis on single-cell level. Early-stage detection and precise enumeration of cells is crucial for efficient therapeutics and improved survival rate of cancer/HIV patients. There is a great clinical need to develop new inexpensive and portable point-of-care (POC) devices for early-stage diagnosis of these fatal diseases. We are developing a novel, low-cost, stabilized (refrigeration-free storage) microfluidic-based cell monitoring tool for rapid and accurate quantification from unprocessed whole blood at POC settings.

Nanofabricated and 3-D Printed Materials for Rapid Bone Healing

Traumatic fractures, age-related fragility, and disorders cause structurally unstable fracture sites, which require metal fixative devices for mechanical support. Titanium (Ti) is the most widely used material for fixative devices, but Ti is bioinert and doesn't promote osteogenesis. Bioactive glass coatings onto Ti implants show promising results by incorporating osteoinductive properties, but macroscale fabrication techniques cause inhomogeneity in the coatings and have thermal expansion mismatch with the underlying Ti, leading to delamination and instability of the coatings. 3-D printing is an additive manufacturing technique that allows fabrication of modular and patient-specific scaffolds with high structural complexity and design flexibility. The major drawback that limits the widespread acceptance of 3-D printing in biomanufacturing is the lack of diversity in "biomaterial inks." We are developing novel composite bioinks to fabricate a new class of fully degradable 3-D-printed scaffolds that can degrade at a desired rate. These 3-D-printed structural biomaterials are tested for their biomechanical properties to understand the role of surfacemorphology and chemistry in cellular attachment, surface bioactivity, and gene expressions for rapid fracture healing.

Development of Highly Sensitive Novel Biosensors for Molecular Detection

Nano-biosensors are low-cost, fast, and easy to use, and have multiple applications, including health, food, and environmental changes. They are small-scale transducers that detect the chemical specificity and sensitivity of a system using biological agents. The advent of nanotechnology permitted the development of improved, micro- and nano-scale biosensors, allowing scientists and engineers to monitor the biological and chemical interactions on the sensor surface. Nanoscale biosensors provide more accurate and sensitive measurements of biomolecules/viruses. We are developing nanofabricated, ready-to-use microchips to sense and characterize important biomarkers for various diseases, including cancer and HIV.



Integrated Medical Systems (IMS) Laboratory

The IMS laboratory conducts research in various fields of Biomedical Engineering.

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AREAS OF INTEREST

Implantable/Wearable Medical Devices

Assistive Technologies

Biological Signal Processing

Modeling Biological Phenomena

Medical Cyber Physical Systems

ACTIVE PROJECTS

Reliable Power-Efficient Miniature Bidirectional Telemetric Platforms for Acquiring Biological Signals

The need for implantable/wearable devices for the wireless acquisition of biological signals is emerging in various medical fields. Electrophysiological applications include: in-vivo recording of gastric electrical activity (GEA) to study dysmotility, single-unit action potentials (APs); electrocorticograms (ECoG) to study neuronal activities; and transcranial motor-evoked potentials (TcMEP) for intraoperative neurophysiological monitoring of spinal cord integrity. The require physically miniaturized devices with low power consumption and the capability of implantation. These systems should provide reliable communication in real time with sufficient data rates.

Closed-Loop System for Real-Time Recognition and Inhibition of Nociceptive Signals

Clinical studies have shown that spinal or cerebral neurostimulation can significantly relieve pain. Current neurostimulators work in an open loop, and thus their efficacy depends on the patient's or physician's comprehension of pain. We are developing a real-time automatic recognition algorithm to detect action potentials and cluster various neuronal activity levels.

Signal Processing for Analyzing APs and ECoG to Detect Nociception

The recent development of neural interfaces has enabled the extraction of a huge amount of information from the nervous system. However, understanding the message of the nervous system requires adequate signal processing. We are conducting signal acquisition (APs and ECoG) and analysis (real-time and off-line) from the nervous system (spinal cord and brain) to better understand and distinguish between various states of mind and pain circumstances.

Modeling Biological Systems: The Process of Long- and Short-Term Potentiation in Chronic Pain-Related Phenomenon

The objective of this work is to understand the mechanisms underlying wind-up generation, a condition related to chronic pain, that might allow clarification of the molecular mechanisms of pain signaling and development of strategies, such as transcutaneous electrical nerve stimulation (TENS) and deep brain stimulation (DBS) for pain treatment. "Wind-up" is a form of plasticity in the spinal dorsal horn that can be observed during electrical stimulation of pain receptors at low frequencies (0.3–3 Hz). We are designing computational models to explain several aspects of wind-up.

Applied Electromagnetics Research Laboratory

This laboratory conducts research on various applications of electromagnetic waves.

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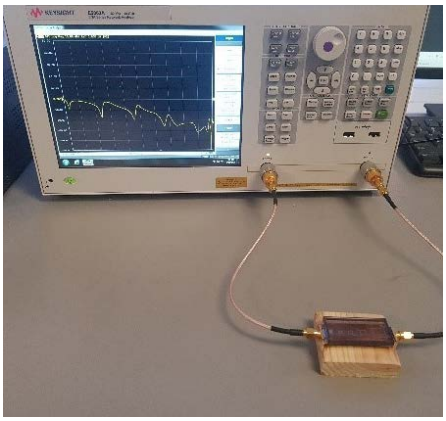
AREAS OF INTEREST

- Biomedical Imaging
- Nondestructive Testing of Materials
- Water/Soil Quality Sensing
- RF/Microwave Circuit Design
- Wireless Power Transfer
- Security Screening
- Wireless Communications
- Underground Imaging
- RF/Microwave Component Design

ACTIVE PROJECTS

Fast and Robust Nondestructive Testing of Cylindrical Composite Components Based on Microwave Measurements (supported by NSF)

We use microwave measurements and novel holographic image reconstruction techniques to provide volumetric images of the interior of cylindrical nonmetallic objects. The main application of the developed imaging techniques is in nondestructive testing (NDT) of nonmetallic pipes. These pipes are rapidly growing in various industrial sectors (such as the oil and gas field) due to their light weight, resilience to corrosion, and low cost. However, traditional NDT techniques do not suffice to inspect these components for detecting flaws and cracks, justifying the use of microwave measurements. Other applications of the developed imaging techniques are biomedical imaging, security screening, etc.

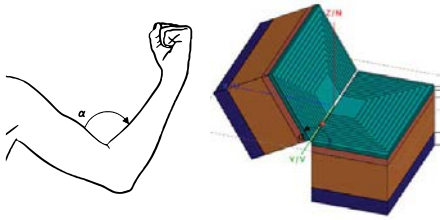


Autonomous Soil Nutrient Sensing System (supported by NSF)

This project is in collaboration with the faculty in Mechanical Engineering and Life Science Departments. The purpose of the project is to develop a wireless sensing system to detect pollutants such as nitrate, phosphate, and heavy metals in the agricultural soil.

Material Characterization With a Microwave Sensor Array: Application to Water Quality Sensing (supported by New York Tech's ISRC)

We design, fabricate, and test highly sensitive microwave sensor arrays for material characterization; in particular, for water quality testing. The fabricated sensors are tested with a set of water samples with pollutants including: nitrate (NO3); phosphate (PO4); ammonium (NH4); chromium (Cr+6); lead (Pb); and mercury (Hg). This project is in collaboration with the faculty in the Environmental Technology and Sustainability Department.



Human Motion Tracking With Inductive Sensors

Currently, there is a rapidly growing demand for wearable textile sensors for applications such as measuring the motor skill performance of patients with autism spectrum disorder, Parkinson's disease, etc. Among wearable sensors, inductive sensors that are made from highly conductive threads are attractive due to their easy development process, high reliability, and low cost. In this project, we analyze and compare the performance of novel inductive wearable sensors.

Biomedical Data Analysis Research Laboratory

This laboratory performs research on signal processing, machine learning, and brain computer interface systems to aid individuals with severe motor disabilities and mental/neurological disorders.

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AREAS OF INTEREST

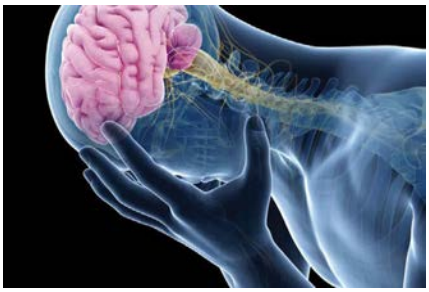
- Epilepsy
- Schizophrenia
- Major Depression Disorder
- Autism Spectrum Disorder
- Bipolar Disorder
- Amyotrophic Lateral Sclerosis
- Stroke
- Cerebral Palsy
- Spinal Cord Injury

ACTIVE PROJECTS

Developing Deep Learning Algorithms to Diagnose Subtypes of Depression

(supported by New York Tech's ISRC)

This project, in collaboration with the Department of Psychiatry and Behavioral Neuroscience, McMaster University, explores a novel deep learning algorithm (DLA) based on effective connectivity between brain's regions that are extracted from resting electroencephalography (EEG) data to diagnose different subtypes of depressions including major depressive disorder, depressive episode of bipolar disorder, manic episode of bipolar disorder, atypical disorder, and psychotic disorder as well as schizophrenia.



Developing EEG Biomarkers to Predict Response to Antidepressant Medications in Major Depressive Disorder (MDD)

(Supported by a collaborative grant from McMaster University)

In this project, in collaboration with the Department of Psychiatry and Behavioral Neurosciences, McMaster University, researchers are developing a deep learning algorithm (DLA) based on our newly developed robust brain source localization technique and the effective connectivity to predict response to three medications Sertraline, Bupropion, and Placebo based on pre-treatment electroencephalography (EEG) data. In addition, the same methodology is used to predict suicide ideation.

Developing Quantitative Sensing Technologies to Measure the Fine Motor Skills and Evaluate the Efficacy of Therapeutic Interventions for Autistic Children

In this study, in collaboration with the Department of Occupational Therapy, New York Tech, researchers are developing sensing technologies that can quantitatively measure the patterns of the fine motor activities that can be used to 1) improve fine motor skills and 2) evaluate the efficacy of the outcomes of the therapeutic intervention. The inexpensive, non-invasive, and accessible tools, designed through this technology, can assist ASD children to improve their motor skills and help the clinician to better evaluate the efficacy of the intervention.

EEG Biomarkers to Investigate the Effect of Vagus Nerve Stimulation (VNS) on the Brain's Functional Activity using Vagal-Evoked Potential

Vagus nerve stimulation (VNS) is a non-pharmacological treatment for epilepsy and depression and has been tested as a possible therapy for tinnitus, post-traumatic stress disorder, headache, sleep disorders, and neurorehabilitation after stroke. However, the cortical effects of VNS, manifesting as vagal-evoked potentials (VEPs) at the time of stimulation on modulating the brain's activity is unknown. Therefore, in this project, in collaboration with the Institute of Bioelectronic Medicine, Feinstein Institutes for Medical Research, researchers plan to find quantitative biomarkers based on advanced signal processing approaches to investigate modulations in brain's electrical activity as a result of VEPs. This has implications for the role of cortical responses to stimuli in ongoing cortical activity, and for the dose calibration of VNS therapies.

Circuits, Networks, and Systems (CNS) Laboratory

The CNS Laboratory specializes in device design for medical and networking/security applications.

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AREAS OF INTEREST

Implantable, Wearable, Point-of-Care, and Assistive Devices

Low-Power Circuit and System Design

Wireless Power Transfer

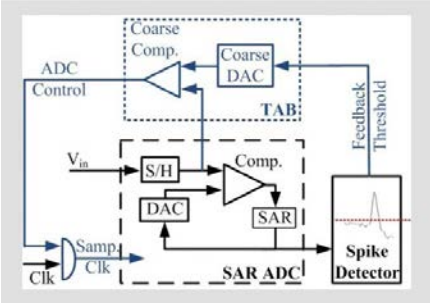
Data Converters

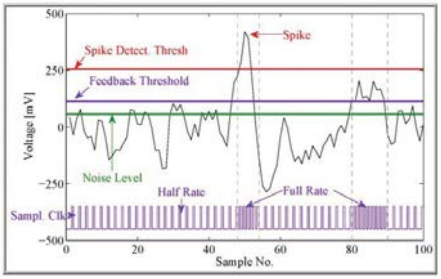
High-Speed Networking and Network Security

ACTIVE PROJECTS

Adaptive Data Converters

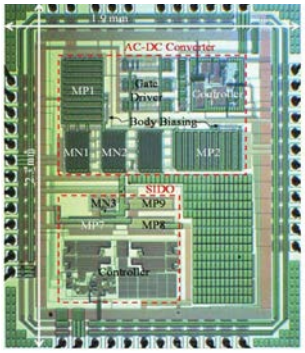
The low-power devices such as implantable devices or Internet-of-Things (IoT) devices generate a deluge of data that can overwhelm these devices due to their limited capabilities. In this project, we investigate methods to curb the amount of data sensed. The ultimate goal is to develop adaptive data converter circuits that only acquire and process data that is relevant in a given context. This is achieved by running the data converters in a closed-loop with the digital signal processing units and adapting the data converter parameters in real time to the context.





Wireless Power Transfer to Implantable Devices

Wireless Power Transfer (WPT) helps extend the lifespan of medical implants such as retinal implants, deep brain stimulators, and implantable cardioverter defibrillators. WPT can sustain these devices or recharge their batteries by providing power from outside the body directed to the implanted device. The amount of power that can be safely delivered via WPT is limited by its power efficiency. In the CNS lab, we are developing coil structures and WPT circuits for boosting the power efficiency of WPT. Our low-profile multilayer planar coil structures improve coil and power link quality factors, allowing higher power transfer without damaging skin tissue. The DC-DC converters we have been developing combine traditional power supply stages, which reduces loss and increases efficiency. Our integrated DC-DC converters incorporate additional functionality on the same chip.



Intelligent Sensing and Communications (ISCOM) Laboratory

The ISCOM lab focuses on developing signal processing, optimization, and machine learning techniques for sensing and communications in future radar systems and 6G communications. It also focuses on developing physical layer security and authentication methods for wireless networks.

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AREAS OF INTEREST

Distributed Sensing and Communications

Joint Radar and Communications

Signal Processing for NG Communications

Physical Layer Security and Authentication

Optimization and Machine Learning for Radar and Communications

ACTIVE PROJECTS

Distributed Radar Sensing and Communications (supported by ARL and NRL)

The sensing (target detection, parameter estimation, and tracking) capabilities of conventional high-powered monolithic radar systems can be significantly enhanced with a low-powered, flexible distributed radar network. The sensing capability relies on the reliability, robustness, and effectiveness of network communications. The main objective of this project is to develop both model-based and deep learning techniques to enhance radar sensing performance by optimizing network resource allocations and communications. The developed techniques will be tested on over-the-air data collected with a software-defined radio (SDR) platform.

Joint Radar and Communications Systems (supported by NYIT-ISRC)

Due to an ever-increasing number of wireless devices and users, there is a need to optimally utilize the available frequency spectrum. The joint radar communication develops the same platform of transmitters/receivers and functions both as radar and communications. The first objective of this project is to develop optimal resource (e.g., bandwidth, power, antennas, time slots) allocation schemes, so that the diverse requirements of radar and communications receivers are simultaneously satisfied. The second objective is to develop signal processing techniques for embedding information into radar waveforms with and without re-modulation approach.

Signal Processing and Security for NG Systems

Next-generation (NG) systems need to support high data rate transmissions under stringent requirements for reliability, coverage, energy consumption, and low latency. The NG systems are also expected to support heterogeneous traffic that includes machine-type communications, Internet of Things (IoT), and vehicle to everything. The objective of this research is to develop coding/ decoding, channel estimation, beamforming/precoding, scheduling, interference management, and resource allocation methods leveraging concepts on reconfigurable intelligent surface (RIS), massive multiple-input multiple-output, mm Wave, full-duplex, non-orthogonal multiple access (NoMA), and edge computing. The development of deep learning techniques for solving NP-hard resource allocation problems and ensuring secure authentication are also the key objectives of this research.

Network and Innovation Laboratory

This research group focuses on research on communication networking and innovative technologies, such as autonomous sensing, unmanned vehicles, and blockchain to solve problems in optimizing the sustainable use of resources.

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AREAS OF INTEREST

High-Performance Computer Networks and Wireless Sensor Networks

Network Security and Forensics

Assistive Medical Devices

Innovation For Sustainability and Resilience of Both Natural and Built Environment

ACTIVE PROJECTS

Food, Energy, and Water Nexus for Sustainable and Resilient Urban Development

This project, in addition to establishing a Research Coordinated Network (RCN), explores the relationships between food, energy, and water systems at different scales in an urban environment. The project team is generating machine learning models to study the interaction of inter-connected systems, developing visualization tools to help stakeholders in decision-making process and using case studies to examine best practices for sustainable urban development. For more information, please visit the project's website at urbanfew.net and media release at nyit.edu/sustainability_grant.

Signals in the Soil

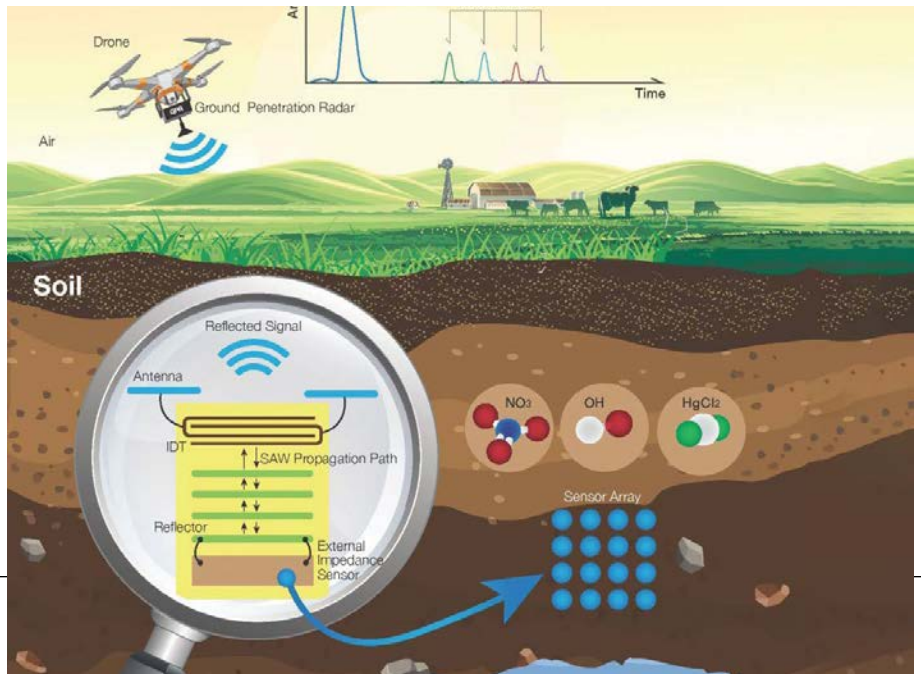
This project focuses on the development of a passive, low-cost, pervasive, maintenance-free sensor that can be interrogated wirelessly and provide measurements of soil water content, temperature, pH, and nutrient concentration for precision agriculture and environmental monitoring. This is a collaborative project with faculty from the College of Engineering and Computing Sciences and College of Arts and Sciences. It is funded by the National Science Foundation.

Assistive Medical Devices

This project investigates innovative devices using sensors, autonomous walkers, and wireless networks to assist rehabilitation for patients with Parkinson's disease. This is a collaborative project with faculty from the College of Engineering and Computing Sciences, College of Osteopathic Medicine, and School of Health Professions.

Geolocation Project

IP geolocation is the process of finding the geographical location of an Internet host bearing a certain IP address. However, this method can lead to inaccurate results due to outdated information. To address this issue, researchers are exploring measurement-based IP geolocation to find a suitable model for anchor nodes to locate an unknown IP, based on delay measurements. IP geolocation has a wide range of applications such as localized advertising, user location verification to avoid credit fraud. The project is also seeking novel approaches through ultra-wideband systems, machine learning, and multilateration of WiFi access point signals for accurate localization in the absence of GPS.



Network Resource and Security Lab (NRSL)

The NRSL laboratoryconducts research in the areas of network services and resource management and associated security vulnerabilities.

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AREAS OF INTEREST

Blockchains for 5G Spectrum and Power Management

Impact of Net Neutrality Repeal and Its Impacts

Communication Infrastructure for Connected Vehicular Networks

Data Reliability in Internet of Things (IoT)

Rumor Spread in Social Media and Influence on Pandemics

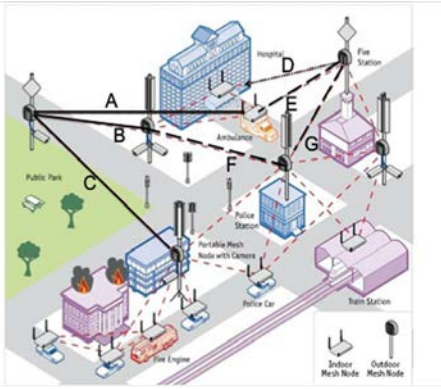
Dynamics of Information Consumption in Internet Media

ACTIVE PROJECTS

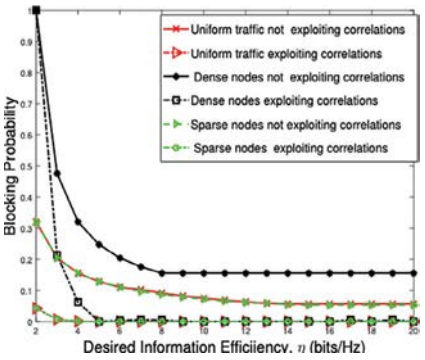
Spectrum Management for Successful Mission Completion in Tactical Networks

(supported by the Air Force Research Laboratory)

Mission completion in tactical networks depends on assigning spectrum for different missions, so that packets reach the destination without being lost and are error-free. This project develops distributed algorithms for spectrum allocation that exploits correlation in the information transmitted by different sources (e.g., multiple CCTV cameras may transmit the same video content). The proposed algorithms result in almost 100 percent mission success (0 percent mission failure).



Correlated videos from multiple cameras



Blocking or Mission Failure Probability

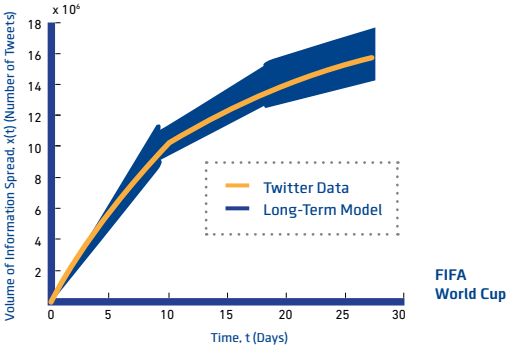
Geolocation of IP Hosts in Large, Congested Computer Networks

(funded by NSF REU)

Geolocation has found increasing importance to detect malicious activity in the internet, like suppression of speech, vandalism, cyber crimes, and localizing and blocking content while managing websites. IP address- based geolocation was found to be erroneous, laden with numerous vulnerabilities. Measurement-based geolocation without accounting for network traffic congestion is equivalent to predicting the estimated arrival time in a GPS navigator without accounting for road traffic congestion. This research proposes geolocation algorithms that yield up to 97 percent accuracy when tested on various nodes in the internet distributed across the world.

Role of User Interaction in Information Spread in Social Media

More than 67 percent of Americans obtain news from social media. Since many people share information without verifying facts, this leads to wrong public opinions and confusion, with those in the age group of 18 to 34 being most susceptible. This research project develops a tool to collect social media data (from Twitter) to study spread of information on various current topics. Stochastic control theoretic "short-term" and "long-term" models are developed to study the spread of rumors. Results show that rumors mainly spread due to "interactions between users" on a topic and not just the number of users actively spreading the news, particularly for subjective topics like sports (e.g., FIFA World Cup) and policies (e.g., immigration).



Computational Mechanics and Biomechanics Laboratory (CMBL)

The CMBL laboratory specializes in the computational mechanics and modeling of solid mechanics and biomechanics. Researchers develop computational methods and employ commercial algorithmics packages to address a wide range of scientific and engineering problems.

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ACTIVE PROJECTS

Biomechanical Evaluation of Fixation Implants for Proximal Femur Fractures

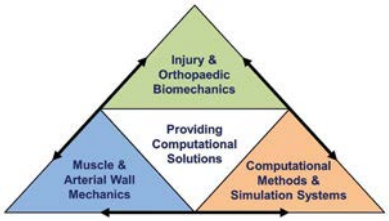
Computational modeling has become an indispensable modern method for orthopedic biomechanics, including implant mechanics and selection for bone fracture healing, without ethical concerns associated with in vitro or in vivo clinical studies. Our project aims to evaluate the biomechanical performance of commonly used internal fixation implants for femoral neck, intertrochanteric, and subtrochanteric fractures by developing a set of finite element models of femur-implant systems. The biomechanical advantages and drawbacks of each implant option are analyzed qualitatively and quantitatively under physiological realistic loading conditions. Our findings will provide valuable references for orthopedic device design optimization, as well as for clinical decision-making in the surgical treatment of proximal femur fractures.

Computational Methods for Hierarchical Modeling of Active Muscle Tissues

Skeletal muscles have a highly organized hierarchical structure, which made predictive modeling a cutting-edge multiscale challenge. The overall goal of this project is to provide a computational framework for the hierarchical modeling of active skeletal muscles, focusing on developing state-of-the-art computational methods and comprehensive FE models that can determine the mechanical roles of microstructure and provide predictive simulations crossing the length scales.

Numerical Simulations of the Non-symmetric Growth and Remodeling of Arteries Under Axial Twisting

Blood vessels are subjected to various types of forces/stresses, such as axial tension, twisting, and lumen pulse pressure during body movement or surgery. Sustained stress may lead to blood vessel growth and remodeling (for example, wall thickening due to hypertension). However, how vessel wall (extracellular matrix) grow and remodel under sustained axial tension/twisting are not fully understood. Our research goal is to explore the role mechanical stress plays in the growth and remodeling of blood vessels and the cardiovascular system due to injury or sustained stimuli using theoretical simulation and experiments, for better prevention and treatment of a variety of vascular diseases, such as stenosis, thrombosis, hypertension, vessel calcification, etc.



AREAS OF INTEREST

- Injury and Orthopedic Biomechanics
- Large-Scale Computer Modeling and Simulation
- Human Body Modeling
- Computational Mechanics and Finite Element Methods
- Cardiovascular Mechanics
- Vehicle Crashworthiness

Human-Robot Collaboration (HRC) Laboratory

In the newly formed HRC laboratory, we focus on control theory-based, data-driven learning techniques for improved control of exoskeletons, collaborative robots (co-bots), and semi-automated driving. In contrast to machine learning-based methods, our learning techniques provide provable guarantees (on the safety of the human operator in HRC). A central relates to the estimation of human intention in this collaboration.

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AREAS OF INTEREST

Dynamics and Control

Data-Driven Iterative Learning Control

Human-Robot Collaboration

APPLICATIONS: Exoskeletons, Robotic Manipulators for Collaborative Assembly, and Shared Driving of (Level 3) Semi-Automated Vehicles.

ACTIVE PROJECTS

Design, Modeling, and Control of an Upper-Limb Exoskeleton

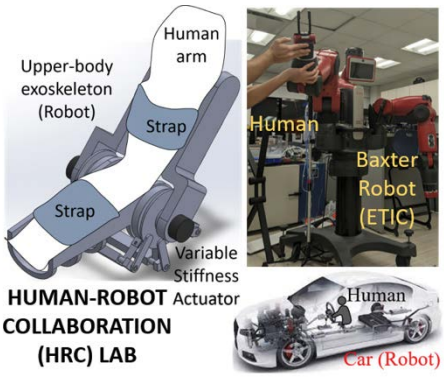
Exoskeletons are developed to restore and augment human functions and have potential applications for rehabilitation (physical therapy), improved occupational health in manufacturing and warehouse management, and military. In this somewhat new field of research, we are interested in making exoskeletons lighter and more comfortable for use. This involves 1) designing exoskeletons with joints that mimic the mechanical properties of human joints and 2) co-designing the controller. Currently, we are developing an upper-body exoskeleton for supporting the elbow and shoulder joints, the CAD rendition of a part of which is shown above.

Co-Bots for Collaborative Manipulation of Large and Heavy Objects:

Co-bots, or collaborative bots, are robots that assist humans on the factory floor or assembly line. By combining the dexterity and intelligence of the human operator with the strength, speed, and repeatability of the co-bot, much more efficient manufacturing processes can be generated. The challenges for the successful implementation of co-bots involve 1) accurate and quick estimation of human intention and 2) collaborative manipulation of the workpiece being handled. We are developing 1) methods that fuse surface EMG signals with other conventional sensing technology present on the robot for quick estimation of the human intention and 2) data-driven learning techniques that use the framework of control theory. We are working with the Baxter robot in ETIC for conducting experiments.

Optimally Shared Authority of the Steering Wheel in Semi-Automate Vehicles

Level-3 autonomous vehicles are primarily driven by a human driver and the steering controller intervenes (gives the steering wheel a kick) only when a potential danger is detected. Many modern cars have this functionality. A conflict arises in this shared steering wheel operation if the car (robot) does not estimate the human intention correctly. Currently, we are interested in high-speed highway driving, where the driver intentionally turns the steering wheel to move away from a trucker crossing over to the driver's lane and, in doing so, comes close to crossing over to the adjacent lane himself. If the car doesn't know the human intention here, it will kick the car back toward the trucker, which is life-threatening if the driver is not skilled enough to fight the robot.



MicroSensor Laboratory

This Laboratory is dedicated to the development of novel microsensors for biomedical, environmental monitoring, and aerospace applications.

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AREAS OF INTEREST

Acoustic Wave Sensors

Piezoelectric Transducers

Stretchable Electronics

Lab-on-a-Chip Devices

ACTIVE PROJECTS

Wireless SAW Sensor System for Cryogenic Temperature and Pressure Sensing

The goal of this project is to develop an innovative wireless sensor system that is capable of providing high-bandwidth measurements of cryogenic temperature and pressure inside a pipeline for rocket propulsion test applications. Our approach is based on the Surface Acoustic Wave (SAW) sensor technology, in conjunction with a wireless data communication scheme.

Signals in the Soil

The goal of this project is to develop a passive, low-cost, pervasive, maintenance-free sensor that can be interrogated wirelessly and provide measurement of soil water content, temperature, pH, and nutrient concentration for precision agriculture and environmental monitoring. This is a collaborative project with the faculty in the Electrical Engineering and Life Sciences departments. Our research group focuses on the SAW sensor design and development and polymer synthesis and testing for nutrient sensing.

Optical Diagnostics Laboratory

This laboratory conducts research and development in advanced optical diagnostics.

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ACTIVE PROJECTS

High-Speed Digital Holography of Acoustic Levitation

Acoustic levitation is a technique for suspending and manipulating objects using sound waves. One application of this technique is the containerless processing of materials, since the suspended objects do not contact solid surfaces. We study solid and liquid objects suspended in air.

To visualize and measure the acoustic field, we employ pulsed digital holography and measure the high-speed phase variations associated with the field. At the same time, we use the technique to measure the object's shape and position. These data can be used in fundamental studies of liquid droplet behavior and of nonlinear acoustics.

APPLICATIONS OF TECHNIQUES

- **Acoustic Levitation**
- **On-Engine Monitoring of Turbine Blade Temperatures**
- **Optical Gas Temperature Measurements**

OUR EQUIPMENT

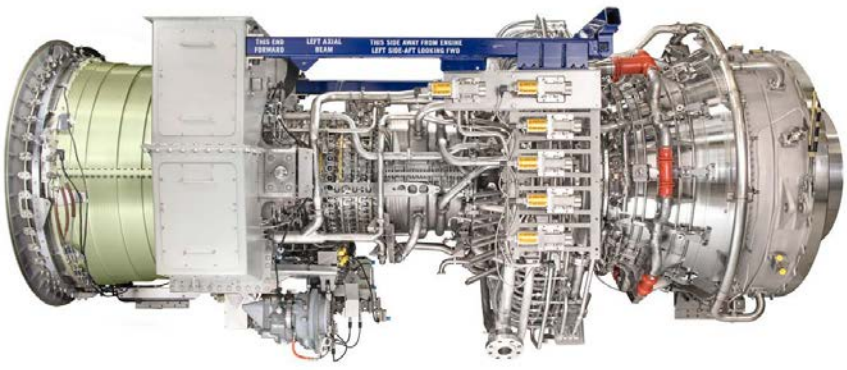
- **Custom-Built Pulsed Digital Holography System**
- **Photron FASTCAM Mini UX100 High-Speed Camera**
- **Sofradir PV640LW Microbolometer Thermal Camera**

AREAS OF INTEREST

Pulsed Digital Holography

Thermal Imaging

Active and Passive Infrared Spectral Measurements



Thermo-Fluid and Instrumentation Research Lab

This laboratory conducts research on thermal fluid science, laser diagnostics, and microsensors, utilizing mathematical analyses, computations, and experiments to develop and demonstrate prototypes across various physical disciplines including thermal fluid science, photonics, and mechanics, and shares a common practical focus on fluid dynamics and its applications.

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AREAS OF INTEREST

Dynamics of Unsteady Separated Turbulent Boundary Layer

Development of Skin Friction Sensors for Low Speed and Hypersonic Speed

Shock Wave Induced by Laser Pulses for Flow Control

Dynamics of Air Bubble Formation During Water Entry of Objects

Laser-Based Diagnostic

The lab is equipped with a research-grade wind tunnel and state-of-the-art equipment to carry out fundamental and applied research in advanced thermo-fluid dynamics.

ACTIVE PROJECTS

Characterization of Turbulent, Unsteady Separation Using Photonic Micro-Skin Friction and Wall Pressure Sensors (Army Research Office)

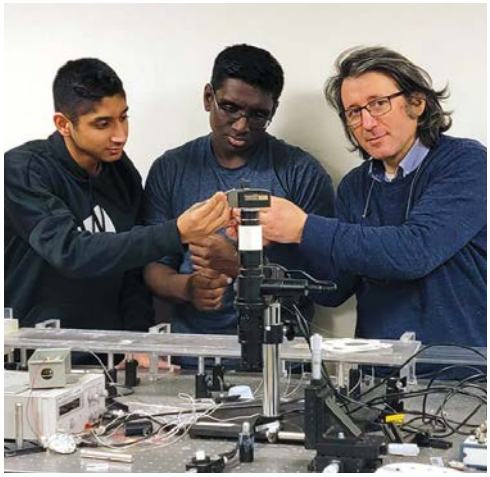
The goal of the proposed research is to study the structure and dynamics of separated turbulent boundary layers for Reynolds numbers in the range $4x103 < Re_\theta < 1.4x104$. The uniqueness of this study is the direct measurement of the streamwise and spanwise fluctuating skin friction and wall pressure simultaneously and at the same spatial location. Up-to-date, simultaneous direct measurements of skin friction and wall pressure at the same spatial location have never been carried out due to the lack of instrumentation. At the same time, detailed high-fidelity measurements of velocity and high-order moments will be measured and analyzed. The ultimate goal is to analyze the data in order to understand the physics beyond turbulent flow separation and the prediction of the onset and extent of stall in transient separated turbulent boundary layer.

Fabrication of Skin Friction Sensors Based on the Morphology Department Optical Resonances (Army Research Office)

The main goal of the project is to fabricate and test in a low-speed wind tunnel a photonic sensor for skin friction measurements. The sensing approach is based on the whispering gallery mode (WGM) of dielectric micro-cavities. In optics, the WGM phenomenon arises from total internal reflection of light at the internal surface of a high index of refraction dielectric resonator embedded in a surrounding medium of lower refractive index. The skin friction is measured by tracking the WGM shift. A key factor that makes this phenomenon attractive for sensor applications is the extremely high measurement resolution. For example, for a resonator of radius R ~100 μm, one obtains a "measurable" radius change of R = 10-11 m, which is smaller than the size of an atom.

Designing and Building a Low Speed Wind Tunnel (Army Research Office)

In this project, researchers are designing and building a hypervelocity wind tunnel for studying high speed and high-temperature gases as well as shockwaves for aerospace and energy applications.



Energy and Green Technologies (ENTECH) Laboratory

This laboratory, which opened in April 2019, represents a real-world environment providing students with hands-on experiences to create new knowledge in the energy and green technology disciplines. Researchers work in different energy generation, storage, and conservation methods.

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AREAS OF INTEREST

Physics-Based Building Energy Modeling (BEM) Using Computer Simulation Tools and Building Information Modeling

Urban-Scale Physics-Based Building Energy Modeling to Evaluate Energy Conservation Measures

Campus-Scale Buildings Digital Twins for Real-Time Energy Monitoring And Analysis

ACTIVE PROJECTS

Urban-Scale Physics-Based Building Energy Modeling

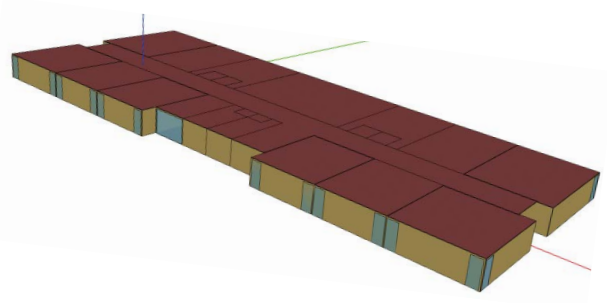
This project creates energy models for over 300,000 buildings in New York to evaluate their energy performance and predict how their energy consumption will be affected by climate change by the year 2099. The outcomes are used to better understand electricity loads in the building sector in the future and evaluate the most effective energy conservation measures.

Building Energy Modeling in 3D-Printed Buildings

This project focuses on facilitating and improving the energy performance modeling and simulation process in 3D-printed buildings. Such buildings are designed and built through a more automated process that enables integrating energy evaluation into the design process.

Physics-Based Building Energy Model – Campus Buildings

These campus building are located at New York Tech's Old Westbury. We collect different building data using wireless sensors and energy audit tools to develop a computer energy model. Revit, OpenStudio, and BIM files (gbXML) are used in this project. The goal is to study different data exchange scenarios, calibrate the building energy model, propose a zero-net-energy (ZNE) retrofit package, and provide a hands-on experience opportunity for students.



Artificial Intelligence, Data Mining, and High-Performance Computing Lab

This laboratory focuses on developing signal processing, optimization, and machine learning techniques for sensing and communications in future radar systems and 6G communications. The lab also focuses on developing physical layer security and authentication methods for wireless networks.

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AREAS OF INTEREST

- Data Science
- Artificial Intelligence
- Data Mining
- High Performance Computing
- Machine Learning
- Probability and Stochastic Processes

ACTIVE PROJECTS

Collaborative Research: CCRI: New: Nation-wide Community-based Mobile Edge Sensing and Computing Testbeds
National Science Foundation (NSF)

The proposed research infrastructure includes three organically connected functionalities to provide repeatable experimental environments, facilitate data/model-sharing, and join separated research groups on a national scale. In particular, this project develops mobile sensing functionalities for supporting compelling research in low-effort large-scale sensing data collection, robot-enabled experimenting, and privacy-preserved learning on mobile edge devices.

Source: nyit.edu/nsfaward

Human-Centric Data Analytics Laboratory

This laboratory aims to advance in the human-centered data analysis using signal processing, machine learning, and data mining with emphasis on developing computational methods, algorithms, and models for speech recognition and natural language processing.

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AREAS OF INTEREST

Data Science

Machine Learning

Multi-modal Affective Computing

Speech and Natural Learning Processing

ACTIVE PROJECTS

Towards Adaptive and Robust Multimodal Emotion Recognition In-the-Wild (supported by NSF)

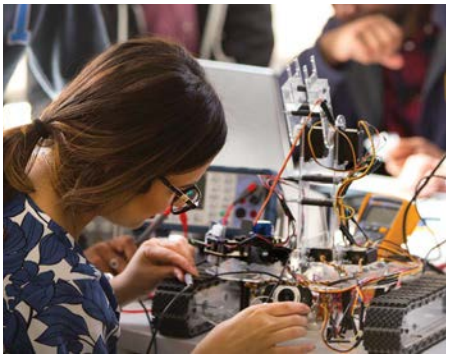
Emotions are essential to human life. They directly influence human perception and behaviors and have big impacts on people's daily tasks, such as learning, social interaction, and decision-making. Automatic emotion recognition has found applications in many domains, such as human-computer interaction, human-robot interaction, multimedia retrieval, social media analysis, and healthcare. Emotional states are expressed through a variety of channels, including facial expression, voice prosody, spoken words, and body gestures. Automatic emotion recognition in real-world applications is a challenging task. Real-world emotions involve subtle expressive behaviors, different degrees of expressiveness in different channels, and the imperfect conditions, such as background noise or music, poor illumination, and uncontrolled head poses. This research project aims to address the challenges of spontaneous emotion expressions and imperfect audio and video signals in the wild and develop a novel multimodal emotion recognition system for real-world applications. The research will lead to advances in data collection, algorithm design, and bench-marking for the next generation of affective computing.

Sequential Recommender System Based on Content Analysis and User Behavior Study (supported by New York Tech ISRC)

In the big-data era, users are increasingly overwhelmed by the information and choices available to them, the so-called "information overload" problem. Recommender systems (RSs) efficiently address the information overload problem by automatically suggesting to users items likely of their interests. Most traditional RSs predict user preferences by static analysis of user data and/or content information of the items. However, in real-world scenarios, both content and users are highly dynamic: New content is constantly added to the catalog and user interests are fast moving. As a result, the content popularity presents strong and complicated temporal variations. We propose a novel sequential recommender system based on multiscale dynamic content analysis and user behavior.

Data-Driven Approaches to Edge Caching

Today's online services, ranging from web hosting, video streaming, social media, and gaming to virtual, augmented, and mixed reality (VR/AR/MR) are increasingly dependent on the timely delivery of rich media content over the global internet. Modern content delivery systems are facing unprecedented challenges. One one hand, emerging new content requires significantly higher bandwidth. On the other hand, some new content also involves live interaction between users. In this collaborative project, we propose research on data-driven caching designs for deep-shallow cache networks. The core idea is to dig deeper into content and user data to learn long-term and short-term patterns in content and user interactions using machine learning models. We further develop hybrid dynamic caching polices and cooperative mining and caching designs for hierarchical cache networks. This is a collaborative project with faculty from New York University.



Intelligent Mobile Edge (IME) Laboratory

The IME laboratory focuses on research on the security and efficiency problems at the cloud-enhanced wireless mobile edge for the Internet of Things (IoT) applications, such as crowdsourced video generation and medical cyber-physical systems.

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AREAS OF INTEREST

- Sustainable Transportation
- Internet of Things (IoT) Applications
- Mobile Edge Computing
- Wireless Networking
- Mathematical Programming
- Data-Driven Optimization

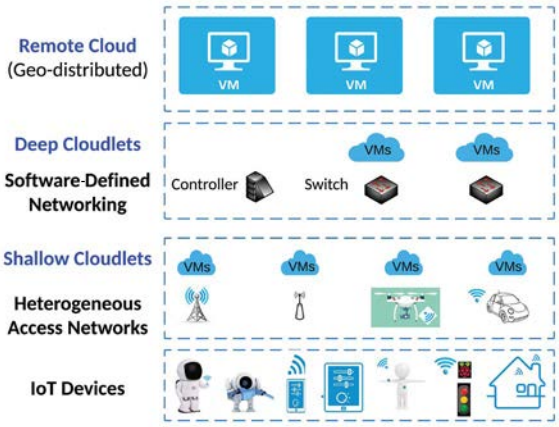
ACTIVE PROJECTS

Advancing Cooperative Video Generation and Distribution

With distance working/learning being the new norm, the video content produced and distributed by user devices has experienced a significant boom. The general public with a remote lifestyle is actively engaged in video crowdsourcing, which involves a large crowd of people in the video generation (e.g., turning on a webcam during a virtual conference), sharing (e.g., sharing videos via social media applications like Facebook Live), and viewing (e.g., video streaming) processes. To empower the crowd-sourced video content delivery at wireless mobile edge, we will investigate how to efficiently transmit data from the content generators to the viewers, where the edge computing resources can facilitate the efficient process of a high volume of user-generated data. The detailed problems include budget-aware server selection and radio/computing/storage resource allocation. The approaches include classical mathematical optimization and data-driven optimization (supervised learning and reinforcement learning).

Resilient and Sustainable Electric Vehicle-Enhanced Mobile Edge Computing

With the collaboration between the transportation industry and telecommunication industry (ICT) and given the recent advancements in renewable energy across the globe, electrifying and computerizing transportation is trending and an electric vehicle equipped with computing resources can be envisioned as one of the fundamental components in the future smart cities. At the electric vehicle-enhanced wireless mobile edge, we aim to provide reliable and smooth experiences in terms of communications, computing, and cruising, which are sharing a unified energy supply. This research objective will be achieved by using mathematical programming and data-driven optimization to understand the limitations inherent in the dynamic network architecture and energy utilization, and then leverage the gained insights to advance computing task offloading decision-making, network resilience, and the subsequent user-perceived quality of service of the proposed electric vehicle-enhanced mobile edge computing framework.



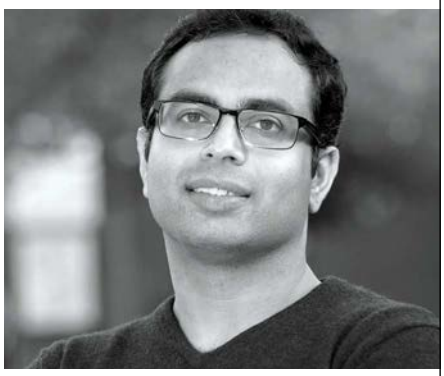
Intelligent Cell Maturation Monitoring and Promotion System

Heart disease is a leading cause of death in Western societies. The capability to direct the differentiation of human pluripotent stem cells into functional cardiomyocytes provides great opportunities for disease modeling, drug toxicity screening, and novel cell-based cardiac therapies. We will study how to quantify the cell maturity level similar to a doctor-defined pregnancy level of a human fetus. Meanwhile, the optimal electrical and mechanical stimulations will be selected and applied to promote cell maturation. The approach will be biostatistics analysis, machine learning (regression modeling), and reinforcement learning.

Laboratory for Behavioral Authentication, Machine Learning, and Privacy (LAMP)

The LAMP is a group of faculty, students, and visitors who enjoy doing research in machine learning and cryptography applied to privacy and authentication.

Paolo Gasti, Ph.D.
Lab Co-Director



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ACTIVE PROJECTS

Leveraging Movement, Posture, and Anthropometric Contexts to Strengthen the Security of Mobile Biometrics (sponsored by NSF)

Active authentication is emerging as a promising way to continuously and unobtrusively authenticate smartphone users post-login. Although research in this area has shown that behavioral traits, such as touchscreen gestures and device movements, can be used to distinguish a legitimate user from an attacker, fundamental questions about these traits still remain unanswered. These include: how, and to what extent, do posture and movement impact behavioral traits; what is the impact of human variability (anthropometric properties, age, gender, and health conditions) on behavioral traits; to what extent can these traits be spoofed using posture and movement observations; and how can we strengthen these traits against spoofing attacks. In this project, an interdisciplinary team of investigators from the Computer Science, Biomedical Sciences, Physical Therapy, and Art and Media Technologies at New York Tech will leverage capabilities in 3-D motion capture, behavioral biometric authentication research, and motor control research to address these questions.

Toward Energy-Efficient Privacy-Preserving Active Authentication of Smartphone Users (sponsored by NSF)

Common smartphone authentication mechanisms such as PINs, graphical passwords, and fingerprint scans offer limited security. They are relatively easy to guess or spoof and are ineffective when the smartphone is captured after the user has logged in. Multimodal active authentication addresses these challenges by frequently and unobtrusively authenticating the user via behavioral biometric signals, such as touchscreen interaction, hand movements, gait, voice, and phone location. However, these techniques raise significant privacy and security concerns because the behavioral signals used for authentication represent personal identifiable data and often expose private information, such as user activity, health, and location. This research advances the state-of-the-art of privacy-preserving active authentication by devising new techniques that significantly reduce the energy cost of cryptographic authentication protocols on smartphones. Further, this

(continued on next page)

research takes into account signals that indicate the user has lost possession of the smartphone, in order to trigger user authentication only when necessary. The focus of this project is in sharp contrast with existing techniques and protocols, which have been largely agnostic to energy consumption patterns and to the user's possession of the smartphone post-authentication. Current neurostimulators work in an open loop and thus their efficacy depends on the patient's or physician's comprehension of pain. We are developing a real-time automatic recognition algorithm to detect action potentials and cluster various neuronal activity levels.

HMOG: Hand Movement, Orientation, and Grasp (sponsored by DARPA)

Hand Movement, Orientation, and Grasp (HMOG) is a set of behavioral features to continuously authenticate smartphone users. HMOG features unobtrusively capture subtle micromovement and orientation dynamics resulting from how a user grasps, holds, and taps on the smartphone. In this project, we evaluated authentication and biometric key generation (BKG) performance of HMOG features on data collected from 100 subjects typing on a virtual keyboard. Data was collected under two conditions: sitting and walking. We achieved authentication EERs as low as 7.16 percent (walking) and 10.05 percent (sitting) when we combined HMOG, tap, and keystroke features. We performed experiments to investigate why HMOG features perform well during walking. Our results suggest that this is due to the ability of HMOG features to capture distinctive body movements caused by walking, in addition to the hand-movement dynamics from taps. With BKG, we achieved EERs of 15.1 percent using HMOG combined with taps. In comparison, BKG using tap, key hold, and swipe features had EERs between 25.7 percent and 34.2 percent. We also analyzed the energy consumption of HMOG features extraction and computation. Our analysis shows that HMOG features extracted at 16Hz sensor sampling rate incurred a minor overhead of 7.9 percent without sacrificing authentication accuracy.

Medical Informatics and Data Analytics Laboratory

This laboratory is devoted to research on biomedical ontology extraction and abstraction techniques, biomedical ontology quality assurance methodologies, and data analysis.

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AREAS OF INTEREST

Biomedical Ontology

Medical Informatics

Data Analytics and Data Mining

Object-Oriented Modeling

ACTIVE PROJECTS

Use of Machine Learning and NLP Techniques for Biomedical Informatic Knowledge Graph Construction and Enhancement

Biomedical terminologies have become an essential tool for research and health information systems. The goal of this research is to use the most current state-of-the-art machine learning and NLP techniques to construct and/or enhance biomedical ontologies. The Systematized Nomenclature of Medicine Clinical Terms (SNOMED CT) is used in the project.

Digit Pathology Application

In this project, we study how to use machine learning and image process techniques to help pathologists predicting clinical behaviors, integrating automated diagnosis into frozen section, identifying elements of interest from frozen sections, and virtual staining.

Mobile Systems and Network Security (MOBISEC) Laboratory

The MOBISEC laboratory focuses on applying machine learning and data analytics techniques to enhance the security and trust of mobile and wireless systems and networks.

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AREAS OF INTEREST

Security, Trust and Policies for Wireless Networks/Applications
Vehicular Networks, Internet of Things,

Cyber-Physical Systems Security of Mobile Devices/Systems
Malware Detection for Android Systems, Particularly in Presence of Machine Learning Attacks

Security/Trust for Blockchain and Applications

ACTIVE PROJECTS

Secure and Trustworthy Data Management for Intelligent Transportation System

In Intelligent Transportation System (ITS), traffic data is generally exchanged during the inter-vehicle communication. Embedded vehicle sensors can report their observations of abnormal road conditions, such as traffic jams, road construction, and accidents to other vehicles, as well as infrastructure-based ITS components. This helps not only in individual route planning, but also overall in traffic optimization. However, the sensor data received from other vehicles might be imperfect due to some environmental factors. For instance, two vehicles traveling in opposite directions might have traveled out of communication range before they successfully finish data exchange.

In this case, the received traffic data may be incomplete and meaningless. To make things worse, vehicles controlled by malicious entities may intentionally propagate fake traffic data so as to disturb the whole transport system and even cause crashes by feeding onboard controllers false information about the speed or movement of the vehicles ahead. Similarly, traffic updates from human sensors (for example, smartphone users) such as new tweets or Facebook status updates for real-time traffic status may also be imperfect due to both environmental factors and malicious intents.

Malware Detection for Mobile System Against Adversarial Machine Learning Attacks

As one of the key components for smart cities and its applications, mobile devices such as smartphones and tablet computers have made our daily lives much more convenient and enjoyable. Among various mobile operating systems, Android has become the leading operating system in terms of the percentage of mobile devices that are based on it. However, at the same time, Android devices are more susceptible to various security threats, including mobile malware, because of the large quantity of mobile users, as well as diversified mobile applications. In recent years, researchers have explored different means, including various machine learning algorithms to successfully detect malicious applications in Android devices. However, many of the existing malware detection systems have suffered from adversarial machine learning attacks, such as data poisoning attacks and evasion attacks, which are designed by malware authors to ensure that malware remains undetected by the traditional machine learning-based approaches.

Entrepreneurship and Technology Innovation Center (ETIC)

The ETIC is a business accelerator that brings together industry, government, and academia to foster economic development across Long Island and the New York City metropolitan region. The center provides support for start-up businesses, including entrepreneurial and high-tech training, commercialization guidance, networking opportunities, and staff recruitment.

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STUDENT OPPORTUNITIES

Students gain practical experience and develop entrepreneurial skills and professional networks that help them grow their careers after graduation. They learn to apply the theoretical knowledge they gain in the classroom to real-world, open-ended design projects with the guidance of industry experts and advisors.

NASA Prototyping Program

NASA has contracted with New York Tech to have ETIC student employees build technology prototypes based on existing NASA patents and create professional materials to market them. "The purpose of this agreement is to provide an operational structure and framework for NASA to move various unrealized and undeveloped intellectual property further towards commercialization through prototyping and production services available at (the ETIC)," said Kris Romig, the commercialization services lead at the NASA Johnson Space Center in Houston. Student employees are working to fulfill the terms of the contract with NASA. Selected students pursuing computer science, mechanical engineering, and electrical and computer engineering degrees are working to build the prototypes based on NASA patents, and Digital Arts students assist in developing instructional and marketing videos to help present the products to investors.

iNTEREST Series

The iNTEREST lecture series introduces attendees to technologies that are in high demand and have dedicated career paths. Attendees gain a theoretical background of the technologies, participate in live demos, and learn how to download them to start learning on their own and moving towards a new career.

Session topics include:

- Designing Computer Networks with Cisco Packet Tracer
- Creating Web Applications With C#
- Introduction to Cybersecurity as a Career
- Programming With Java
- Introduction to Raspberry Pi
- Introduction to Command Line Usage in Windows and Linux
- Introduction to Blockchain Technology
- Developing Applications with Microsoft Visual Studio
- Creating and Managing Databases Using Microsoft SQL Server
- Programming With Python
- Introduction to Kali Linux

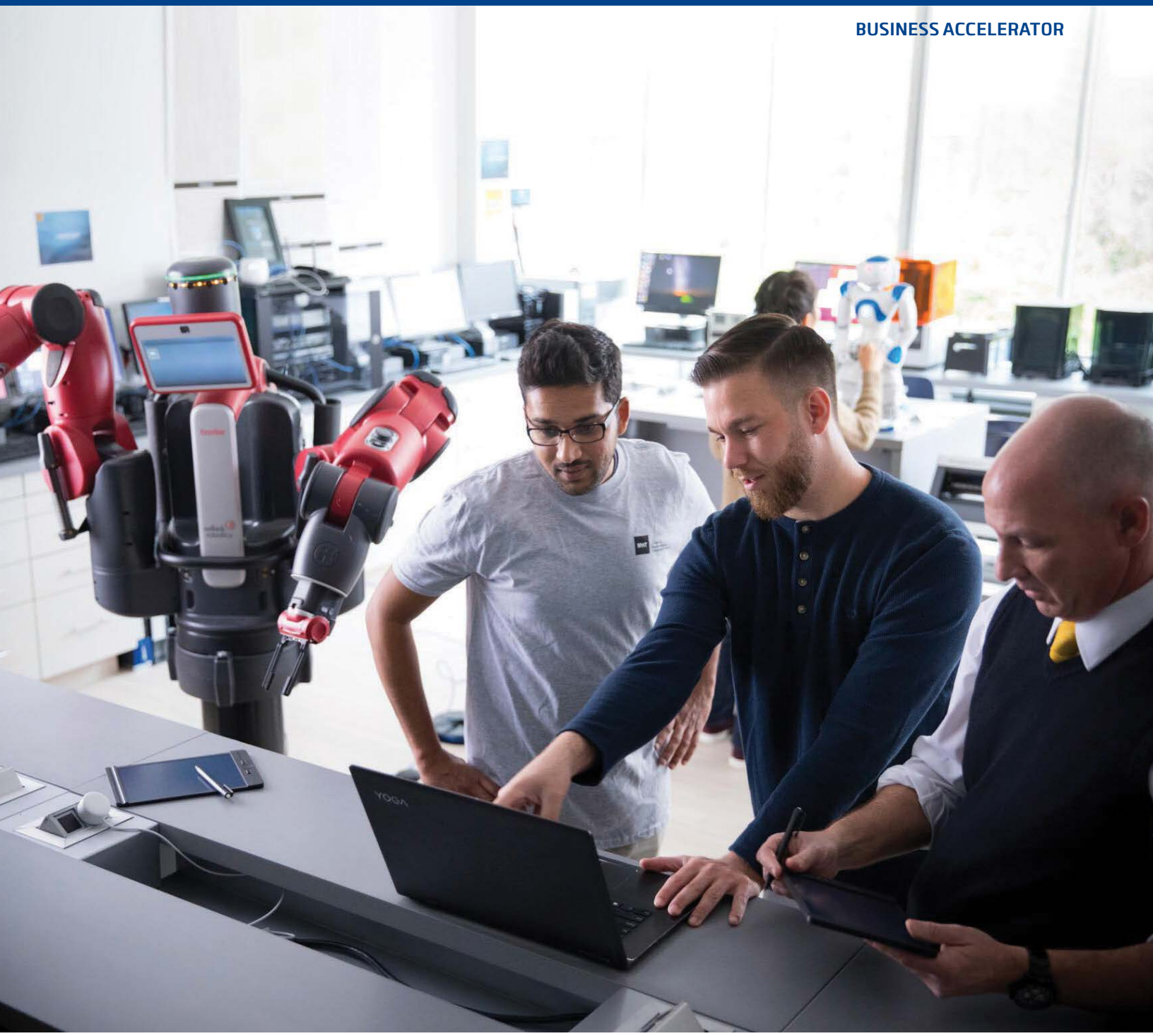
For more information: nyit.edu/interest

Entrepreneurship Program

Students learn entrepreneurial concepts and business philosophies through seminars and consulting sessions and are encouraged to explore their technology-based ideas and innovations. Each student's venture is treated as a real start-up company. The center provides business consulting services, business and prototyping supplies and guidance.

ETIC Cybersecurity Hackathon

At the Cybersecurity Hackathon, undergraduate and graduate students from the New York City, Long Island, and Vancouver B.C., campuses roll up their sleeves to take part in a six-hour competition. This virtual event introduces them to the fields of cyber-



security and cryptography. It is open to all skill levels and begins with an explanation of the challenge and ground rules. Participants then form teams of up to three students each and race to figure out the 15 challenges that were presented in zip files. The goal is to solve the most challenges in the shortest amount of time.

For a sample of a past event, visit: nyit.edu/etic_hackathon.

ETIC YouTube Channel

This channel offfers programs including:

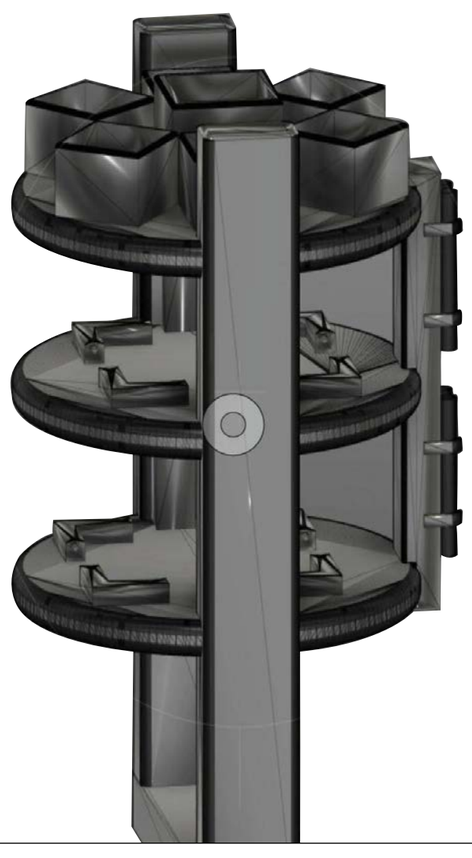
- **New York Tech Tips**—A series of short and informative tips for for using proprietary technologies
- **E.R.R.S.E.L.A**—A collaborative research program for students to engage in multiple engineering projects.
- **IEEE Industry Lecture Series**—A web-based lecture series from the Institute of Electrical and Electronics Engineering—hear from and interact with distinguished professionals in the tech industry
- **INTEREST**—Remote Engagement Sessions in Technology , a weekly online lecture series detailed above.

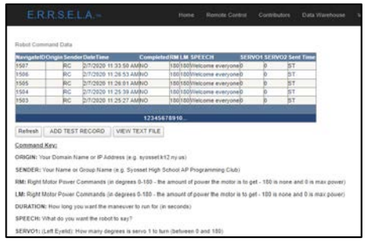
Watch at: youtube.com/@nyitetic.

ERRSELA

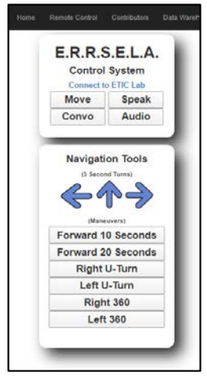
ETIC Research Robot for Student Engagement and Learning Activities

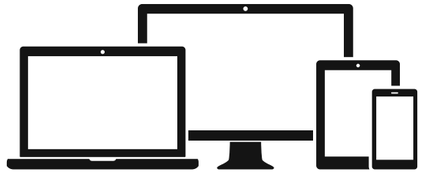
E.R.R.S.E.L.A.™ is a collaborative research and student engagement program founded by Dr. Michael Nizich. The program enables students from multiple disciplines and with varied skill levels to collaborate and participate in the robot's design and functionality. Students from New York Tech as well as students from various high schools and other regional colleges can participate in the design project to gain real-world experience in various areas of engineering and computer science.





Web and mobile interfaces allow control from any device.

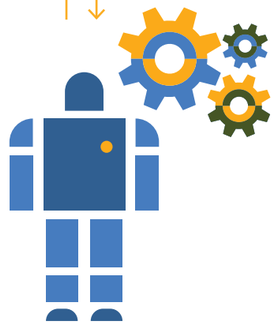




Programming languages such as Java, Python, C#, ASP.NET, or SQL enables ETC students stay engaged in various research projects.

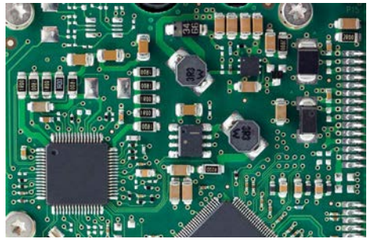
API enables student projects to work from anywhere.

A SQL Server database stores data for use in machine learning algorithms.



Basic machine learning algorithms allow ERRSELA to learn.

ERRSELA OS controls movement, speech, sensor operation, and data collection.



Raspberry PI Motor & Servo Controllers

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