SIXTEENTH ANNUAL

UNDERGRADUATE SUMMER RESEARCH PROGRAM ABSTRACTS

2022

2022 SUMMER RESEARCH

NYU Tandon School of Engineering's Undergraduate Summer Research Program (UGSRP) provides a unique opportunity for NYU Tandon, NYU Abu Dhabi, NYU Shanghai, NYU College of Arts and Science + NYU Tandon 3+2 Dual Degree Program, and other select students to engage in research over the course of the summer months. This program offers far more than the traditional classroom experience; it allows students to work alongside faculty mentors, PhD and masters students, as well as research staff on cutting-edge research projects. Aside from this, they get to interact with other students of all different levels from various fields of study within NYU and outside over a 10-week period. Aiming to enhance and broaden students' knowledge base by applying classroom learning to solve practical and contemporary problems, this program prepares all participants for lifelong learning.

Close interaction with faculty and research staff promotes an educational experience that advances Tandon's i2e model of invention, innovation and entrepreneurship. As such, Tandon's faculty participation in this program is essential. Along with the faculty, other Research Staff have extensively mentored the students, helping them to learn what research is and what the best practices are for their specific subject areas. In addition to the research performed, students participate in various workshops, lectures, and seminars throughout the summer. Matthew Frenkel joined the program for the third year through the provision of the Student2Scholar (S2S) Series where students learn more about moving towards scholarship. A tremendous thanks to him as well as the other guest speakers and lectures that provided the students with pertinent information and resources to ensure their future success. Detailed information is included of each event and the presenters are included later within this booklet.

Financial support from NYU Tandon, faculty research grants, and outside donors is also essential to the program's continuation. This year marked the 11th year of the Thompson Bartlett (TB) Fellowship. Ten of this summer's female researchers were graciously supported through this fellowship, made possible by Mrs. Dede Bartlett whose father, Mr. George Juul Thompson, was a graduate of the Electrical Engineering program at the Polytechnic Institute of Brooklyn in 1930. My infinite thanks goes out to Dede for her extended support of our women participants. The program houses additional fellowships, including the Tandon Scholars Fellowship, the IIIE Fellowship, and the Visiting Student Fellowship. Similar to Dede and the funding for these fellowships, donors' gifts allow us to engage more student researchers, faculty mentors, and further strengthen this truly unique summer experience.

The coordination of this program takes a large amount of effort. I would like to acknowledge Sara-Lee Ramsawak, Director of Undergraduate Academics & Global Programs, who has coordinated the UGSRP and ensured that the program's daily operations run seamlessly since 2013. Jen Piro, Associate Director of Undergraduate Programs, joined in on the coordination efforts in 2019 and took charge of the program's administration, especially the summer participant placements. Kat Arrendondo, Tandon's UGA Program Administrator joined in on the coordination of the program this year and spearheaded the end of program culminating event. Krysta Battersby, Sophie Chalsma, and Ananya Singh worked together to create this year's Abstract Booklet. A special thanks also goes out to the UGA Office Student Assistants, Angela Jiang and Bright Hu. A big thanks to the team!

After 2 years of virtual research, students had the opportunity to participate in in-person research on campus at NYU again. All of the seminars, workshops, and events were held virtually. At the end of the program, all students participated in a video presentation event where select students were chosen as winners. The abstracts published in this year's volume are representative of the research done this summer and celebrate the accomplishments of the undergraduate researchers. Congrats to all of the student researchers who participated in the 2022 Undergraduate Summer Research Program, thanks to the Research Staff and Dede Bartlett, and thanks to all the presenters, the coordinators, and the student workers. I look forward to future summers of continued intellectual and scholarly activities!

Peter Voltz
Associate Dean for Undergraduate and Graduate Academics

CONTENTS

FACULTY, MENTORS, AND RESEARCH STAFF

FACULTY

Jennifer Apell (CUE)
S. Farokh Atashzar (ECE, MAE, BME, CSE)
Eray Aydil (CBE)
Jonathan Bain (TCS)
Kurt Becker (TMI)
Justin Cappos (CSE)
Alesha Castillo (BME Langone)
Luis Ceferino (CUE, CUSP)
Weiqiang Chen (BME, MAE)
Joseph Chow (CUE)
Nicholas DiZinno (MAE)
Brendan Dolan-Gavitt (CSE)
Graham Dove (TMI, CUSP)
R. Luke DuBois (TCS)
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Chen Feng (CUE, CSE, MAE, CUSP)
Bruce Garetz (CBE)
Reginé Gilbert (TCS)
Nikita Grigoryev (CBE)
Nikhil Gupta (MAE)
Ryan Hartman (CBE)
Elizabeth Henaff (TCS, CUE)
Danny Huang (ECE, CUSP)
Amy Hurst (TCS)
Ramesh Karri (MAE)
Farshad Khorrami (ECE)
Jin Ryoun Kim (CBE)
Joo H. Kim (MAE)
Giuseppe Loianno (ECE, MAE)
Dzung Luong (MAE)
Miguel Modestino (CBE)
Jin Montclare (CBE)
Kaan Ozbay (CUE)
Shivendra Panwar (ECE)
Ingrid Paredes (GE)
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Quanyan Zhu (ECE)

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Mwanarusi Mwatondo
Charlie Mydlarz
Kelechi Ndukwe-Ajala
Riccardo Negri
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Shlok Joseph Paul
William Payne
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Hyunjong Song
Rayan Succar
Bing Yang Ta
Minh Tran
Harrison Trethowan
Will Wachter
Andrew Wang
Hang Wang
Xuchu Xu
Steven Yoo
Peng Zhang
Zhuoyu Zhang
Hanwen Zhao
Fan Zuo

CALENDAR OF EVENTS

Coordinated by Sara-Lee Ramsawak

JUN 6
Program Orientation
Sara-Lee Ramsawak, Jennifer Piro, & Kat Arredondo

JUN 6 to AUG 10
Student to Scholar Series (S2S)
Matthew Frenkel & Lindsay Anderberg
- What is Research?
- Developing a Literature Review
- Writing a Research Statement
- Developing a Research Proposal
- Ethics in Research
- Constructing a Research Poster
- Leadership Management Workshop
- Presenting Research
- Writing for Publication

JUN 9
Lab Safety Training
Emery McKinstry

JUN 15
MakerSpace Session
Molly Ritmiller

JUN 16
NYU Abu Dhabi Information Session
Lily Gjidija

JUN 23
NSF GRFP
Vikram Kapila

JUN 30
Pre-Capstone Information Session
Sara Thermer

JUL 7
Global Information Session
Colby Hepner

JUL 14
Vertically Integrated Products (VIP) Information Session
Maria Dikun & James Um

JUL 21
Tandon Graduate Admissions Information Session
Ryan Glowacki

JUL 28
Wasserman Presentation
Samantha Micek

AUG 12
Culminating Event
Sara-Lee Ramsawak, Jennifer Piro, & Kat Arredondo with the assistance of Angela Jiang and Bright Hu

UGSRP FELLOWSHIPS

The Undergraduate Summer Research Program is funded by various different entities across NYU, including both internal and external funding. Thank you to all of the donors who support the program. Thanks also to faculty who support UGSRP students through their grants. Some of the funds used for the programs go towards placing students into specialized fellowships.

THOMPSON BARTLETT FELLOWSHIP

11th Anniversary

- Supports summer research internships for ten outstanding female undergraduate students.
- Access to additional events and opportunities.
- Sponsored by Dede Bartlett, a career coach to thousands of college and graduate students across the U.S.A. Her lectures on career and work/life issues are drawn from her impressive background as a senior officer with two Fortune 500 companies.

IIIE FELLOWSHIP

- Supports summer internships for four exceptional undergraduate students
- Work over the summer via the Future Labs
- Sponsored by Dr. Kurt Becker, Tandon Vice Dean for Research, Innovation, and Entrepreneurship

SCHOLARS FELLOWSHIP

- Supports all Tandon GLASS Program Honors students within the UGSRP
- Access to additional funding for supplies and conferences as well as the possibility of housing

VISITING STUDENT FELLOWSHIP

- Supports non-NYU students within the UGSRP
- Allows for entry from students outside of the University
- Access to additional funding for housing

STUDENT RESEARCH REIMAGINED

This year we tried something innovative: we asked all research participants to create a 3-4 minute video about their summer research project geared toward a "non-STEM" audience. We wanted the students to use their soft skills and tap into their creative side when explaining their research to the general public. These are the winners from each of the Tandon Areas of Excellence between two categories: Most Innovative and Best Narrative. Check out more about our culminating event here. Click on the project titles below to read their abstracts.

MOST INNOVATIVE WINNERS

Cybersecurity/Wireless

First Place: "Lind"
Justin Koe
Faculty: Justin Cappos
Mentor: Nick Renner

Second Place: "Micro-Computed Tomography For Authentication of 3D Printed Composite Parts"
Aryan Rastogi, Aakar Jain, Diksha Sharma, Meenakshi Mandal
Faculty: Nikhil Gupta

Third Place: "TUF"
Eileen Twimasi
Faculty: Justin Cappos
Mentor: Marina Moore

Data Science/AI/Robotics

First Place: "Robotic Energy Expenditure: Electronics and Mechanics"
Daniel Plaza
Faculty: Joo H. Kim
Mentors: William Z. Peng, Hyunjong Song, Stacy Ashlyn, Vishal Oza

Second Place: "Racing Drones for Perching"
Daniel Tang
Faculty: Giuseppe Loianno
Mentor: Guanrui Li

Third Place: "Shocking Developments: CFD Simulations of Shock Waves"
Thomas Cuvillier, Yilin (Sheffield) Wang
Faculty: Nicholas DiZinno

Emerging Media

First Place: "Visual-Audio Integration for VR and AR"
Yunyi (Rainee) Wang
Faculty: Qi Sun
Mentor: Dong Woo (Steven) Yoo

Second Place: "Education Metaverse"
Elijah Whittle, Michelle Houchins, Andrew Sosunov
Faculty: Dzung Luong

Third Place: "Open Source Audio Technology - Bass Guitar Effects"
Michael Gardell
Faculty: R. Luke DuBois

Health

First Place: "Engineering Human Genomic DNA"
Deniz Ece Aydin
Faculty: David Truong
Mentor: Sarah Levovitz

Second Place: "Nanoparticles for Pain Therapeutics"
Ashley Han
Faculty: Nathalie Pinkerton
Mentor: Rachel Pollard

Third Place: "Erosion of Silica in Biological Buffers"
Nora Sherman
Faculty: Iwao Teraoka
Mentor: Natalie Luo

Sustainability

First Place: "Development of Flash Joule Heating Process"
Stonny Liu
Faculty: André D. Taylor

Second Place: "Physical Vapor Deposition of Quantum Cutting Materials for Increasing Solar Cell Efficiencies"
Kajini Sandrakumar, Rafa Saa Rodriguez, Joseph R. Geniesse
Faculty: Eray Aydil
Mentors: Iver Cleveland, Minh Tran, Yukun Liu, Seda Sarp

Third Place: "Underwater Solar Cells"
Alice Zhang
Faculty: André D. Taylor
Mentor: Jason Röhr

Urban

First Place: "Digital Model for Flooding in NYC"
Yi-Jen (Jennifer) Tsai, Megan (Meg) Fernandez
Faculty: Luis Ceferino
Mentors: Riccardo Negri, Bing Yang Tan

Second Place: "Response of Air-Backed Composite Panels to Hydrodynamic Loading"
Yichen Guo
Faculty: Maurizio Porfiri
Mentors: Peng Zhang

Third Place: "Future of Multiple Sclerosis Healthcare Work"
Xiyan (Christine) Wang
Faculty: Graham Dove
Mentor: Jason Röhr

Most Innovative: People's Choice

"Development of Flash Joule Heating Process"
Stonny Liu
Faculty: André D. Taylor

BEST NARRATIVE WINNERS

Cybersecurity/Wireless

First Place: "Pushing The Limits of Ultra-Low Latency Communication Networks"
Dimitrios Mastrogiannis
Faculty: Shivendra Panwar
Mentor: Fraida Fund

Second Place: "Preventing EMI Emissions Using MXene Film Protection"
Eros Kuikel
Mentor: Hammond Pearce

Third Place: "Analyzing Threats in 3D CAD Files to Mitigate Cyber Attacks"
Anant Chaturvedi, Alejandro Ortega, Kevin Jun, Janice M. Kangolongo
Faculty: Nikhil Gupta

Data Science/AI/Robotics

First Place: "Pedestrian Intention Prediction"
Lukelo Luoga
Faculty: Kaan Ozbay
Mentors: Jingqin Gao, Fan Zuo

Second Place: "Wearable Mechanomyography for Muscle Activity Analysis"
Afra Apshora
Faculty: S. Farokh Atashzar

Third Place: "Black Hole Interior Reconstruction and the Information Loss Paradox"
Herbert Ortiz, Kyle Lleras
Faculty: Jonathan Bain

Emerging Media

First Place: "Inclusive and Accessible XR Experiences"
Isabella Lopez
Faculty: Regine Gilbert

Second Place: "Open Source Audio Technology"
Ozioma Chukwukeme
Faculty: R. Luke DuBois

Third Place: "Accessible Interpretation in Historic Sites and Museums"
Maisha Mahrin, Ziyi (Claire) Huang
Faculty: Amy Hurst

Health

First Place: "Aquatic Bacteria"
Sunny Nath
Faculty: Nikita Grigoryev

Second Place: "Metagenomics Sequencing Studies"
Esther Wang
Faculty: Nikita Grigoryev

Third Place: "Thermal Uncaging of Light-Responsive Model Prodrug"
Vic Hempstead
Faculty: Nathalie Pinkerton
Mentor: Amy Moreno

Sustainability

First Place: "In-Situ Monitoring And Non-Destructive Testing For Additive Manufacturing"
Gabrielle Naquila
Faculty: Nikhil Gupta
Mentor: Youssef Abouel Nour

Second Place: "Upgrading Biomass To Fuels And CO2 Reduction Using Designer 2D Transition Metal Nanocatalysts"
Hao Xian Zheng
Faculty: Ayaskanta Sahu
Mentor: Steve Farrell

Third Place: "Sustainable & Equitable Food Systems"
Harry Rios, Lu YII Wong
Faculty: Alice Reznickova
Mentor: Wythe Marschall

Urban

First Place: "Accessibility For Everyone: Inclusive Design For Persons With Visual Impairment"
Lamia Tahsin, Joanna Ibrahim
Faculty: Maurizio Porfiri
Mentor: Fabiana Sofia Ricci

Second Place: "Developing Diversity & Equity Training for Undergraduate Engineering Teaching Assistants"
Kaz Burns, Mei Schuerch
Faculty: Ingrid Paredes

Third Place: "Computer Vision for Smart Cities"
Daniel Zhang
Faculty: Kaan Ozbay
Mentor: JingQin Gao

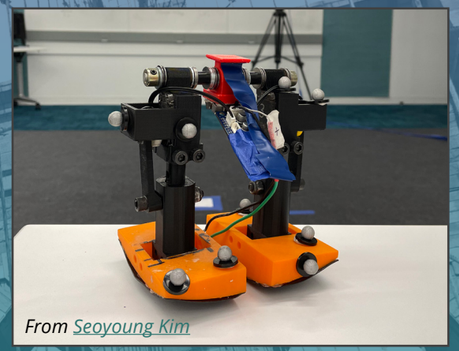
Best Narrative: People's Choice

"Accessibility For Everyone: Inclusive Design For Persons With Visual Impairment"
Lamia Tahsin, Joanna Ibrahim
Faculty: Maurizio Porfiri
Mentor: Fabiana Sofia Ricci

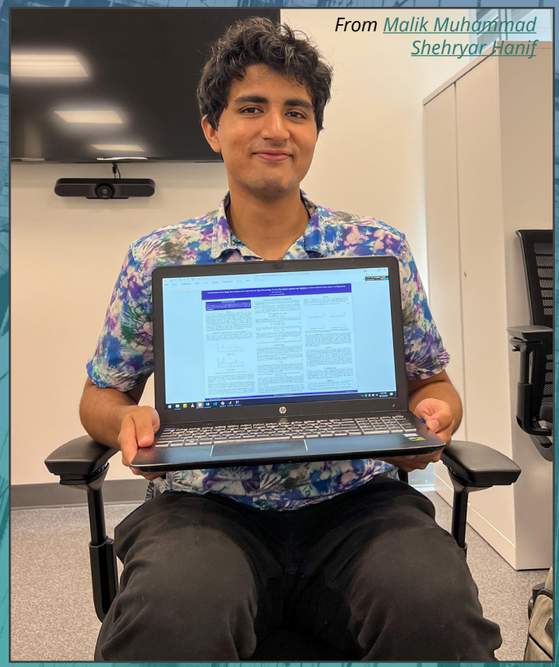
Summer 2022 winners' videos can be viewed here.

From Rashik Chand


From Rafaella Saa Rodriguez

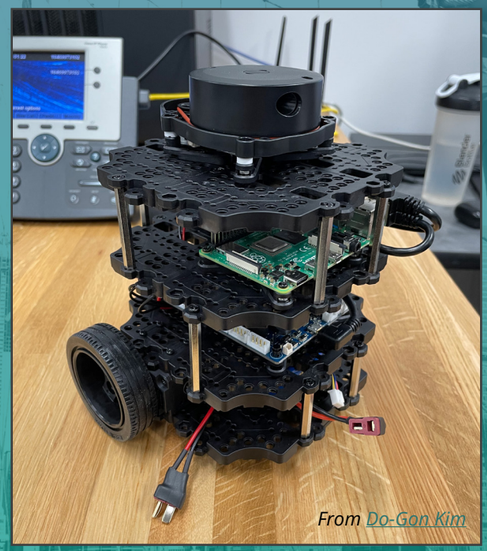

From Seoyoung Kim


From Do-Gon Kim

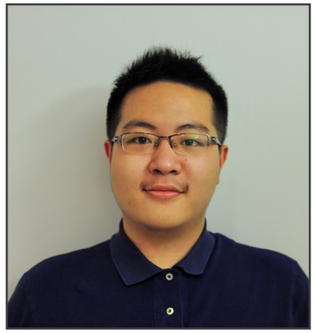

From Malik Muhammad Shehryar Hanif


From Isabella Lopez

From Megan (Meg) Fernandez


From Do-Gon Kim

BIOMEDICAL ENGINEERING



YICHEN GUO

Computer and Data Science, Psychology B.S., 2025
NYU College of Arts & Science

Faculty
Maurizio Porfiri

Other Mentor(s)
Peng Zhang

Response of Air-Backed Composite Panels to Hydrodynamic Loading

Marine vessels operating in extreme environments are frequently exposed to impulsive hydrodynamic loading. Composite materials are frequently employed in the design of marine vessels to withstand this loading condition; however, their response to hydrodynamic loading has not been fully investigated due to a lack of full-field, simultaneous measurement techniques. In this project, a series of experiments are conducted to study the dynamic response of air-backed composite panels to hydrodynamic loading. Specifically, a composite panel is positioned at an air-water interface, and loading on the panel is induced by the motion of a solid end-effector through water surface. Interaction between the panel and water is studied through a combined visualization technique based on particle image velocimetry (PIV) and digital image correlation (DIC). The velocity field is quantified through planar PIV, from which the hydrodynamic loading is reconstructed. Simultaneously, the deformation of the panel is measured through DIC. Through repeated trials using end-effectors of different shapes, the response of composite panels is systematically investigated at a range of hydrodynamic loading conditions. This study demonstrates a combined experimental method to quantify fluid-structure interactions, which could provide further insights in the design of marine structures.

DENIZ ECE AYDIN

Biomolecular Science B.S., 2025
NYU Tandon School of Engineering

Faculty
David Truong

Other Mentor(s)
Sarah Levovitz

GLASS Fellow

Genetically Engineering HLA Types for Personalized Cellular Therapy Applications

Cellular therapies have the potential to treat numerous diseases by introducing healthy cells into a patient's body. Pluripotent stem cells, with their ability to differentiate into any human cell type, are promising in providing patients with the required cells. While patient-derived stem cells are ideal, they are obtained through a costly process. However, allogeneic (donor-derived) stem cells also have a significant setback: the immunological incompatibility of the donor cells with the host can cause an immune response that can cease the positive outcomes of the treatment. The HLA complex, which is a highly polymorphic genetic system that functions in creating an immune response to foreign antigens, plays an important role in this process. The goal of our project is to synthesize 12 of the most prevalent types of the HLA class I locus in humans using Saccharomyces cerevisiae yeast cells. Upon synthesis, the HLA alleles will be inserted into the genome of pluripotent stem cells. This method will make it possible to create a bank of PSCs with essentially any existing HLA allele in the global population, without having to derive the cells from the patients. If successful, the synthetic patient-matched HLA containing pluripotent stem cells will be a personalized option in cellular therapies where the risk of immune response to the cells will be eliminated.

BIOMEDICAL ENGINEERING

YU XIE

Chemical & Biomolecular Engineering B.S., 2024
NYU Tandon School of Engineering

Faculty
Weiqiang Chen

Other Mentor(s)
Lunan Liu

Microengineering a Cancer-on-a-Chip Model for Cancer Immunotherapy Study Research Project

Pancreatic ductal adenocarcinoma (PDAC) is a deadly aggressive cancer that is most prevalent for pancreatic malignancy. The early diagnosis has little efficiency in detecting the PDAC, which causes no symptoms in the early stage until it becomes progressively deteriorates, passing the most curable period. In recent, immune checkpoint blockades (ICB) have proven to be an efficient therapeutic strategy in the treatment of tumors. Despite it, PDAC therapy is a continuous clinical challenge: tumor immunosuppression and microenvironmental heterogeneity serve as potential barriers to PDAC ICB treatment. To further analyze the ICB treatment on PDAC and mechanisms of resistance, an accurate methodology is imperative. This research aims to integrate the techniques of organ-on-a-chip and state-of-the-art organoids to develop a 3-dimensional vitro platform, which deeply mimics integrated organ-level functions as well as complex disease processes, for more precise immunotherapy screening. Such 'PDAC-on-a-chip' model allows researchers to develop and test various personalized immunotherapeutic strategies for PDAC patients, better retain the inherent trait and quantify the immunotherapy efficacy. We believe this powerful biomimetic model could help us gain a more accurate dissection of the microenvironmental heterogeneity and further improve patient response to ICB.

RASHIK CHAND

Bioengineering B.S., 2024
NYU Abu Dhabi

Faculty
Weiqiang Chen

Other Mentor(s)
Zhuoyu Zhang

Multiplex Test Strip Biosensor for Cytokine Detection and Immune Response Analysis

Biomarkers are molecules found in the body that mark the presence and development of disease. Proper identification and quantification of clinically relevant biomarkers is of great relevance for personalized medicine in terms of monitoring patient condition and progression. Clinicians can make crucial decisions regarding patient treatment based on these biomarkers. Cytokines are a broad class of small proteins that have been increasingly gaining much interest as biomarkers for various biochemical processes involved in pro-inflammatory and anti-inflammatory effects in response to infection. However, efficient and reliable measurement of cytokines still remains a major challenge. Current detection methods, such as ELISA, fail to provide a time-efficient assay that is sensitive to low concentrations of molecules. As a result, our project aims to develop and validate a rapid and minimally invasive test strip biosensor capable of multiplex analysis of target biomarkers. Through the fabrication of such a device, the immune response following infection can be more efficiently and accurately studied.

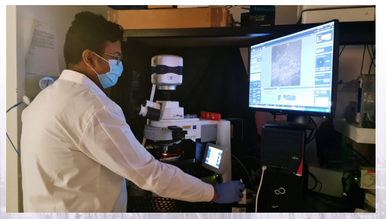
SAEE PATWARDHAN

Biomolecular Science/Biomedical Engineering B.S./M.S., 2025
NYU Tandon School of Engineering

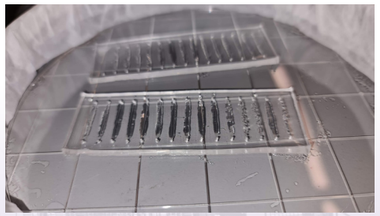
Faculty
Weiqiang Chen

Other Mentor(s)
Zhuoyu Zhang

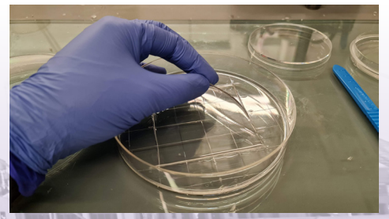
GLASS Fellow



Operating a dark field microscope to view the gold nanoparticles conjugated detection antibody attached to the capture antibody strip.



The PDMS film is lined with the capture antibody and allowed to incubate overnight.



Peeling the PDMS film off the Petri dish after incubation.

BIOMEDICAL ENGINEERING LANGONE

KAITY PACSAI

Biomolecular Science B.S., 2023
Biomedical Engineering M.S., 2024
Minor: Mathematics and Psychology
NYU College of Arts & Science
NYU Tandon School of Engineering

Faculty
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AYESHA SAMEER

Biomedical Engineering B.S., 2022
NYU Abu Dhabi

Faculty
Alesha Castillo

Other Mentor(s)
Tareq Anani

DANIEL WU

Biomolecular Science B.S., 2023
NYU Tandon School of Engineering

Faculty
Alesha Castillo

Osteogenesis-Angiogenesis Coupling During Bone Repair

One of the most critical events in fracture healing is reestablishment of a functional vascular network. Angiogenesis, the formation of new vessels from existing vessels, depends on both biological and mechanical cues, and growing evidence links the process of rebuilding a vascular network with the program of bone formation. Endothelial cells (ECs) receive signaling cues from adjacent ECs as well as from skeletal stem and progenitor cells (SSPCs), which reside in distinct niches. SSPCs have been shown to: (1) preferentially co-localize with vessels located at the endocortical surface and metaphysis in long bone; and (2) co-invade a bone injury with new vessels during repair. This close spatial relationship between SSPCs and ECs suggests functional codependency via cell-cell contact and/or paracrine signaling. The overall goal of this project is to elucidate the mechanisms underlying osteo-angio coupling in bone. To address this hypothesis, we will demonstrate functional codependence of SSPCs and vessels in bone injuries, evaluate SSPC-EC coupling during repair in loss-of-function and gain-of-function models, and identify key SSPC populations contributing to bone repair. Results from these studies will advance our fundamental understanding of mechanisms regulating osteogenesis-angiogenesis coupling during bone repair and may reveal a key signaling pathway regulating angiogenesis in bone. Our findings would directly impact pro-angiogenic biologics and current indications for autologous stem cell injections to treat diminished angiogenesis, delayed healing, and nonunion.

CHEMICAL AND BIOMOLECULAR ENGINEERING

ANJOLAOLUWA AJAI

Biomolecular Science B.S., 2023
NYU Tandon School of Engineering

Faculty
Nikita Grigoryev

Thompson Bartlett Fellow

CRISPR for Disease Modeling

A single nucleotide mutation in the PTPN22 gene has been found to be associated with many autoimmune diseases including Grave's disease, Type I diabetes, systemic lupus erythematosus, and rheumatoid arthritis. The mutation, C1858T, is a missense mutation that causes a change in the 620th codon from Arginine to Tryptophan (R620W) in humans. PTPN22 is the gene that encodes the lymphoid tyrosine phosphatase protein (LYP) which plays an important role in inhibiting TCR signaling. The R620W mutation is a gain-of-function mutation which causes the Lyp to inhibit TCR signaling more strongly, leading to an increased risk for autoimmune diseases. This mutation can be modeled in mice as an R619W mutation of the PTPN22 gene, which encodes PEP, the mice ortholog of LYP. In our research, we will be taking advantage of CRISPR/Cas9 genome editing, a robust tool that could be used to create an in vitro model of genetic diseases for the purpose of understanding their effects and developing drug targets. This research explores the use of CRISPR/Cas9 genome editing to model the single nucleotide polymorphism (SNP) in NIH/3T3 mouse cells. We start by designing three guide RNAs which we transfect into mice cells along with the donor DNA and Cas9 nuclease in order to create the desired SNP edit. We then measure the on-target genome editing efficiency of each guide RNA generated by non-homologous end joining activity (NHEJ) using a T7 endonuclease I based method. To accurately determine if the genome of the transfected cells contain the desired R619W SNP edit, we sequence the genome using the Illumina iSeq 100 system.

TASNIM AMRAN

Biomolecular Science B.S., 2024
NYU Tandon School of Engineering

Faculty
Nikita Grigoryev

Metagenomics

In the USA, it has been estimated that each year 560,000 people suffer from severe waterborne diseases, and 7.1 million suffer from mild to moderate infections, resulting in an estimated 12,000 deaths a year. Bacterial contamination of bodies of water used for recreational activities, such as swimming and fishing, have been attributed to various outbreaks of central nervous system, respiratory, and gastrointestinal illnesses in humans. Surveillance data from the United States of America (USA) showed that, during 2009 and 2010, there were 24 recreational water disease outbreaks associated with the use of natural waters. Escherichia coli, which are gram-negative bacteria that have been found to cause respiratory illnesses, diarrhea, and urinary tract infections, and Shigella, another type of gram-negative bacteria that has been also linked to diarrhea, cramps, and fever, are two pathogens that have been known to cause waterborne diseases. The 16S ribosomal RNA region is a highly conserved region in Bacteria and Archaea that contains 9 variable regions. Each variable region's sequence is particular to the type and class of the organism. Although the full V1–V9 region consistently produced the best results, the V3–V5 region produced good results for Klebsiella, and the V1–V3 region produced good results for Escherichia/Shigella. The purpose of this study is to utilize 16S Metagenomic sequencing to identify the presence of these two pathogens in various recreational bodies of freshwater in NYC using the V2 and V3 variable regions. After filtration of water samples, DNA is isolated from the samples using the Qiagen PowerWater isolation kit. The isolated DNA then undergoes PCR for amplification of V2 and V3 variable regions. After PCR, gel electrophoresis is done to ensure that PCR and isolation of the DNA has been done successfully. The amplified fragments are then further processed to prepare a sequencing library, which is sequenced on our iSeq100 system. After the variable region fragments have been sequenced, they are aligned and compared with already sequenced genomes of bacteria to identify which bacteria was present in the water sample to assess metagenomic distribution of bacterial species in the original samples.

CHEMICAL AND BIOMOLECULAR ENGINEERING

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The "Patient Zero" Concept From Tracing Outbreaks to Stigmatizing People, Groups, and Countries

The term "Patient Zero" refers to a person suspected to have initiated an infectious disease outbreak. A notable example was Mary Mallon, better known as Typhoid Mary, a healthy typhoid carrier forcefully quarantined for over two decades in the early 20th century. Vilified in stories and caricatures, Mallon's story became one of prejudice against a poor, female immigrant, and her treatment vastly contrasted with that of several contemporary men who infected at least as many people as she did. In the wake of the HIV/AIDS pandemic, Gaetan Dugas was relentlessly labeled "Patient Zero", called a "monster", and accused of bringing the virus to the Americas, leading to the stigmatization of the LGBTQI community. Years after his death, Dugas was exonerated based on molecular studies, but the stigmatization persisted much longer. The sensationalist media portrayal of Thomas Eric Duncan, the first Ebola patient in the US, led to discrimination against his fiancée, who was refused to rent an apartment, and against people born in or returning from Africa, often from locations far away from countries with Ebola. Carmela Hontou, the Uruguayan fashion designer connected to a COVID-19 outbreak after returning from Spain, was vilified on social media and required treatment for the resulting mental distress. Edgar Enrique Hernández was thrown into the media spotlight at only age five and called "virus boy" at school after being identified as the first patient with the H1N1 flu in Mexico. A year later an earlier case was identified in another town, and doubts emerged on whether the pandemic even originated in Mexico. In this project, we are exploring the utility of the concept "Patient Zero" for tracing outbreaks, along with the way that its use in the media can stigmatize and vilify individuals, groups, and countries, perpetuating stereotypes and discrimination in society.

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Fabrication of Polydimethylsiloxane Microfluidic Chip for Analysis of Dean Flow-Focused Microplastics by Flow Cytometry

Microplastics are plastic particles on a microscopic level, from lengths of 5 millimeters down to a few micrometers. Biologists and physiologists are currently conducting studies on how these microplastic particles could potentially be dangerous to marine life and human physiology. Current methods for the analysis of microplastics are time-consuming and they rely on trial-and-error and probability. By using microfluidics, a technique to manipulate fluids in channels with dimensions ranging a few micrometers, we can exploit fluid dynamics to bring the microplastics to spectroscopic analysis. In this study, we introduce an antisymmetric serpentine channel design on a polymer-based microfluidic chip that utilizes Dean flow to reorder the distribution of microplastics within the sample. The use of a polymer-based chip allows for reproducibility and an efficient system for microplastic focusing. The technique of Dean flow-focusing utilizes the flow-field created through the instability that builds up with curved channel geometries, consisting of two counter-rotating vortices that guide particles into a center region equidistant to the tube walls. Finally, spectroscopic methods will be used to analyze the vibrational and chemical frequencies of these microplastics, leading to a forthcoming conclusion about the bearing dangers of microplastics.

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Optical Characterization of Block Copolymers

Current lithium batteries in electric cars present many issues including poor battery life. One of the reasons lithium batteries break down easily is because within the battery dendrites tend to form on the lithium anodes reducing its efficiency and lifespan. This means the lithium in the solution tend to posit onto the lithium anodes forming growths which are known as these dendrites. This research focuses on investigating the structural properties of the block-copolymer and lithium salt complexes which are used in these batteries to find how to reduce the phenomenon of dendrites forming. This research specifically uses depolarized light scattering (DPLS) to observe the grain structure of the mixtures and these results are triangulated with small angle neutron scattering (SANS) experiments done in a partnering lab. Once these mixtures are properly studied perhaps the results can be used to determine which mixture is the most viable for use in lithium batteries. The results of our research has yielded a graph that could be used by others to determine the miscibility and immiscibility of any mixture of blends of poly(ethyleneoxide) (PEO), poly(styrene-acrylonitrile) – poly(methyl methacrylate) (PMMA) and bis(trifluoro-methanesulfonyl)imide (LiTFSI) salt.

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Protein Based Biomaterial for Therapeutic and Diagnostic Applications

Non-alcoholic fatty liver disease (NAFLD), a condition characterized by the accumulation of lipids in hepatocytes, affects a significant population of obese and diabetic adults. When NAFLD progresses to non-alcoholic steatohepatitis (NASH), these lipids cause inflammation and liver fibrosis, eventually leading to liver failure. This process results in a chronic deposition of type I collagen throughout the liver. Yet, current noninvasive diagnostic methods provide limited in-vivo information concerning the biodistribution of this triple helical protein. As a result, the Montclare Lab has devised a collagen type I-targeting thermoresponsive assembled protein (COL1-TRAP) to monitor the progression of liver fibrosis in NASH. This protein consists of a cartilage oligomeric matrix protein coiled-coil (C) domain, elastin-like peptide (E) regions, and a collagen-binding tag. Through non-canonical amino acid incorporation, COL1-TRAP can be imparted with additional chemical functionality, enabling highly specific chemical conjugation reactions. This new COL1- TRAP variant containing azidohomoalanine, an analog of methionine, can then be utilized for SPECT imaging through a cycloaddition linkage with metal chelating alkynes.

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The Development of Optimized β-Glucosidases

This project aims to optimize the nature of β-Glucosidases to usher in more efficient bioethanol production. In combination with exoglucanase and endoglucanase, β-glucosidase converts discarded plant material, called lignocellulosic waste, into glucose, which is fermented into bioethanol. The analysis of β-Glucosidases from the bacteria Pyrococcus Furiosus and Talaromyces Amestolkiae undergone by this project aims to produce a more efficient enzyme that is currently the bottleneck in the process. Enzymatic characterization is fundamentally split into a combination of thermostability and enzymatic efficiency. As Pyrococcus Furiosus is hyperthermophilic and lives in 100°C water, the β-glucosidase it produces is exceptionally thermostable, although not very efficient. Talaromyces Amestolkiae, on the other hand, has an efficient β-glucosidase, which is not particularly thermostable. Using HotSpot Wizard, specific mutant libraries were made to provide improved characteristics in the two enzymes and analyzed through a screening method utilizing esculin hydrate and ferric ammonium citrate. The colonies producing the most promising mutations were further isolated, characterized through UV spectroscopy, and sent for genetic sequencing of the mutation present. In addition, this project produced a database of the genetic diversity in β-glucosidases among a plethora of organisms, in the interest of developing a machine learning algorithm to predict the efficiency and thermostability of proposed mutants, to assist in a heightened rate of β-glucosidase optimization.

CHEMICAL AND BIOMOLECULAR ENGINEERING

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NanoParticle Library for Optimizing Neuronal Drug Delivery

Rapid developments in nanomedicine and nanodelivery systems for neuronal drug delivery are inevitable due to the potential for targeting tissues and cells, exceptional circulation time, and stability. With these new developments, our understanding of commonly used block co-polymers as materials used for nanoparticle shells is challenged and our knowledge of alternatives is lacking. Therefore, we need to research other biocompatible polymeric materials, their ability to form nanoparticles, and interactions with neurons to obtain optimal effectiveness for shuttling encapsulated drugs to neurons in vitro and in vivo. We are designing a nanoparticle library of varying surface chemistries by using the flash nanoprecipitation (FNP) assembly process and creating micelles with poly(ethylene glycol -b-poly lactic acid) (PEG-PLA), poly-2-ethyl-2-oxazoline-b-PLA (P2OX-PLA), and a newly synthesized poly(hydroxylethylmethacrylate)-b-PLA (PHEMA-PLA). Through this process we are able to tune the size of the nanoparticles and develop an understanding of their assembly mechanics, potential uptake kinetics, and stability through visual characterization and dynamic light scattering. Nanoparticles with PEG-PLA and P2OX-PLA successfully developed the predicted sizes, whereas nanoparticles with PHEMA-PLA exhibited unstable nanoparticle assembly dynamics. We suspect that PHEMA-PLA solubility in water depends on their molecular weight and that smaller chain lengths will result in more predictable nanoparticle formation. With these new results we are closer to understanding the nanoparticle design and research for chronic conditions such as neuropathic pain.

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Thermal Uncaging of Light-Responsive Model Prodrug

Encapsulation of therapeutic agents in nanocarriers has the potential to improve control over localized drug delivery. These nanocarriers can be designed to release encapsulated molecules in the presence of external stimuli, such as biological conditions or UV exposure. The use of light sensitive carriers is useful since the method can be remote, minimally invasive, and easy to manipulate through wavelength, intensity, and duration. Although UV sensitive nanocarriers, which release drugs through the disruption of the external nanocarrier itself, have been explored previously, more research is needed to understand the potential of encapsulating UV sensitive drug platforms. These platforms can release therapeutic agents through photochemical processes, known as light responsive uncaging. O-hydroxycinnamic acid is a platform which can uncage a small molecule along with a fluorescent co-product. These products can then be quantified to calculate the concentration of the drug released. However, in addition to UV exposure, uncaging can also be thermally induced. To properly understand this mechanism and potential applications of this platform, O- hydroxycinnamic acid's rates of release and rates of degradation need to be quantified in a variety of conditions. This project seeks to quantify the rate of uncaging from the O- hydroxycinnamic acid platform with respect to temperature.

CHEMICAL AND BIOMOLECULAR ENGINEERING

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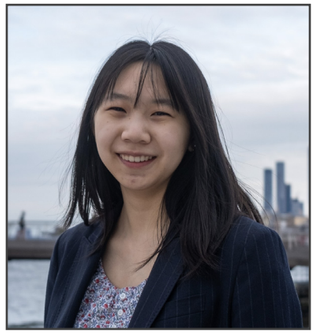
Amyloid Protein Aggregation

Two main amyloid protein aggregations are alpha synuclein and beta amyloid. These two proteins cause Parkinson's and Alzheimer's disease, respectively. They go through the same modification from monomer and oligomer to fibril. There are several different ways to detect these proteins, but in professor Kim's lab, we are to use ThT method. According to past experiment, among characteristics of each stage of amyloid proteins, monomer sample's intensity of ThT Fluorescence decreased after a few days. Moreover, there are different methods to detect the interaction between alpha synuclein and beta amyloid for each state of monomer, oligomer, and fibril, which shows that alpha synuclein fibrils hindered soluble beta amyloid from converting into insoluble aggregates by the formation of large oligomers. However, it is not possible to recognize that beta amyloid fibrils dissociate over the course of our study and remain structurally unchanged. This project aims to characterize and modulate amyloid aggregation of proteins, including those intrinsically disordered and natively folded. Amyloid aggregation of many intrinsically disordered proteins is disease-associated. Amyloid aggregation also represents an overlooked mechanism by which industrially important enzymes inactivate. The main goal for the whole 10 weeks is to optimizing purification of Tau protein including cationic exchange and size exclusion.



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Engineering and Characterization of Fluorinated Thermoresponsive Assembled Protein for Theranostic Application

Glioblastoma Multiforme (GBM) is the most common primary brain tumor. Notably, GBM has no known cure, and current treatments present a poor prognosis, where only 4-5% of patients survive more than five years, their typical survival time being around 15 Months. The greatest challenge with glioblastoma treatment is the inability of small molecule chemotherapeutics to cross the blood-brain barrier (BBB). To overcome this challenge, our lab has engineered a protein called near-infrared fluorinated thermo-responsive assembled protein (NIR-F-TRAP). NIR-F-TRAP contains a fluorescent tag and a surrogate amino acid called trifluoroleucine (TFL) that replaces leucine residues, cumulatively endowing F-TRAP with fluorescence as well as fluorination. F-TRAP has been designed as a theranostic agent to perform therapy through thermoresponsive drug release and diagnosis via fluorine magnetic resonance imaging (19F-MRI). F-TRAP was characterized and found to form self-assembling micelles; capable of encapsulating and releasing small therapeutic molecules. It was further characterized through dynamic light scattering (DLS), revealing its micelles ~30 nm in diameter. Through circular dichroism (CD), we confirmed its α-helical structure consisting of a hydrophobic pore that encapsulates the chemotherapeutic doxorubicin. In vivo data suggests that F-TRAP exhibits desirable pharmacokinetic properties with a half-life of about 112 minutes and a favorable plasma retention time. Our studies also indicate successful delivery of the drug-encapsulating fluorinated nanomaterials as a trojan horse across the generally impermeable BBB. Animal studies using doxorubicin-loaded F-TRAP have also shown successful tumor shrinkage, potentially making F-TRAP a powerful theranostic agent.

CHEMICAL AND BIOMOLECULAR ENGINEERING

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CEC-dopa as a Protein Hydrogel for Wet Adhesive

Wound healing involves a stage of inflammation, which can be prolonged in patients with diseases such as diabetes, leading to discomfort and poor patient outcomes. Hydrogels have the potential to promote recovery, serving as scaffolds for sustained drug release. Many hydrogels available today are either harmful to the patient or dysfunctional in wet environments. To address this, we are investigating CEC-DOPA as a possible wet-adhesive hydrogel for drug delivery. Our lab has engineered CEC, a triblock polymer composed of two cartilage oligomeric matrix protein coiled-coil domains (C), and one elastin-like polypeptide domain (E). It has good mechanical properties, is able to bind to small molecules, and responds to stimuli such as temperature, pH, or cation concentration. Previous work has successfully created photopatterned hydrogels that sustain small molecule release, and ongoing work incorporates non-canonical amino acids into the hydrogels to further increase adhesive properties. Dihydroxyphenylalanine (DOPA) is a non-canonical amino acid found in naturally occurring adhesive proteins in mussels. The residue-specific incorporation of DOPA into CEC produced a variant with increased adhesive properties through increased hydrogen bonding with other surfaces. To better understand what contributes to CEC's mechanical properties, we compared two incorporation processes of DOPA: post-translational modification of tyrosinase, as well as residue specific incorporation. The characterization of CEC-Y as a negative control and CEC-DOPA confirmed the adhesive properties of DOPA. Having expressed CEC-DOPA and CEC-Y, the differences in structure and mechanical properties were characterized using circular dichroism and rheology. The results of CEC-DOPA constitute a step towards a photo-patterned, wet-adhesive hydrogel drug delivery system.

CHEMICAL AND BIOMOLECULAR ENGINEERING

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Novel Synthesis of Cobalt Doped Carbon Fiber Catalyst via Electrospinning and Flash Joule Heating

Hydrogen fuel cells, fertilizer synthesis, polymer generation are all reliant on the oxygen reduction reaction (ORR) and or the hydrogen evolution reaction (HER). While the ORR and HER are fundamental for many advances in renewable energies, it has long been limited by expensive and non-renewable Pt based catalysts. Cobalt-nitrogen doped carbon materials have been repeatedly shown to be effective catalysts for the OER and HER reactions due to the thermoneutrality of the half-step reactions involved, and offer a potential substitution. Herein we use Flash Joule Heating (FJH) to graphitize stabilized and cross linked polyacrylonitrile fibers in a fast, safe, and scalable method to produce cobalt-nitrogen doped carbon fibers as a replacement to traditional ORR and HER catalysts.

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Optimizing Silver Selenide Interdigitated Electrodes for High Sensitivity Near Infrared Imaging

Near infrared imaging has promising potential applications including but not limited to detecting crop conditions, enabling night vision, and studying changing weather patterns. In the technology, colloidal quantum dots, which are semiconductor particles a few nanometers in size, are used as photodetectors, converting absorbed light in the range of 700 nm to 1400 nm into electrical current. In our work, we study silver selenide (Ag2Se), for its potential as a near infrared photodetector. By manipulating particle sizes, ligands, annealing parameters and dopants, we can alter the electrical properties of silver selenide. Interdigitated electrodes, which are electrode structures infused in a comb-shaped arrangement, serve as a substrate for depositing silver selenide quantum dots and as a tool for measuring the properties of silver selenide at different spacings. By evaluating the impact of each factor on the rise of conductivity and responsivity of the silver selenide interdigitated electrodes device, we aim to optimize Ag2Se interdigitated electrodes for high sensitivity near infrared imaging.

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Electrosynthesis of Adiponitrile from Acrylonitrile and Tetrabutylammonium

Nylon 6,6 is a polyamide widely used in textiles, plastics, and a variety of other industries. With a growing demand for Nylon 6,6, it becomes increasingly necessary to investigate sources of carbon emissions in its production. The synthesization of Nylon 6,6 comes from organic compound hexamethylenediamine. An important precursor to hexamethylenediamine is adiponitrile (ADN). ADN is produced in one of two ways. The first method is the hydrocyanation of butadiene, which is an energy intensive process carried out at high temperatures. The second method is the electrochemical hydro-dimerization of acrylonitrile (AN). This method does not require high temperatures and can be powered from renewable sources of energy. However, the efficiency and yield of this method has not been maximized, as there are undesired reactions that compete with the production of ADN. Many factors in the reaction can contribute to the selectivity and yield of ADN. Temperature, pH of solution, and even cathode materials have been shown to affect selectivity. One promising factor in increasing ADN yield is the composition of the electrolyte solution. Previous studies have shown that solutions containing tetrabutylammonium (TBA) as a supporting electrolyte greatly improved selectivity and ADN yield. However, it is unknown how the concentration of AN in relation to this electrolyte affects the selectivity.

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Filtering Aquatic Bacteria

Clean drinking water is still out of reach for most residing in developing countries. While there have been many attempts to bring some of the proven techniques to sanitize water to these areas, many cannot be implemented due to the differences in our location, economy, or culture. The developing countries have created some of their own techniques to make their water more palatable. These include using the sunlight, the peels of fruits, and an assortment of clay pots filled with different materials. This study aims to use 16S rRNA sequencing to observe which bacterial groups are targeted by the different methods and to determine which one is the most effective. 16S rRNA sequencing targets the 16S rRNA gene that is the blueprint for the small subunit (SSU) of a prokaryote's ribosome. The gene contains multiple hypervariable regions that identify which species of bacteria this DNA originated from. Water collected from Westchester Creek throughout the course of a week and divided into different samples. The samples were subjected to various purification methods. The DNA from the bacterial population of the filtered water is isolated and undergoes a preliminary PCR round with primers targeting different regions. These universal primers bind to 16S DNA regions, which are amplified by PCR. After determining which regions to focus on and which primers to use, the untreated DNA is further processed. Following amplification with a first round of PCR, samples go through DNA clean-up, and an additional PCR that attaches primers with Illumina library overhangs. These sequenced DNA fragments are then compiled and aligned against known 16S Metagenomic sequences to assess bacteria distribution before and after purification.

CHEMICAL AND BIOMOLECULAR ENGINEERING

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Electrochemical Synthesis of Adiponitrile from Glutamic Acid

Adiponitrile is a colorless and oily liquid used as a corrosion inhibitor, solvent, and rubber accelerator. Additionally, it is an important chemical used in producing hexamethylenediamine (HDMA), which in turn is used to produce nylon fibers and resins. The variety of uses of this strand of nylon in electronic, automotive, chemical, and healthcare sectors lend to the growing demand for the production of adiponitrile. The chemical has several different industrial routes for synthesis, but they are all mostly based on petroleum resources that require external nitrogen sources. Due to environmental concerns and declining fossil fuel supplies, it's necessary to find efficient methods of deriving adiponitrile from renewable resources. One specific route is a biomass-based synthesis of adiponitrile from glutamic acid. The pathway utilizes electrochemical methods under mild conditions to convert glutamic acid to glutamic acid 5-methyl ester (Glu-Me), then to 3-cyanopropanoic acid methyl ester (CPA-Me), and then to adiponitrile via the Kolbe coupling of potassium 3-cyanopropanoate (CPA-K). The established pathway creates adiponitrile solely from renewable materials, however, its production efficiency must be improved in order to use the electrochemical pathway as the main method of synthesis. The conditions in which adiponitrile is synthesized from CPA-Me are studied and engineered to optimize adiponitrile production.

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Membrane Characterization for Application in Redox Flow Batteries

Clean water is a scarce resource in many parts of the world. Although scientists and engineers have developed various solutions to resolve this crisis, many of these solutions lack economic and operational efficiency. A promising novel technology that has gained attraction for its low cost and high efficiency in the past decade is redox flow batteries. While also utilized for energy storage, these electrochemical flow batteries provide the capability to remove salt from water. Key components inside the redox flow batteries include cation exchange membranes, an anion exchange membrane, and a redox-active solution. In this research, the focus is to optimize the durability of these batteries by characterizing different ion- exchange membranes. Membranes utilized in the battery allow for the transport of ions within a salt solution but have the tendency to react differently with various redox couples. This creates a problem known as membrane fouling; redox-active material accumulates on the surface of the membrane and gets stuck in the microstructure of the membrane preventing ions from transporting through the membrane. Utilizing methods of electrochemical impedance spectroscopy, chronopotentiometry, and chronoamperometry, researchers at New York University's Transformative Devices & Materials Lab collect data on electrical resistivity to better characterize these membranes and develop membrane and redox couple combinations which will reduce fouling to increase the durability and decrease the cost of the desalination system.

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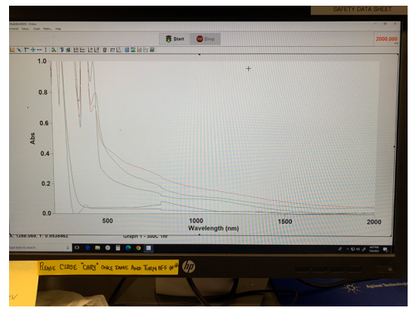
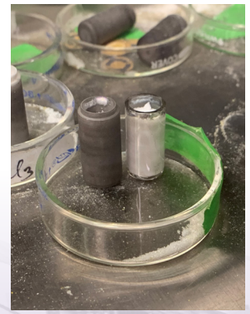
Synthesis of Cesium Sodium Bismuth Bromide Thin Films via Physical Vapor

Advancements in silicon solar cell efficiency have plateaued in the last two decades. One reason for this is the poor external quantum efficiency in the blue and ultraviolet (UV) region. Another reason is the mismatch between the silicon absorption and the sun's spectral distribution: silicon solar cells convert infrared to current more efficiently than UV or blue light. Ytterbium-doped inorganic halide perovskites have garnered attention for applications in high- efficiency solar cells, as they exhibit quantum cutting (QC), generating two near-infrared (NIR) photons (1.25 eV) from each blue or UV photon absorbed at energies >2.5 eV. Such materials address the current deficiencies in solar cells by shifting blue and UV photons to the NIR region, where silicon solar cells are more efficient. Current leading QC materials utilize lead which is toxic and the photoluminescence quantum yield (PLQY) of these materials decreases at high photon fluence, thus developing lead-free QC materials is of interest. A novel double perovskite, Cs2NaBiBr6, was synthesized by depositing thin films using physical vapor deposition. The effects of precursors' fluxes, substrate temperature, and post-deposition annealing conditions on the films' optical properties were investigated. Structural and optical properties of Cs2NaBiBr6 were characterized using X-ray diffraction, Raman, absorption, and photoluminescence spectroscopy. The material was observed to decompose in air after long exposure and thus further research must be done to understand its structure and stability. The bandgap of Cs2NaBiBr6 was found to be comparable to that of other perovskites studied, which indicates that it is a promising candidate for a lead-free quantum cutting material if it can be stabilized.





CHEMICAL AND BIOMOLECULAR ENGINEERING

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Non-Photochemical Laser Induced Crystallization Using Microfluidic Devices

The principle behind crystallization is nucleation, which is the beginning of a material's phase change without alteration of its chemical formula. Nucleation can occur spontaneously or be induced by an external force. The aim of this study is to increase the rate of nucleation in pharmaceutical compounds by inducing it with a laser. This nucleation method offers a great degree of temporal control of nucleation by manipulating the time and duration of the laser pulse, spatial control through the shape, size, and pathway of the laser beam. Non-photochemical induced crystallization is important in its ability to affect the physical properties of active pharmaceutical ingredients (APIs) such as crystal purity, phase, shape, and size distribution. The polymorphism of the crystals induced can greatly affect the quality, safety, and efficacy of the drug product. In this project, we designed and implemented a microfluidic device in order to increase the surface to volume ratio of the substance that is in contact with the laser, limit contamination, achieve chemical conservation, and implement scalable modular design. In comparison to traditional batch systems of crystallization, we are able to rapidly collect data and observe better experimental control while simultaneously manipulating the conditions for crystallization. This greatly simplifies the investigation and analysis of crystallization mechanisms as through the integration of the microfluidics device with various real-time characterization methods like optical microscopy, dynamic light scattering, X-ray diffraction, and Raman spectroscopy.

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Erosion of Silica in Biological Buffers

In biology and biochemistry, silica and its silicate are widely used for everything from containers, to microscope slides, to biosensors. Thus, the stability of silica in various biological buffers is vital when designing and conducting biological experiments. In this project, stability of silica spheres is evaluated in various buffers and at various pH levels using Whispering Gallery Mode (WGM) sensors, to determine which buffers are least disruptive to the silica. In this study, Whispering Gallery Mode (WGM) is used, with silica sphere resonators immersed in various Good's biological buffers at various pH levels. WGM measures the change in the size of the sphere by measuring the resonance wavelength change in ppm. Kaleidoscope software is used to compensate for the temperature change that causes shift, and then is used to analyze the shift and therefore erosion of silica or buildup on the silica surface. Results of this study will conclude the buffer and pH level in which silica is most stable, and thus is most optimal for silica biosensor experiments.

CHEMICAL AND BIOMOLECULAR ENGINEERING

JANE SMELYANSKY

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Faculty
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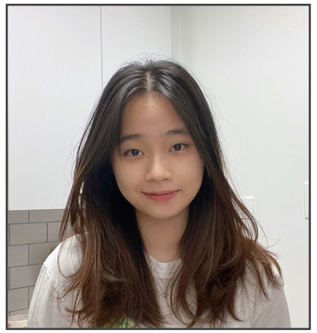
Other Mentor(s)
Håvard Mølnås

Synthesis of Metal Dithiocarbamates to Aid Light Transmission in Solar Cells

Metal sulfide compounds have been shown to be efficient in electron emissions in solar cells; nanoparticles of these compounds have a significant role in the storage and transmission of light. Barium zirconium trisulfide (BaZrS3) is an example of this, in which the substrate coatings are a promising material for the development of solar cells. They are more flexible than other current films and are less toxic than other sources because of their absence of lead, arsenic, and cadmium, which are contained in high quantities in current films being used. The low band-gap levels of BaZrS3indicate strong light absorption properties in solar cell films, which is essential in the conversion of electrons in their excited states into usable energy. This low-cost material lacks negative environmental impacts, which makes it a candidate for an efficient power source than using other materials. There are different routes to synthesize this compound, such as decomposition using nitrogen, annealing the sulfide metals, and spin-coating. The primary precursors used in these synthesis techniques are called dithiocarbamates, which are amino groups attached to an organic compound containing sulfur. In these synthesis techniques, Barium and Zirconium dithiocarbamate are reacted with metal precursors and decomposed to yield metal sulfides. The decomposed products are being investigated to see if they align with Barium sulfide and Zirconium sulfide groups. These sulfide compounds can then be synthesized into BaZrS3. The tools used to guide the identification of the compounds such as x-ray diffraction scans, thermo-gravimetric analysis, SEM (Scanning Electron Microscopy) imaging. Ultimately, the goal is to obtain the highest yield of the compound to develop perovskite nanoparticle films that are cost-effective, flexible, and energy-efficient for future solar cells.



THU VU

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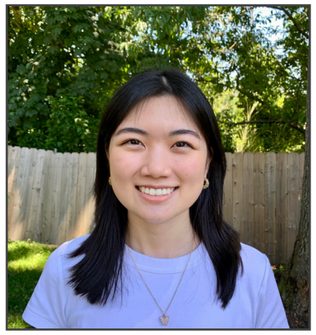
High-Throughput Flash Joule Heating Synthesis of Electrocatalysts on Micropatterned MXene

MXene and metallic glass nanostructures (MGNs) have been receiving increasing attention by material scientists recently for their electrocatalytic properties. MXenes are two- dimensional, multi-layered, transition metal carbides and nitrides which gives it its high conductivity, large surface area, and flexibility. This makes MXene an excellent material for electrochemical devices. MGNs, which are amorphous alloys, have also shown outstanding electrocatalytic performance due to their unique properties as nanomaterials such as high activity and stability, etc. In order to test the activity of a catalyst, its precursor must first be loaded on a conductive substrate and go through thermal annealing - a heat treatment to initiate decomposition - to obtain nanoparticles. Then, the substrate with catalyst loading will undergo the reaction (e.g. oxygen reduction reaction, oxygen evolution reaction) from which data about its catalytic activity and potential is measured. This method has two drawbacks: first, it can only test one catalyst at a time, since loading multiple catalysts on the substrate will lead to cross-contamination and the result will be inaccurate; second, annealing is a time-consuming process that can take up to hours. Our project proposes a new method that can solve these two problems - a high-throughput metallic glass synthesis method by flash Joule heating on micropatternable MXene. Flash Joule heating (FJH), an advanced, ultrafast, and controllable heating method will be used to decompose the precursor instead of furnace annealing. With this method, the synthesis process can be significantly shortened from hours to seconds with FJH, and with micropatterned MXene as the substrate, multiple catalysts can be synthesized and tested on one substrate simultaneously. We expect this new method to introduce a simple, scalable and high-throughput way to synthesize electrocatalysts for oxygen reduction reactions.

CHEMICAL AND BIOMOLECULAR ENGINEERING



ESTHER WANG

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Nikita Grigoryev

Characterization of L. acidophilus and L. casei in Commercially Available Probiotics with 16S Metagenomics

Lactobacillus acidophilus (L. acidophilus) and *Lactobacillus casei (L. casei)* are two commonly used bacterial species in commercially available probiotics. Both species can attenuate symptoms of gastrointestinal distress and inflammatory bowel disease. Probiotics are also marketed with generalized health benefit claims to consumers. However, there can be mislabeling of microbes and lack of clarification pertaining to the number of colony forming units (CFU) in probiotic products. It is important for consumers to receive what is advertised. Yogurt and probiotic supplements listed as containing *L. acidophilus* and *L. casei* were analyzed through culture-independent and culture-dependent 16S rRNA sequencing methods to verify product claims. The 16S rRNA gene contains 9 variable regions: V1-V9. The V3, V4, and V7-V8 regions were targeted. Sequencing amplicons of these variable regions provides value in taxonomic identification, known as 16S metagenomics. Slower evolving regions are used to determine higher-level taxa, while less conserved regions are useful in identifying low-level taxa.

ZHUORAN WANG

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Xin Wang

Raspberry Pi Car with Ethanol Detection and Object Detection of Chemical Equipment

Raspberry pi is a small single-board computer with a linux based operating system. A Raspberry pi board has GPIO pins, HDMI and USB standards that can be connected to multiple sensors, and therefore it is a great tool to make prototypes of research models. We connected one Raspberry Pi with motors and camera, and one connected to an ADS7830 A/D converter and an ethanol sensor. We put the pi on top of each other, and they communicate through UDP connection.The Raspberry Pi car keeps taking pictures while detecting ethanol concentration, and it will calculate the maximum ethanol concentration at the end of trial and do object detection to find the equipment with potential alcohol leak. Object detection is related to computer vision and image processing for detecting instances of a certain class of semantic objects in digital images and videos. You Only Look Once (YOLO) is a widely-used object detection algorithm that divides images into a grid system. It uses a novel convolutional neural network (CNN) that detects objects in real-time with great accuracy. By using the Yolo algorithm, we trained our own dataset with approximately 90% accuracy. We were able to use the pt model to do object detection, which recognizes different chemical equipment in the senior chemistry lab. We have tried training a dataset with both yolov3 and yolov5. But due to the processing power of Raspberry Pi, it takes longer to detect compared to a regular 64 bits laptop or computer.

CHEMICAL AND BIOMOLECULAR ENGINEERING

ALICE ZHANG

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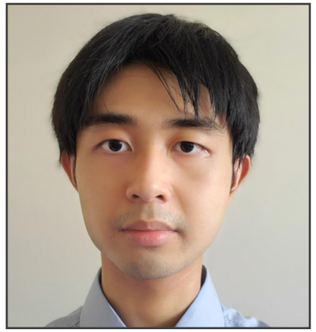
Underwater Solar Cells

Improving solar energy collection in aquatic environments will allow for true autonomy of underwater autonomous systems, allowing for improved means of communication and sea-bed monitoring. Here, we developed a protocol for a simple bench-top characterization technique that can characterize underwater solar cell performance but does not require direct access to water, thereby simplifying testing during initial trials of development. This technique has also previously been used to investigate inorganic technologies such as CdTe and GaInP. Using an LED solar simulator to replicate underwater solar spectra at various depths below sea level, we will compare Si solar cells with organic photovoltaic (OPV) cells that typically have a wide band gap (~1.8-1.9 eV) ideal for underwater solar harvesting. We aim to show that while Si cells outperform OPVs under terrestrial AM1.5G solar irradiance, OPVs such as P3HT:PCBM, PM6:PCBM and PM6:Y6 have the potential to outperform, or perform just as well as, Si at depths > 2 m.



HAO XIAN ZHENG

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Steve Farrell

Engineering Two-Dimensional Nanostructured Catalysts for Sustainable Aviation Fuel Production

The conversion of oxygen-rich biomass molecules into paraffinic kerosene via hydrodeoxygenation (HdO) is a significant chemical process that is an established pathway to produce sustainable, low-carbon fuel for the aviation sector. In this process, catalysts are employed to facilitate the removal of oxygen functional groups from biomass molecules to yield fuels that can be utilized in current generations of kerosene powered aircraft. Although noble metals such as platinum exhibit excellent hydrotreating activity, they are expensive and prone to deactivation by contaminants in biomass feedstocks. These constraints can potentially be overcome by replacing noble metals with transition metal dichalcogenide (TMD) compounds. TMD compounds can be fabricated as stable two-dimensional nanosheets. Compared to bulk TMDs with crystal sizes greater than nanoscale, which are used in other industrial scale hydrotreating processes, nanostructured TMDs contain comparatively more surface area that is catalytically active. The dependency of catalytic activity on the catalyst surface presents the possibility of applying various surface engineering techniques to modify the surface of these materials and hypothetically alter their catalytic properties. We are aiming to understand the impact of various surface engineering techniques on the catalytic activity of nanostructured transition metal dichalcogenide materials in hydrodeoxygenation. These findings can potentially be applied for catalyst design in scaled up hydrodeoxygenation operations for sustainable aviation fuel production.

CIVIL AND URBAN ENGINEERING

PROGGA BHUIYAN

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Electret Air Filter Aerobiome Analysis: Curating an Efficient DNA Extraction Method

A growing body of literature is showing that human health and wellbeing is tightly linked to interactions with diverse environmental microbiomes. However, urban microbiomes tend to be more sparse and less diverse, usually measured on surfaces both indoor and outdoor, but little is known about the composition, diversity and dynamics of aerobiomes. In particular, methods to collect biomass from air for downstream DNA analysis are still in development. Here we describe benchmark experiments to assess the extraction efficacy of two approaches to aerobiome sampling. A typical DNA extraction method involves exposing electret air sampling filters to the environment for a certain period using the BioFyte BioCapture machine. Then the filters go through a standard, tested DNA extraction procedure following the DNeasy PowerSoil Pro kit. The samples made from the kit are put in the Qiagen Qiacube machine for the last step of DNA extraction. The previous DNA extraction method consists of cutting the filter (treated with a standard microbial community as a positive control) into quarters as this makes it easier to insert them into 2 mL tubes required for the DNeasy PowerSoil protocol. The method resulted in about 31% DNA extraction efficiency (tested through previous experiments of 2ng/uL DNA). The low extraction efficiency can be due to contamination as the filter is handled a lot. The new DNA extraction method (made through research of previous experiments) consists of rolling the filter (treated with a standard microbial community as a positive control) into a 15mL tube and syringing out the liquid DNA into one tube. The method resulted in about 1.4% DNA extraction efficiency. The low extraction efficiency can be due to not using enough enzyme solution to lyse the cells. However, with the proper materials, this method should hopefully have a higher DNA extraction efficiency. Even if the DNA extraction efficiency remains low, this method is easier to handle, requires less time, and is much more scalable.

LUCAS BOTERO VIVAS

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Learning-Based Fluid 3D Printing Defect Detection

Additive manufacturing, most commonly known as 3D printing, has triggered a revolution in the manufacturing process by decreasing the fabrication time and costs of objects. Not only that, but the past few years have taken 3D printing much further than a tool for rapid prototyping in plastic to full-scale manufacturing in various industries by implementing other materials such as concrete or clay. This has unveiled new challenges for 3D printing as concrete and other earthy materials are softer, more inconsistent, and require more drying time than the standard 3D plastic filament, PLA, commonly used in 3D printers. This project aims to build a clay 3D printer using an industrial robot arm to create and test a machine learning algorithm that can detect defects as they are being printed and correct them in real time. To accomplish this, an RGBD camera capable of detecting depth differences between layers is implemented on the printing apparatus. Using point cloud data gathered from the RGBD camera, the printed object can be compared against its respective CAD model and autonomously correct the printing characteristics to ensure superior printing quality and correct defects. This technology can be implemented to 3D-printed concrete infrastructure like houses. This will ensure adequate structural strength while saving time, as currently when a defect is detected the print process has to be restarted from scratch.

CIVIL AND URBAN ENGINEERING

MEGAN (MEG) FERNANDEZ

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NYU College of Arts & Science

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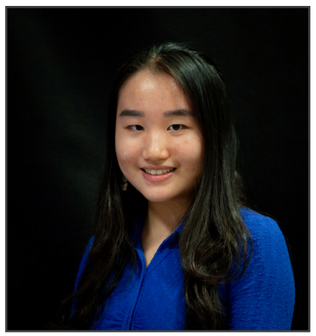
Digital Model for Flooding in New York City

Due to the effects of climate change, extreme rainfall events are becoming more frequent and devastating for New York City infrastructure. To quantify the damages done by extreme weather events, disaster risk analysis is conducted to identify infrastructural vulnerabilities. This project aims to create a digital model of flooding in New York City using open data to assess the impact of flood hazards. The objective of this study is to identify and quantify the extent of flood damages at an infrastructural, economical, and social level. To achieve this, Hurricane Ida was used as a case study to create a digital model. The first step involved combing through open source data, such as MTA ridership records and 311 service requests. After organizing the data, interactive maps were created using GIS software to visualize the information. Conducting a quantitative study on the impact of flooding is a crucial first step in completing cost-benefit analysis at a city level, informing the public on flood vulnerability and promoting further research. This study contributes to a broader project that aims to create a digital model for disaster risk analysis containing data for all of New York City. This digital model will not only address various forms of flooding, but also other forms of extreme weather in the near future to better prepare for the impacts of climate change.



YI-JEN (JENNIFER) TSAI

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Riccardo Negri, Bing Yang Ta

All four of Professor Ceferino's undergraduate researchers presented their progress at a midway-point presentation on July 8. (Starting from rightmost side: Yishi Wang, Riccardo Negri, Jennifer Tsai, Meg Fernandez, Richard Liu, Luis Ceferino, Prateek Arora, Bing Yang Tan)

CIVIL AND URBAN ENGINEERING

NIDHI DESU

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Charlie Mydlarz, Praneeth sai venkat Challagonda

Thompson Bartlett Fellow

FloodNet

The risks of flooding have become increasingly urgent due to a higher frequency of precipitation events and sea-level rise caused by climate change. New York City, being a coastal city, is especially prone to flooding, and the FloodNet project works to alleviate this risk. Sensors have been deployed around the city in areas susceptible to flooding, and this data can be accessed by residents to track their flood risk, as well as by researchers. In an effort to make the data from the sensors more readable and useful, a machine learning model is trained using hundreds of past events to filter out real flood events from anomalies that the sensor reads. Being a coastal city, New York City is subject to tidal flooding as well as pluvial. The main difference between pluvial and tidal flooding is that the former is caused by precipitation events whereas the latter is a consequence of high tides. Along with collecting data specific to each type of flood, the FloodNet team also aims to explore the relationship between the two, if any. Another part of the project involves analyzing precipitation prior to flood occurrences.

SADHVI SURENDHRAN

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CIVIL AND URBAN ENGINEERING

NGOC NHU HOANG

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Joseph Chow

Other Mentor(s)
Xiyuan Ren

Equity Analysis with Replica Synthetic Population

A standing challenge in statewide transportation planning is the lack of consistent travel data, especially for underserved and rural communities in which travel demands are under-presented. This is changing with the development of large-scale Information and Communication Technology (ICT) in recent years. Replica, a data company, has developed a consistent, nationwide synthetic population dataset by combining census, travel survey, and mobile phone data. With this unique data opportunity, it is now able to develop behavioral models that can account for individuals in underserved communities, which means it is potentially possible to analyze the equity impacts of new mobility scenarios. However, it is essential to get a better understanding of the data before achieving our final goal. Therefore, this study aims to check the quality of Replica's dataset as well as conduct descriptive analysis. First, the quality of Replica synthetic population dataset will be examined by checking the consistency with census data and travel survey data at the aggregated level. Second, based on detailed trip information, we will focus on the differences of mobility patterns among major cities in New York State, including trips within/between counties and on weekdays/weekends. Finally, this project will link socioeconomic factors to mobility patterns at the individual level in order to explore statewide transportation inequity. This project will serve as an intermediate step for the C2SMART project "NY Statewide Behavioral Equity Impact Decision Support Tool with Replica." The findings can provide important support for the next modeling part.

CHIN-LING (GENIE) HOU

Computer Science and Interactive Media B.S., 2024
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Semiha Ergan

Other Mentor(s)
Keundeok Park

Virtual Reality/3D Modeling for Building and Urban Scale Virtual Environments Research

The manufacturing industry has welcomed the automation of factories ever since industrialization. An assembly stage recognition system is crucial for an automated production line. As the manufacturing product changes, the recognition system will have to be built again for the individual product. Therefore, it is hard for the construction industry to achieve automation since its products are always varying and it would not be cost-effective to develop the recognition system each time. In the research project, we are aiming to build an AI recognition system that can quickly adapt to the new stages of assembly as the project changes. To achieve the goal of an AI-based recognition system, we are first building a twin model of the modular construction factory in a realistic Virtual reality environment. With the VR environment, we will train AI, confirm the Sim2Real AI in a modular construction factory works, and eventually develop an assembly stage recognition system with AI.

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GLASS Fellow

LAMIA TAHSIN

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Faculty
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Other Mentor(s)
Fabiana Sofia Ricci

Accessibility for Everyone: Inclusive Design for Persons with Visual Impairment

Visual impairment (VI) refers to any degree of vision loss that affects a person's ability to perform the usual activities of daily life. According to the World Health Organization, approximately 285 million individuals have VI, and this number is predicted to increase due to the aging population. Persons with VI may encounter various difficulties while navigating most present environments, which are not accessible to everyone. In recent decades, a growing awareness of disability rights has led to the belief that disabled persons deserve environments that are more accessible and barrier-free. Current literature highlights the applicable benefits of designing environments according to inclusive design principles. Inclusive design theory includes identifying points of exclusion, analyzing situational challenges, recognizing personal bias able-bodied persons may have, creating various ways for all to engage in their environments, producing equivalent experiences, and extending the solution to everyone despite their disability. Our project aims to build two environments in virtual reality (VR): the first environment will be the reproduction of a chosen environment, and the second environment will be the same chosen environment but modified following the inclusive design rules. Users will navigate both environments through a VR headset while experiencing a simulated VI. We will then qualitatively and quantitatively analyze mobility performance of experimental subjects in VR. From our findings, we hope to gather supporting data to emphasize how the design of highly accessible spaces and facilities could cater to the broadest spectrum of population. Additional help was provided by Anya Chu, a student at Brooklyn Technical High School. She helped with literature review as well as worked on her independent project to create better bully environments in residential areas by researching crime prevention through environmental design (CPTED).

XINHAO LIU

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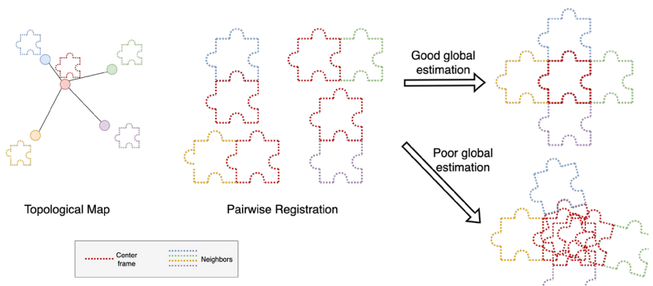
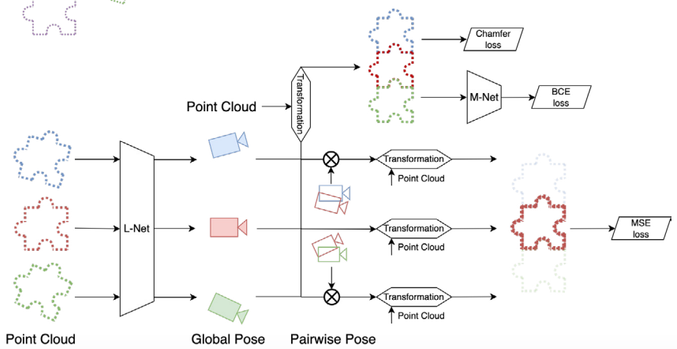
DeepMapping++: Unsupervised Loop Closure and Map Estimation

Mapping and state estimation are two of the most fundamental capabilities of an intelligent robot. Efforts have been made to achieve real-time 6 degree-of-freedom simultaneous localization and mapping (SLAM) using lidar methods. In most SLAM systems, traditional mapping methods employ filters to inputs. However, most of the methods will perform pose estimation and mapping in sequential order. And the pose estimates are highly correlated to the last estimated pose. As a result, the entire mapping process will be both erroneous and cumbersome. Deep Learning has been successfully applied on mapping problems including estimating camera motions from a sequence of images, or registering multiple point clouds. DeepMapping is one pioneer work that utilizes a self-supervised method to estimate each camera pose in small scale settings. However, in DeepMapping, the point clouds are inputted in a temporal order and it has no constraint in correcting wrongly estimated pose generated by the neural network. In the long run, the pose estimation will drift and the localization error will propagate. In our research, we try to figure out how loop closure and local consistency modules can help improve the performance of DeepMapping, and how to incorporate them into its network architecture.



Main idea of the consistency loss



Main pipeline of DeepMapping++

CIVIL AND URBAN ENGINEERING

SEAN LIN

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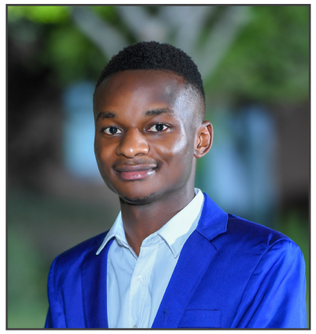
Modeling Framework for Mobility-as-a-Service Platform

Mobility-as-a-Service (MaaS) is the service that enables users to preplan and prepay for different types of mobility services in one platform. Multiple mobility service providers are combined through a service platform to provide multimodal services to travelers. Users of such a platform would be able to make their decision based on the types of mobility services involved, the estimated travel time, and the fare cost. With the rising demand of more personalized mobility services in recent years, the market is trending towards this type of modern transportation service. In this research project, we focus on modeling the service of the Long Island Railroad (LIRR) in a MaaS environment. This project aims to design a set of Mobility-on-demand (MOD) services that would help people in Suffolk and Nassau County to better access the Long Island Railroad. Data regarding demand and travel time for each origin destination pairs in the region were gathered to help design and model the network. This network would then be imported to an existing model to estimate the level of increase in the ridership of LIRR with the MOD access design. With a better access to public transportation and newly innovative sharing system among cars and bikes, MaaS platform could potentially not only provide better travel experiences, but also reduce the total car ownership, which could significantly improve the efficiency of urban transportation systems like the ones in New York City and Long Island, where congestion has been a major issue over the years.



LUKELO THADEI LUOGA

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Jingqin Gao, Fan Zuo

Intention Prediction Algorithms for Cooperative Driving and Connected/Autonomous Vehicle Applications

Cooperative Driving has become one of the new research frontiers in the field of connected and autonomous vehicle (CAV) research. Pedestrian safety remains to be one of the critical issues in Cooperative Driving and CAV applications. This is because it has been a challenging task for connected and autonomous vehicles to estimate when pedestrians will cross streets since pedestrians can move in different directions, suddenly change motion, be occluded by a variety of obstacles, and be distracted while talking to other pedestrians or typing on a mobile phone. Moreover, their decisions can also be affected by several factors. Intention prediction algorithms can provide essential information for warning systems or autonomous driving systems to avoid pedestrian-vehicle incidents. Existing methods for pedestrians' intention prediction include trajectory inference and pose inference. The goal of this project is to explore existing methods of intention predictions, implement State of Art methods to develop a deep learning-based intention prediction algorithm to improve vehicle and vulnerable road user safety in urban areas. Real- world videos recorded by CCTV cameras on different streets of New York City will be used to extract vehicle and pedestrian behaviors to be used in the development of intention prediction algorithms.

CIVIL AND URBAN ENGINEERING

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MARAM ASSI

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Other Mentor(s)
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Photodegradation of Pesticides

Pesticides are substances that are used in order to destroy, prevent, or control pests. Although proven toxic and potentially hazardous to human health, pesticides are deliberately released into the environment and have the potential to contaminate water, sediment, and vegetation. It is, therefore, important to better quantify the environmental fate of pesticides to achieve sustainable food production. Sunlight-driven processes can degrade pesticides; an understanding of photodegradation mechanisms and quantifying reaction rate constants will improve the predictive capabilities of environmental fate models. In this study, direct photodegradation was investigated to understand the environmental fate of a set of pesticides, including pyridine herbicides, strobilurin fungicides, and triazole fungicides. Direct photodegradation occurs when the pesticide absorbs a photon, resulting in a reaction. Molar absorptivity measurements, using a UV- vis spectrophotometer, were performed to determine if pesticides would absorb sunlight. The compounds were then placed in a photoreactor using bulbs that emitted photons in varying wavelength ranges (UVC, UVB, and UVA), and the fraction of degradation over different time periods were quantified using liquid chromatography (LC- UV). Preliminary results indicate that pesticides absorbed light strongly within the UVC wavelength range. We also determined that compounds with similar structures have different molar absorptivities. Using this information, the quantum yields of these pesticides were found to be different when using different light sources in the photoreactor. Although some of the pesticides have similar structures, small differences in structure resulted in different molar absorptivities as well as differing susceptibility to photodegradation as demonstrated by differing quantum yields.

CIVIL AND URBAN ENGINEERING

JOY SURE

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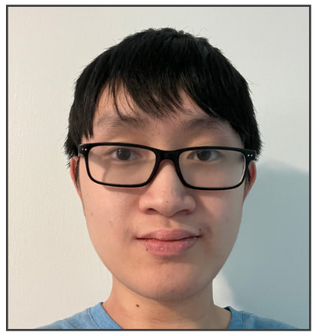
Decay of Microbial Contaminants in Water Treatment and In the Environment

Monochloramine is typically used in water purification as a secondary step to prevent the regrowth of micro- organisms that were previously inactivated in the first step of disinfection. A recent study had shown that bacteria indigenous to the environment such as those found in wastewater were more resistant to chlorine disinfection (which is commonly used in the first step of disinfection) as compared to laboratory cultured bacteria (Mwatondo and Silverman, 2021). An open question is: what is the mechanism of resistance that is present in the environmental bacteria? Based on isolated experiments where bacteria from wastewater grown in the lab were more susceptible to disinfection compared to those in wastewater, it is hypothesized that the mechanism of resistance to disinfection stems from changes in physiology (Mwatondo and Silverman, 2021). Since monochloramine is typically used as a residual disinfectant for drinking water, it is important to understand the mechanism of resistance of indigenous bacteria to it. Here, we test the hypothesis that disinfection resistance of bacteria in the environment is induced through physiological factors. Three isolate colonies of Enterococci and Escherichia coli obtained from wastewater were cultured using the same procedure for laboratory-cultured bacteria where they were incubated in nutrient broths then rinsed in phosphate buffer saline (PBS) prior to exposure to monochloramine. This is significant as Escherichia coli and Enterococci have been classified as biological indicators for the presence of disease-causing microorganisms in fecal contaminated water. Furthermore, while there are several papers on disinfection with chlorine or sunlight, very few focus on monochloramine. Based on preliminary experimental data, we expect that the wastewater-sourced bacteria grown in the lab will behave like laboratory cultured bacteria due to a lower resistance to disinfection compared to wastewater-sourced bacteria. This will further provide critical information on the mechanism of resistance employed by environmental bacteria so that more effective disinfectants and procedures are innovated.



ETHAN WONG

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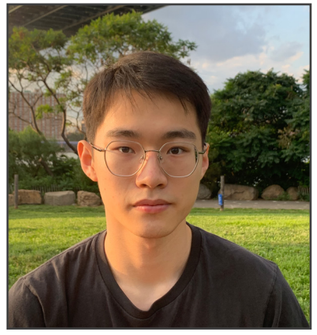
One-to-Many Simulator Interface with Virtual Test Bed for Equitable Tech

Multi-agent simulators, such as MATSim, allow for the analysis of travel decisions of agents from a simulated population. While multi-agent simulators are great for understanding travel behaviors of a large synthetic population, the simulator is unable to consider granular details. Local simulators, such as traffic and mobility simulators, can address some of the shortcomings of multi-agent simulators at a smaller scale. But currently there is no efficient way to connect local simulators with multi-agent simulators to replicate these benefits at a broader scale. This project aims to develop an interface that would allow users to connect a multi-agent simulator with multiple localized simulators, allowing them to expand the types of scenarios that can be handled without having to develop time consuming extensions. The user would be able to select regions of the multi-agent simulator network that they want to simulate with a local simulator. For these specific regions, local simulators can provide a detailed understanding of the behaviors of agents at the microscopic level. The development of a generalized interface would not only help to more efficiently connect multi-agent simulators with local simulators, but provide a framework for the efficient implementation of new transportation technologies and algorithms as they emerge and speed up their utilization.

CIVIL AND URBAN ENGINEERING



YISHI WANG

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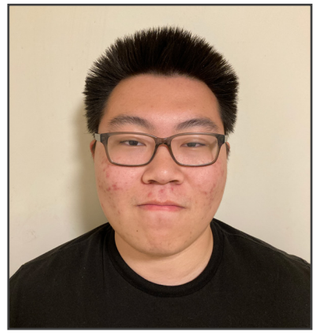
Visualize Power Outage Forecasts During Hurricane in Coastal Region

Hurricanes can cause severe damage to the power systems causing disruptions to the residential and industry operations. Frequency of strong hurricanes is expected to increase in the future due to the projected climate change. Climate change could exacerbate the situation, resulting in low reliability and resilience of power systems. A resilient power system should serve the consumers at all times. Utilities plan to place their resources ahead of a storm to reduce the impact on power systems and ensure a rapid recovery of power systems after a storm. Reducing the impact of storms to the power system requires accurate forecasting for the extent of electric power outages in advance. This project aims to build a publicly available power outage forecast system using state-of-the-art machine learning models to predict city wide power outages caused by the hurricane. Power outage prediction model is developed through collected datasets of environmental variables, hurricane intensity characteristic indicator and socio-demographic information of hurricane impacted areas. The early warning of outages will be forecasted through visualizations on a webpage sustained by Nodejs server and databases, which also supports live updates and auto data extraction and processing. Power outage early warning systems could assist utilities to allocate resources for a rapid recovery and arrange back-up during power disruptions. Power outage predictions could benefit community members to arrange for countermeasures during power disruptions.



DANIEL ZHANG

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Computer Vision for Smart Cities using Existing Traffic Cameras

C2SMART Center has been collecting perishable video data from existing public traffic cameras for more than 100 locations in NYC and Seattle since April 2020. We would like to leverage this camera data and use deep-learning image recognition techniques to build smart city applications, such as traffic and pedestrian counting, curb/bus lane usage, COVID-19 impacts, illegal parking, incident and flooding detection with the goal of using these data as an input to various decision-making algorithms being developed by the Center researchers. Despite significant developments in the integration of computer vision and smart cities, progress in the area of short-term urban work zones has remained stagnant. Short-term work zones are crucial to urban progress, encompassing repairs such as utility work, traffic hardware maintenance, tree trimming, and many other operations, however, they also present many challenges: sudden stops, mandatory merging, and uneven road surfaces are a major cause of congestion, delays, and crashes. In this project, we first generated a small novel dataset for short-term urban work zones by running real-time public traffic camera footage through a deep learning model a trained YOLOv5 (You Only Look Once) model that based on Convolutional Neural Networks (CNNs) that uses residual blocking and Intersection over Union (IoU) concepts to achieve object detection in one pass of the image. This allows us to detect work zones using extracted images that contain urban work zone objects, such as traffic cones, barriers, channelizers, vents, and so on. This tool would allow researchers and the city government to detect work zones in real-time, track its mobility and safety impacts, and can be adjusted to different use-cases.

COMPUTER SCIENCE AND ENGINEERING

Lind

Lind is a single-process sandbox that can safely execute programs. A new library operating system created with Rust (RUSTPOSIX) runs in Google Native Client (NaCl), a runtime system that performs software fault isolation (SFI), to provide a lightweight cloud environment for the x86 architecture. Lind executes programs while limiting access to the operating system kernel where bugs may live. Running untrusted applications is possible using Lind without making modifications to the kernel while securing legacy program's access to commonly used system functionality such as sockets and file I/O and providing spatial isolation, performance optimization, and portability. For operating system access, Lind provides a subset of POSIX API that is constructed in Rust for performance optimization and memory safety.

JUSTIN KOE

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The Cooper Union For The Advancement of Science and Art

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A Computer Vision-Based Approach for Automated Façade Inspections Using Synthetic Point Cloud Data

Façade inspections are necessary for the maintenance of buildings as well as for ensuring public safety. In current practice, façade inspections are mainly conducted visually and manually which results in costly, labor-intensive, and time-consuming processes. Besides, the results are based on the experiences of inspectors, and they necessitate a high level of expertise and domain knowledge. Yet, they are inadequate for eliminating safety issues and accidents due to debris falls. Therefore, there is a need for an automated method for inspection and condition evaluation. This research focuses on surface deformations on façades that require 3D geometry-based analysis. In this regard, we use point-cloud data to generate synthetic façade defects that will later be used for 3D deep learning and computer vision applications to identify defect types. By doing so, we aim to overcome the problems caused by the deficiency of 3D datasets that include surface deformations. Further, the developed deep learning algorithm will interpret the generated data, classify them based on predefined defect types and quantify the deformation.

XIAOJUN (OLIVIA) LIN

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COMPUTER SCIENCE AND ENGINEERING

Spatial Reasoning

Traditional feature matching algorithms and deep learning methods perform well in simple scene matching problems with non-extreme viewpoints. However, once we introduce wider baselines and larger degrees of rotation, the efficacy of such methods rapidly decreases. It is evident that there is a need for a more robust method to reason whether or not two images are spatially accessible. Put more formally, the question becomes: given two images with very small overlap, can we reason that a direct passage exists between the two images? We introduce this question as Spatial Reasoning. In our work, we demonstrate a novel method that better addresses the task of Spatial Reasoning compared to the current state-of-the-art. We include a new dataset to serve as a benchmark designed specifically for the problem of Spatial Reasoning.

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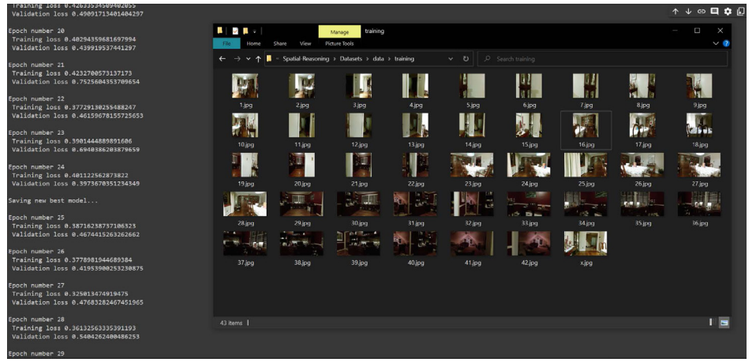

Training a Deep Learning Network

Convolutional Neural Network Baseline Sample Output

COMPUTER SCIENCE AND ENGINEERING

RICHARD LIU

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Resilience of Power Systems with Renewable Sources of Energy

Hurricanes can cause cascading power outages for many communities. The strong winds and precipitation from hurricanes can damage the power distribution system of electric poles and lines. A resilient power system should withstand sudden changes and serve the community at all times. Microgrids can provide power to communities when the main power grid is off. Solar energy, a renewable power source, has the potential in the microgrids to act as a backup to prevent power outages and allow the economy to operate normally. To determine the applicability of solar panels as a resilient power source in the microgrids, we do a what-if analysis of solar power adoption in New Jersey during Hurricane Isaias in 2020. We study information on New Jersey solar power available from the New Jersey Department of Environmental Protection (NJDEP) and utility companies. ArcGIS is used to process the data and produce maps to visualize the information available from NJDEP. The visualizations through maps portray the current solar power landscape of New Jersey and the locations of power outages in the aftermath of Isaias during 2020. The power outage and solar panel maps provide the information to understand the relation between power outages and the presence of solar panels. We use the python programming language to analyze millions of power outage records and produce key graphs. During a preliminary investigation of outage data, we observe that the majority of power outages happened in houses that lacked solar panels, demonstrating that solar power can potentially serve as a resilient power source in the Microgrids. Next, we determine the amount of solar power received by each panel and calculate potential electricity generation from solar panels. Hurricane high winds can also damage solar panels, and reduced solar irradiance can impact the solar power generated from solar panels. We determine the reliability of solar energy by taking into account all the various factors, including damage to the main power grid and the formation of clouds.

EILEEN TWIMASI

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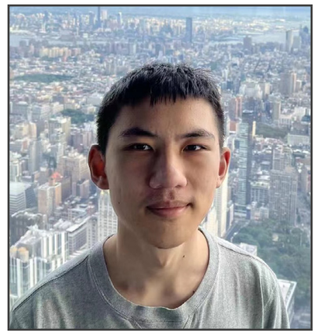
User Selection of the Top-Level Target Files Through Mapping Metadata

The Update Framework (TUF) helps developers maintain the security of software update systems, providing protection even against attackers that compromise the repository or signing keys. TUF provides a flexible framework and specification that developers can adapt into any software update system. The goals for implementation of TUF are to make the client side of the framework straightforward to implement in any programming language and for any platform, make the process by which developers push updates to the repository simple, and to make the framework secure to use in environments that lack support for SSL (TLS). The TAP 13 project discusses a means by which users of the same repository may elect to use different, repository-hosted, top-level targets metadata. This effectively enables different namespaces to exist on a repository which a client may choose to trust – or not – in a granular fashion, and also provides additional resilience to attack in the case that the root keys on the repository are compromised. To allow for safer use of these untrusted repositories, we propose adding namespaces to TUF repositories to enable explicit trust decisions. In summary, this proposal enables clients to restrict the targets they consume to filtered views of the repository.

COMPUTER SCIENCE AND ENGINEERING



CHENGYANG SONG

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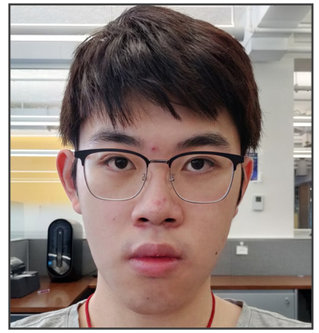

FEI XIONG

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Fast Nearest Neighbors for Faster Candidate Generation for Complex Rankers

Nearest Neighbor Search (NNS) is a widely-used approach for information retrieval in web search engines. It can be applied in recommendation systems, music identification, and pattern recognition. For example, each song can be embedded into a high-dimensional vector in the music recognition scenario, and it is useful when we are looking for a song that only plays a part of the melody. The NNS algorithm finds the most similar vectors, i.e. the closest neighbors to the query with a certain distance definition. However, the naive approach for nearest neighbor search costs linear time complexity and makes it difficult to scale up for high-dimensional datasets. Approximate Nearest Neighbors Search (ANNS) Algorithm arises as a solution. It reduces the time complexity to logarithmic or poly-logarithmic with a tradeoff in recall, which means the algorithm performs an approximate search for better query performance. Our research is mainly focused on Hierarchical Navigable Small World graphs (HNSW), which is a top-performing graph-based ANNS algorithm that outperforms previous state-of-the-art ANNS approaches. It originated from Navigable Small World graphs (NSW). NSW algorithm builds a graph where each node in the graph connects to its nearest neighbors, which is aiming at providing good performance in vector similarity search, with an (O(log2(N)) time complexity. Based on NSW, HNSW utilizes the concept of skip lists by building multi-layer graphs in a hierarchical structure, making the search complexity to be (O(log(N)), more efficient than NSW. We implement the HNSW algorithm in C++ and collect experimental data on the algorithm to analyze the impact of different parameters on the recall and Query Per Second (QPS). Based on the analysis, we aim to optimize the querying for the HNSW algorithm by introducing methods such as caching or frequency count to further improve the query processing with better time complexity and recall.

COMPUTER SCIENCE AND ENGINEERING

GAYATRI TYAGI

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GLASS Fellow

Soft Robotics

Rather than rigid components, soft robots leverage the use of soft materials in order to enhance user comfort and safety, as well as to broaden the usage of robotic devices in fields such as physical rehabilitation and remote care of patients. Physical therapy involves individualized attention from healthcare professionals for long periods of time. The development of soft robotic devices, like exosuits, could be used under remote supervision of a medical professional, and allow for more patients to receive better care. A critical step in developing these actuators is understanding how different design parameters alter the output behavior. Air pressure is used to inflate the actuator, but the same air pressure may produce a different displacement or amount of exerted force based on parameters such as chamber height, width, gap, and wall thickness. The optimization process for parameters has been and continues to be extensively investigated by the scientific community. By characterizing how different parameters affect output displacement and force, it is possible to design an actuator to precisely meet necessary specifications with low pressure to ensure patient safety and efficient energy use. In order to expand on the current developments in the field, it is critical to fully understand previous discoveries and the type of work that has already been done. To this end, an extensive literature review has been conducted on papers which have discussed the effect of various parameters on actuator displacement and force exerted by the tip of the actuator. Other factors such as material properties, fabrication methodology, and actuator type affect actuator behavior as well, and are taken into consideration.

YUNYI (RAINEE) WANG

Interactive Media Arts B.S., 2023
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Other Mentor(s)
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MusicUnderground: Facilitating Augmented Reality in Live Streaming Performances to Improve Public Mental Health of NYC Subway Riders

This study explores augmented reality (AR) as a new way to improve public mental health by moving the digital social networking of live streaming to the physical world, creating a hybrid and interactive place for arts and music performances. Specifically, we propose this AR intervention as a potential solution to mitigate anxiety, distrust, and phobias around commuting by the NYC subway. We created MusicUnderground, an AR application that allows users to watch, share, and interact with live music performances at the NYC subway in a hybrid social networking environment. We intend to examine the necessity and approaches to implementing interventions to reduce the negative psychosocial impact on public mental health.

ELECTRICAL AND COMPUTER ENGINEERING

JULIA (YULIA) GRAJEWSKA

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Understanding Convolutional Neural Networks (CNNs) for Sparse Signal Denoising

Convolutional Neural Networks (CNNs) have recently gained increased recognition with signal denoising tasks, however there is little insight towards understanding the networks themselves. The aim of our research project is to understand what a Convolutional Neural Network learns during the training process of denoising a signal. The insights allow us to derive constraints to produce constrained CNNs which require less training without a loss of performance. Our work is an extension of the research paper, Positive Sparse Signal Denoising: What Does a CNN Learn? This research publication considered three layers for a single sparsity level of ten percent; in our project however, we train a four-layer CNN with a range of sparsity levels. We analyze the filters that the network learns, and identify patterns in the filters, for example: time reversal, negation and scaling. Next, based on our findings, we impose the derived constraints on the network parameters for future training. This allows the CNN to maintain its performance with a significant decrease in training time, therefore considerably increasing the efficiency of the signal denoising process.

RAMEEN MAHMOOD

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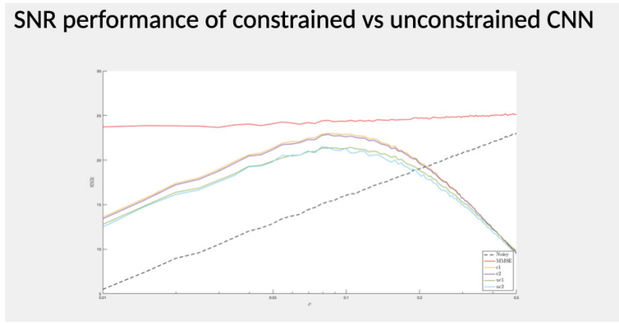
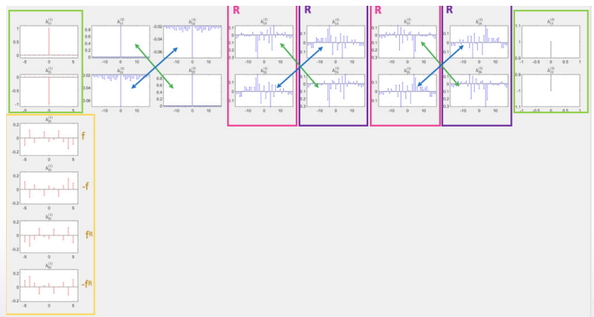


Patterns noticed in the unconstrained Convolutional Neural Network (CNN) during sparse signal denoising



Filters after imposing constraints in the Convolutional Neural Network (CNN)

ELECTRICAL AND COMPUTER ENGINEERING

DO-GON KIM

Mechanical Engineering B.S., 2023
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Faculty
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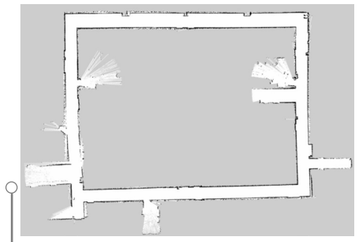
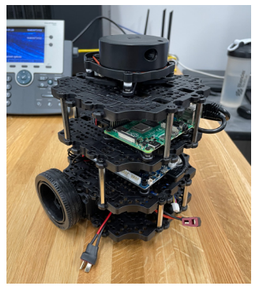
Prashanth Krishnamurthy, Bolun Dai

Autonomous Navigation

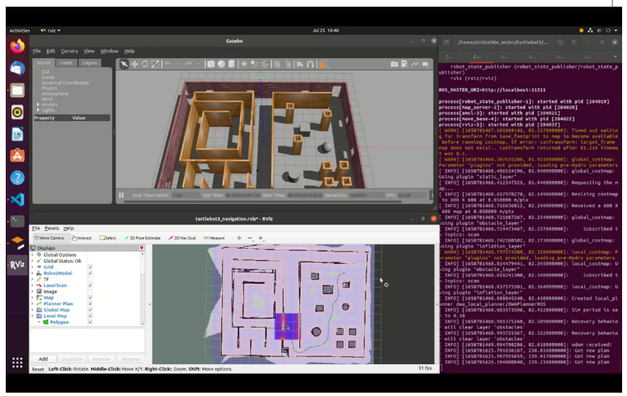
In autonomous navigation, it is crucial for robots and vehicles to have the ability to recognize the environment they are operating in, classify objects in that environment, and build a real-time awareness of the environment. In the case of autonomous unmanned vehicles, visual data including pedestrians, other vehicles, and obstacles must be processed from various sensors such as cameras, LIDARs, and RADARs. An overall view of the environment needs to be developed to create a map. This can be achieved via software platforms such as Robot Operating System (ROS). During this summer research project, I studied how to utilize ROS to read all these sensors from an actual robot and how to integrate data to build a map of the environment using gmapping, which is one of the Simultaneous Localization and Mapping algorithms. I also investigated the Adaptive Monte Carlo Localization algorithm to localize robots in a known environment and visualize the map using the Rviz tool. In this project, I used several sensors such as a LIDAR, encoder, and IMU and enabled a robot to detect obstacles, map the environment, and autonomously navigate in an uncertain environment. The algorithms and software tools that I explored have broad applicability such as unmanned vehicles, intelligent robots, and planetary rovers. Particularly, these techniques are fundamental to emerging autonomous driving applications, which have crucial real-world relevance and are expected to dramatically decrease the frequency of car accidents and reduce travel times in the next few years.

Map of the basement of the Dibner Library created by the Turtlebot3 burger (SLAM algorithm)



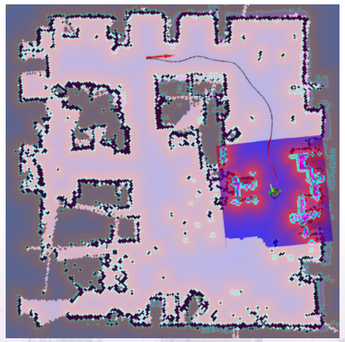


Turtlebot3 burger



Simulation of Autonomous Navigation using custom world of gazebo simulator

Controlling Turtlebot3 burger with the laptop controller to map laboratory 029 (Control/Robotics Research Lab) in the basement of the Dibner Library.



Autonomous Navigation

Map of Lab029 at Dibner Library created by using gmapping (SLAM algorithm)

ELECTRICAL AND COMPUTER ENGINEERING

MALIK MUHAMMAD SHEHRYAR HANIF

Computer Science and Mathematics B.S., 2023
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Ivan Selesnick

An Extension of the Single Best Replacement Algorithm for Signal Processing: Finding Pair-Sparse Approximate Solutions to Non-Invertible Linear Systems of Equations

Signal denoising, that is the act of removing noise from an unknown signal, is an important optimization problem. In the case of sparse signals, that is signals with only a few non-zero values, the problem is often formulated as a discrete case of the least-square problem with an l0 constraint. In 2011, Soussen et al. proposed a forward-backward greedy algorithm that aims to solve the sparse signal denoising problem without forcing constraints on the associated linear system's invertibility. Termed as the "single best replacement algorithm", the method has a stepwise regression approach that identifies or removes a single potential impulse per iteration. Herein, each iteration requires solving potentially as many least square problems as there are dimensions in the signal, with the custom cost function penalizing approximating solutions more if they have a higher number of impulses. This project proposes a specialized adaptation of the single best replacement algorithm that aims to better identify pair-sparse signals with added noise. In particular, we present a modified cost function that preferentially selects pairs of signal impulses occurring in adjacent positions. Based on a small number of tests conducted on signals of dimensions 100 to 500, we believe that, compared to the original algorithm, the adapted version primarily performs better in identifying adjacent impulses in the original signal when the signal-to-noise ratio is relatively higher (i.e., the sub-100 range). Notably, however, the new algorithm also potentially has an increased sensitivity to changes in the signal-noise ratio compared to the original version.

ELECTRICAL AND COMPUTER ENGINEERING

HEMING HUANG

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Prashanth Krishnamurthy, Bolun Dai

Franka Controller Package Design in Robot Operating System

The emphasis of this project is to develop feedback control systems for Franka Emika Panda arm utilizing Robot Operating System (ROS). ROS facilitates interfacing to various sensors and actuators and has many built-in functions to implement various algorithms for robotic controls (e.g., path planning, obstacle avoidance, map generation, SLAM). During this project, I interfaced a simulation platform for Franka Emika Panda arm to ROS that also mimics the actual sensor and actuator data transmission and corresponding packets creating a hardware-in-the-loop (HITL) simulation of the overall system. This HITL can be utilized to test control systems in the simulator for eventual implementation on the robot arm. In particular, we implemented a PD controller for target reaching and a feedback linearization controller for trajectory tracking. The PD controller uses real-time measurements of sensor data to calculate the commanded joint torques. The feedback linearization controller uses a trajectory generator to obtain the desired end-effector position, velocity, and acceleration, which are then mapped into joint space. The joint space targets and joint measurements are then used to compute the torque. The performance of our controller was validated and visualized in the Gazebo simulation environment.

DIMITRIOS MASTROGIANNIS

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Fraida Fund

Using Multicast for Reliable Low-Latency Communication over mmWave Mesh Networks

Redundancy, sending multiple copies of data across different network paths, has the potential to mitigate poor reliability and delay performance in mesh networks. However, this has not been fully explored because mesh networks were traditionally subject to tight capacity constraints that made redundant transmissions less practical. With the recent availability of mmWave links that have very high capacity but poor reliability, the potential of this approach should be revisited. If it can deliver improved reliability and delay performance on high-capacity mmWave links, it can enable new applications like remote surgery and cloud-controlled autonomous driving. To address this, we develop a protocol for one-to-one data delivery with redundancy using multicast protocols and evaluate it in a testbed environment that is representative of a mmWave mesh network. The results of this research will inform further protocol design and development for reliable low-latency communication over mmWave links.

ELECTRICAL AND COMPUTER ENGINEERING

JOSH SCHROCK

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Faculty
Quanyan Zhu

Visiting Student Fellow

Decomposing the Brain: An Analysis of Cognition Using Game Theory and Dynamic Mode Decomposition

It has long been known that neural dynamics characterized by signal oscillations in different frequency bands correspond to a variety of neural functions. Recent studies have specifically found a connection between choosing to play the defect strategy in a hawk-and-dove style game and activity in the beta frequency band. As such analysis requires a combination of both spatial and temporal data, we propose applying dynamic mode decomposition (DMD) to electroencephalogram (EEG) data as a novel method for differentiating between defective and cooperative behavior. The players will engage in a modified game of chicken using a brain-computer interface to make decisions. We then aggregate EEG signals that correspond to the planning phase before the player chooses an action. After applying DMD to the beta band, the average vector distance from a defect action vector to the average defect vector was 7.048e-4, whereas the average distance to cooperative actions was 8.340e-4. This difference was found to be statistically significant using the Student's T-test, suggesting that DMD can extract differences in brain activity from actions in game-theoretic scenarios.

SICHENG XIE

Electrical Engineering and Computer Engineering B.S., 2023
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Faculty
Danny Huang

IoT Supply Chain Vulnerabilities Detection

The data is being sent and received from almost all devices that can connect to the internet. These devices that communicate with the internet are called Internet of Things, or IoT. However, data sent is usually difficult to track on an end-user' side. The user has no clue whether their data are already leaked and where their information is leaked. Modern software is built up on hundreds or even thousands of different layers. It brings difficulty to identify the layer that leaks the information. Therefore, Professor Huang is working on this project to help the users spot the layer that causes the information leak, along with the purpose of identifying potential privacy and security threats. Currently, we are trying to identify all the open source libraries that a software uses such that we can spot the possible vulnerabilities to analyze the layer that could cause the information leak.

GENERAL ENGINEERING

KAZ BURNS

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Developing Diversity & Equity Training for Undergraduate Engineering Teaching Assistants

Undergraduate TAs play a key role in student success in the first-year engineering experience at Tandon. Effective TAs are leaders and peer mentors; they assist with content delivery, assessment, and completion of hands-on labs and projects. As initial points-of-contact for students, TAs' own understanding of how to foster inclusivity is essential for creating an equitable classroom environment. In conjunction with the TA body and DEI experts at our institution, we have thus sought to co-create diversity, equity, and inclusion (DEI) training for our program. The training introduces TAs to DEI concepts such as inclusive communities, inclusive language, inclusive leadership, and conflict resolution techniques. We deliver these concepts through workshops comprised of active discussions and case scenarios. To better inform our work, we present a literature review of DEI studies in engineering education. We plan to implement the findings from this review in the near future; regular climate surveys, listening sessions, and self-evaluations will be used to measure the effectiveness of training. We have also created an accessible website summarizing our work and listing DEI resources and opportunities for our TAs. Through this process, we seek to establish a set of DEI learning objectives for undergraduate TAs applicable beyond our institution.

MECHANICAL AND AEROSPACE ENGINEERING

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3D Shape Reconstruction of Soft Bodies Using Vision-based Proprioception and Deep Learning Models

Soft robotics is a subfield in robotics that specializes in the building and controlling of bodies with flexible and deformable materials instead of traditional rigid links. The compliant materials allow the robot to change shape either passively or actively and provide a high degree of sensitivity to external factors. This allows soft robots to perform tasks like grasping and manipulating irregular surfaces in a safer and more effective way than traditional rigid robotics. Nonetheless, due to its multidimensional deformation capabilities, proprioceptive sensing has proven to be a great challenge, and very few methods have provided reliable 3D representation using embedded sensors. The primary objective of this research project is to develop a soft robot finger that enables 3D shape reconstruction and force estimation using vision-based proprioception and deep learning models. The ultimate goal is to employ soft finger grippers to pick, handle, and sense fragile objects that would be challenging for conventional rigid grippers. The soft finger was designed with a constraint layer that permits the soft finger to extend along a particular curve when powered by pneumatic actuation. In addition, a data-gathering system was designed to collect training data for neural network models. The system consists of an RGB camera that captures the interior image of the soft finger, which contains bumps in a specific pattern, and two RGBD cameras that collect the external shape/geometry information of the soft finger. The deformation of the embedded bumps combined with the data from the RGBD camera will allow the convolution neural network to assimilate internal deformations with specific 3D shapes and angles. This correlation will allow the neural network to estimate the 3D shape and angle of the soft finger under arbitrary deformations based solely on the embedded images.

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Wearable Mechanomyography for Muscle Activity Analysis

Wearable devices dedicated to muscle activity analysis can help revolutionize current prosthetic devices. By acting as a sensing interface between the prosthetic device and the user, prediction of intended body movements, evaluation of motor skills, and gathering real-time muscle activity data can be made possible. These wearable devices can also be implemented for industrial workers who use exoskeletons to lift heavy objects. Additionally, these wearable devices can also be utilized in mixed reality technology, simulating the user's movement more efficiently and seamlessly than the popular hand-held controllers and motion tracking cameras. With today's state-of-the-art technology, wearable muscle activity related technologies pose a practical issue. Current technology relies on Electromyography, which is expensive and input invasively in order to sense muscle activity. In addition, Surface Electromyography (sEMG) is susceptible to issues associated with electrode-skin impedance, location of the sEMG sensors, and due to the need for direct skin contact issues with sweating and body hair, as well as elaborate signal amplification and noise cancellation technology. We aim to implement a low-cost, non-invasive, wireless accelerometer-based mechanomyography (MMG) wearable device coupled with a machine learning algorithm for real-time seamless gesture classification and prediction that uses the transient state of signals for faster gesture classification unlike the current state of the art methods and technology. We have designed our wearable device with simple, but effective, noise canceling technology to only obtain muscle vibration readings, send signals over Wifi to allow for free movement and to operate wirelessly, all with a high data transmission rate.

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Detecting Counterfeit Parts in Additive Manufacturing for Cyber Attacks Prevention

Additive manufacturing (AM) is growing at a very brisk pace in the industrial sector as well as in the research field due to its customizability and high precision product manufacturing. AM also provides production of highly complex shapes including body implants, titanium brake calipers, jet engines, which require high precision and intense quality control during production. AM saves cost and time by printing entire assemblies without the need to assemble individual components together. Stereolithography (STL) is a file format that represents the 3D model in the form of triangular facets as an approximation of the model's actual surface, and it is the preferred file format shared among designers, manufacturers, and quality control firms. It is easy to share and access the STL file through the internet, but the internet also brings eminent risks: third party hackers might sabotage and steal the file during transfer. This loss or theft of the STL file can cause production of counterfeits used by third parties in their manufacturing processes. There are a lot of risks associated with unauthorized changes in the assembly components, and these changes may result in failure in the assembly system during operation. The current challenge is to be able to prevent such changes in large, complex assemblies due to the lack of features to ensure the integrity of all the parts in an assembly during the manufacturing process. This research will focus on preventing and protecting against such malicious acts in assemblies and developing methods to detect design infringement in assemblies.

MECHANICAL AND AEROSPACE ENGINEERING

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Developing Modular/Sequential Multi Inlet Vortex Mixers for Formulation of Nano-Particles through Flash Nano-Precipitation

Flash Nano-Precipitation (FNP) is a well-established controlled precipitation process used to make nanoparticles (NPs) for various biomedical applications. This is usually achieved using either a confined impinging jet (CIJ) mixer or a multi-inlet vortex mixer (MIVM), both technologies are traditionally manufactured using computer numerically controlled (CNC) machines. CNC machining is an expensive and geometrically constraining manufacturing method and as such is not ideally suited for the creation of these mixers. Using stereolithography (SLA) 3D printing, we have developed a system of modular sequential multi-inlet vortex mixers (MS-MIVM) which allow the rapid and cost-effective creation of custom mixer geometries. Using stackable mixing stages secured through a bolt-through design, the MS-MIVM allows the user to streamline otherwise complex mixers, enables precise assembly of inorganic-organic nanoparticles, and allow a variety of input and output options, all while drastically reducing hold-up volume. These features make the MS-MIVM a more efficient, versatile, and easy to use mixer than a traditional MIVM.

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Shocking Developments: CFD Simulations of Shock Waves

Shockwaves have long been the subject of interest to both the military and civilian sector in aircraft design for supersonic flight. Whether for the design of air and spacecraft or their engines, researchers have published their findings from expansive, yet still limited, data. Shockwave development can be characterized by reflections and deflections under simple boundary conditions such as single wedges. But with a double wedged boundary condition, interactions between shockwaves occur and introduce further complexity to such problems. Under this complex boundary configuration, theories of the Mach stem, attach and detach conditions, and shockwave types should all be considered and assessed. The coordination between the engine's design and the consequent flow field can optimize the engine's output given that engine failures often occur when factors are not compatible. Therefore, the objective of this research is to characterize and assess the flow field downstream of the double wedge boundary configuration that has been subjected to shockwave interactions and upstream flow conditions. Computational Fluid Dynamics (CFD) will be applied in this study to investigate the flow field at any desired point local to the condition studied.

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The Education Metaverse: Simulating a Materials Science Lab Environment

Virtual reality (VR) is an emerging technology that has been used for education in medical training and job-specific technical skill training since its inception. The COVID-19 pandemic has caused a large shift in the mode of education from in-person meetings to remote learning through video calls. However, classes involving experimentation, such as the materials science lab using expensive or special universal testing systems, cannot be easily replicated in a virtual learning environment through video calls. In order to increase learning engagement, our group is focusing on designing a VR application using Unity that simulates the materials science lab in New York University Tandon School of Engineering. It will provide students with a laboratory experience in a completely virtual environment, free of distractions, and can be done at any pace. In addition, using a head-mounted display (HMD) would provide the student the ability to familiarize themselves with the virtual lab equipment, and then proceed with completing the experiment. With the immersive and interactive nature of the application, we aim to provide students with a tool that enhances their experience in the classroom while also best suiting their learning style.

The universal testing machine and interactive computer within the VR application

MECHANICAL AND AEROSPACE ENGINEERING

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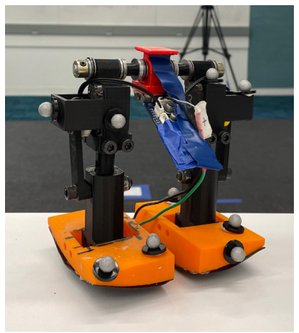
Development of Speed and Stability Testing Platform for Penguin Robot



Penguins are known to have high efficiency in walking and achieve a stable gait on slippery terrain that makes them a good model to improve passive dynamic bipedal robots, which has high potential in application to rehabilitation devices for mobility-impaired people. In this project we designed a pelvis and link for an under-actuated bipedal robot which allowed it to have variable mass distribution. Furthermore, we aim to perform gait analysis on the robot using Vicon Nexus software. We create a skeleton model of the robot and calculate the center of mass position based on the marker trajectory collected using motion capture cameras. In addition, the gait parameter data including walking speed were recorded. A test bed to record how the robot reacts to perturbations in the form of tugging is built where the walking robot is subjected to a specific amount of force for a brief instance. By analyzing the forces felt by the robot, and using the Vicon Nexus system to identify the robot's behavior, a quantitative analysis can be concluded on the limits of stability for the robot. By better understanding the behavior of the system, future passive dynamic bipedal robots can be optimized to better fit objectives, such as increased stability, walking speed, or controllability.

MECHANICAL AND AEROSPACE ENGINEERING

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Preventing EMI Emissions Using MXene Film Protection

EMI (Electromagnetic Interference) occurs when any electronic device emits unwanted electrical waves from their designs during operation. This causes design certification problems as well as reduced cybersecurity properties, as EMI waves include vital system information which is attractive for side-channel attackers to steal. Current industry standard for EMI shielding is based on solid shields which are not suitable for flexible electronics, and EMI shielding for flexible electronics are based on external foils and/or conductive cloth. Since these components are external to the circuit, it requires additional construction steps to ensure proper shielding which is not convenient as they introduce additional mechanical design complexity with shifting and tearing risks. The goal of this project is to explore the possibility of alternate methods to achieve EMI shielding effects in flexible electronics. In particular, the project explores the use of MXenes, a class of two-dimensional inorganic compounds with remarkable EMI shielding properties. These MXenes can be directly applied to the Printed Circuit Board(PCB) instead of dealing with external shields. The major demands of the project include the design of a flexible PCB, appropriate application of MXenes in the PCB, measurement of EMI effects at various spots of the PCB and comparison of the before-vs-after effects. The research project will help provide interesting insights into EMI shielding in PCBs and the cost-effectiveness of the application of MXenes, which have the potential to be useful to PCB security and fabrication fields.

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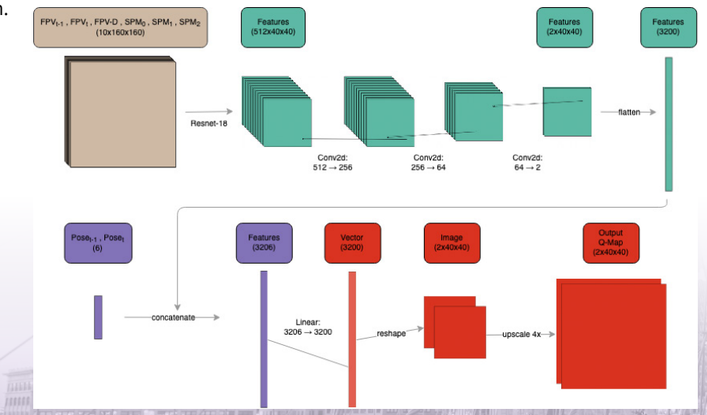
Learning to Simultaneously Navigate and Manipulate with Deep Q-Learning for Mobile Rearrangement

Rearrangement consists of various tasks of which an agent must move objects from a given representation to a target representation. Recent research applying deep reinforcement learning to noisy-less rearrangement tasks use camera images (RGB and RGB-depth) in combination with the ground truth pose (global coordinates) as inputs. In noisy environments (e.g. the intended position of the robot is not equal to the actual position), however, these networks cannot effectively complete the task as incorrect coordinates continue to be fed rather than the GT pose. State-of-the-art-algorithms (such as SAC-Discrete), thus, misrepresent the incorrect coordinates to the inputted images which results in such agents performing negatively, often failing the task completely. In this work, we aim to argue that agents need not use the GT pose, i.e., we are researching a solely vision-based robot controller that outperforms against current baselines. Taking camera images and short path maps as inputs, our controller implicitly learns the robot's position and outputs a spatial action map to determine pixels with the highest expected return.



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Securing Additive Manufacturing Digital 3D Models with Encryption Techniques

Additive manufacturing can be described as a cyber-physical system because the process involves several design files being transferred and communicated through the network before the part is created on the 3D printer. The risk of unauthorized access to these design files is a major threat, as illegal access can lead to counterfeit and sabotage. This is especially alarming because additive manufacturing technology makes it relatively easy for someone with little to no experience to create a copy of a product with the stolen design file. In order to help prevent this unauthorized access, it becomes paramount that important intellectual property is secured through encryption methods that cannot be decrypted without the required knowledge. This will result in design creators being able to identify IP theft by looking for any traces of their encryption methods in any suspicious designs. Our group researched and experimented with different encryption methods to safeguard several STL files and tested their effectiveness by attempting to decrypt them without prior knowledge. Some techniques we incorporated were the inclusion of visible and hidden watermarks in the design files and further securing them with several/multiple layers of encryption. These layers included modifying vectors or fully encrypting the file to make it unreadable without the decryption key.

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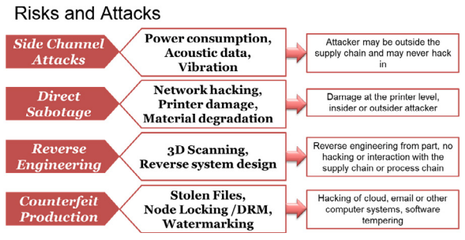
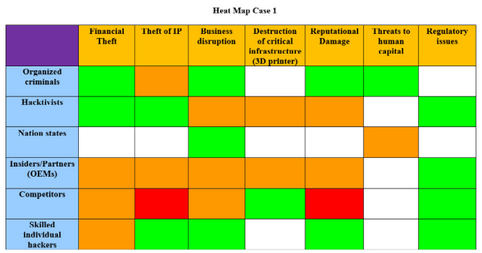
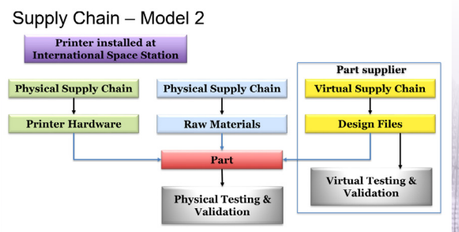
Evaluation of Threats to the Digital Manufacturing Sector and their Impacts

With the advent of Industry 4.0, digital manufacturing has seen a steady rise in usage and importance with an expansive number of industries and companies employing digital manufacturing solutions to meet their needs. This new heightened significance, although increasing production efficiency, has caused the safe-keeping of confidential files and data from the wrong hands to gain much value. Consequently, threat analysis has become an important step in creating safeguards against hackers or competitors that may steal or corrupt confidential files and data. In this study, we have analyzed various scenarios to learn where there are weak spots in the digital manufacturing supply chain. We considered various models of the Additive Manufacturing supply chain. We did that by changing our thought process to match that of the customer, the part supplier and the design supplier for each supply chain model respectively. Additionally, we have considered the different roles from which an attack vector could emerge and how these unique perspectives, be it a freelance hacker or a competitor, might change how or why someone would want to corrupt or steal intellectual property. This analysis has been aided by our own attack and defend scenario we have played out where one group would try to encrypt or secure a file (defend) while another group would try to hack said file (attack). Because this forced us to think both as a hacker and a defender, we had better insight into determining what were the riskiest and most important attack vectors.







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In-Situ Monitoring and Non-Destructive Testing in Additive Manufacturing

Additive manufacturing (AM), also known as 3D printing, is a revolutionary technology for fabricating components with complex geometries using various materials. It allows for manufacturing custom parts in fewer steps than conventional manufacturing and complex parts with optimized geometry, including internal feature production. However, print error and residual and thermal stresses during the printing process can cause internal defects that compromise the integrity of AM products. One of the major challenges in the AM industry is ensuring product quality and consistency by real-time in-situ defect detection, which otherwise can severely deteriorate the quality of AM products and even the sustainability of AM technology. The objective of this study is to develop an in-situ, or real-time, non-destructive monitoring to detect the effects of different parameters on the outcome of the print in fused filament fabrication (FFF) AM process. This is implemented using thermal and optical cameras to acquire defect formation data during the printing process.

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Non-Smooth Dynamics Modeling for Energy Expenditure of Electromechanical Systems

Due to the nature of robotics, most modern electromechanical systems require the use of non-smooth dynamics to perform important tasks such as locomotion or manipulation. Therefore, as most of these systems are reliant on aperiodic movement or transient behavior to perform certain functions, it becomes, not only necessary, but more difficult to model the energy expenditure of these systems. More current, and typical modeling approaches for the power consumption of these electromechanical systems only consider periodic motion or steady-state behavior. Therefore, improved modeling is needed to consider the non-smooth dynamical characteristics of current robotic systems. To create a better approach for this, a servo motor was used as a basis for this model because of its simplicity and its non-smooth electromechanical aspects. A theoretically built servo motor was constructed using a brushed DC motor along with an H-bridge for direction control of current. Using this servo motor, a model was constructed using both electrical and mechanical state variables to better accurately portray the energy expenditure of non-smooth electromechanical systems. The experimental setup consisted of a dual-servo motor test platform in which a driver and test motor were connected together and the output torque acting on the test motor was recorded. The theoretical model was then justified as the tested energy consumption was measured and compared to that of the theoretical model. This model has the ability to create more energy efficient electromechanical systems by utilizing a more accurate model of energy expenditure and optimizing for minimal power consumption.

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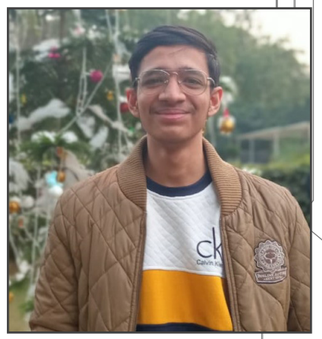

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Analyzing the Threats in 3D CAD Files Through a Cybersecurity Red-Team Blue-Team Approach

Computer-aided design (CAD) files are essential in the digital manufacturing process and are often shared with different parties during a product's lifecycle. The different ways of transferring CAD files involve email, cloud storage, and file-sharing services, which are all vulnerable to network security threats such as tampering, sabotaging, and plagiarism. For example, someone can intentionally sabotage the file to cause the final product to fail during usage, or someone can steal the design file and sell it to a third party for financial purposes. Our research consisted of participating in a red team, blue team challenge where the blue team would be responsible for designing a CAD part with a built-in security system to protect the design from being copied or tampered with. The secured CAD files would then be given to the red team, who would attempt to infiltrate those CAD files. The red team would act as hackers and employ different strategies that would allow them to identify what changes were made to protect the file. Notes consisting of observations and strategies to protect or attract the CAD file were recorded by both the blue and red teams. By keeping a record of the observations taken down in the research, different strategies that could be used to further protect the CAD files during the transferring of the file were explored. The plan is to carry on with the experimental red-team, blue-team approach to continue discovering the different ways that CAD files can be protected and therefore mitigate the cyber security threat to the CAD file.

MECHANICAL AND AEROSPACE ENGINEERING

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Application of Micro-Computed Tomography for Authentication of 3D Printed Composite Parts

Recent advances in the field of Additive Manufacturing (AM) have inevitably given rise to studies that seek to ensure the security of 3D printed parts. From the point of conceptualization of the design to the end printing stage, there are various avenues for malicious third parties to steal valuable intellectual property (IP) and develop counterfeits of the original part. The presence of such attack vectors have led to significant cybersecurity concerns regarding the authenticity of 3D printed parts. We particularly base our study on fiber-reinforced polymer (FRP) samples, which offer a higher strength-to-weight ratio and better durability than traditional filament materials. The microstructure of FRP contains fibers and porosity that are unique to the sample and the print parameters. We seek to develop a part authentication algorithm by identifying markers based on the distinguishing characteristics of FRP from micro-computed tomography (μCT) scans of a 3D printed part. Such markers can be used as an effective means to differentiate the original part from counterfeits, and to help combat rising cybersecurity concerns with respect to part authentication. We hope that this work would stimulate further developments in ensuring the verifiability of the parts produced via AM, which would invariably contribute to securing IP and lead to rapid adoption of these techniques by the industry.

MECHANICAL AND AEROSPACE ENGINEERING

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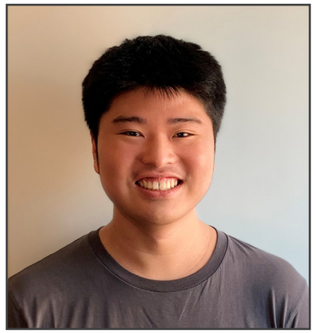
How & Why Fish School

It is widely known that fish school in order to protect themselves from predators, improve their search for food, and swim more efficiently. However, the process of how sensory information is integrated, processed, and propagated through the group is not yet fully understood. In this project, we seek to explore the role of hydrodynamic cues underlying the swimming of zebrafish in response to a pitching airfoil. Specifically, we designed a series of controlled experiments to study the interaction of a robotic airfoil and a live fish swimming in a water tunnel. The robotic airfoil was positioned upstream of the water tunnel and was programmed to simulate the startling behavior of a fish. The airfoil was controlled to alternate between phases of periodic pitching at +/- 10 deg in amplitude. Locomotory activity of the live fish interacting with the pitching airfoil was recorded using a video camera and time series of heading and tail beat angles were obtained.Interaction between the airfoil and fish was quantified using a data-based information- theoretic approach. The results of this project are expected to help understand the pathways of collective startle response and the emergence of complex anti-predatory maneuvers, which could aid the design of control strategies capable of taming the collective behavior of complex interconnected systems such as the power grid or a team of cooperative robots.



DANIEL TANG

Mechanical Engineering B.S./M.S., 2023
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Faculty
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Other Mentor(s)
Guanrui Li

Design and Validation of Racing Drone for Autonomous Navigation and Environmental Interaction

Agile autonomous aerial vehicles are widely used in applications for surveillance and monitoring. This project focuses on designing and validating an autonomous racing drone platform to be used for these tasks and additional modalities for environmental interaction. Due to the autonomy algorithms' computational complexity, the drone is designed around using the Jetson Nvidia Xavier NX. The Xavier NX is a powerful embedded board that equips with both advanced ARMv8 CPU and NVIDIA Volta™ GPU. A 3D printed mount is designed and validated to carry the embedded board, battery, and sensors. This mount is found to be sufficiently robust for continued use. The design features a swappable front camera mount that can accommodate different cameras such as the Intel T265 stereo cameras, Intel L515 Lidar cameras, or Lepton thermal cameras, to increase the sensor modality and modularity of the platform for autonomous navigation during the surveillance task. In addition to the design for navigation, this project also extends the design of the drone platform to have additional perching capability for environmental interaction. Perching allows vehicles to carry out missions with improved mission efficiency and time by conserving battery life. Previous studies have shown the viability of perching on inclined surfaces and various natural structures, but often have drawbacks like weighty mechanisms or complex active systems with actuators. Hence in this project, a lightweight passive perching mechanism is designed for vertical perching. The design uses strong magnets to hold the drone when perched on the metal surface. It then leverages precise magnet placement at the front of the drone in order to use the torque generated from the offset of the magnets to tilt off the perching surface.

TECHNOLOGY, CULTURE, AND SOCIETY

GONZALO DE LA CRUZ CUBEIRO

Mathematics and Computer Science B.S., 2023
NYU Abu Dhabi

Faculty
Amy Hurst

DIY Assistive Technology

In the Assistive Technology (AT) industry products are usually designed for general customer groups of people with disabilities, without taking into consideration that most types of disabilities are different and therefore require unique solutions to perform day-to-day tasks. In addition, previous work suggests that one of the biggest barriers in AT is the high costs of products and insufficient funding. This project proposes alternate approaches to design and develop AT devices for people with physical disabilities that are unique to each individual, while keeping prices of production to a minimum so the products can reach larger audiences. As a case study for this research project, I will partner with the NYU Moses Center for Student Accessibility to design and develop an affordable AT device for NYU students who cannot physically raise their hands in class to be able to notify their professor when they want to join class discussions.

OZIOMA CHUKWUKEME

Integrated Design and Media B.S., 2023
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Faculty
R. Luke DuBois

Audio Visualization in Processing through Machine Learning

Machine Learning is a field that has many applications in our world today, yet has a high barrier to entry, making it difficult for people to gain transparency into the process. Teachable Machine is a free web tool that makes it possible to train and export machine learning models that classify unique data samples. With the ML5 library, models trained in Teachable Machine can be integrated into code, such as that written in Processing. Processing is an open source Java based library intended to teach computer programming fundamentals through visual and media arts. With these three tools a computer can be trained to listen for various instruments and sounds, recognize classifications and execute code depending on what it recognizes. This project aims to use machine learning to generate audio-reactive art or music visualization in real time. It comprises a publicly available pre-trained model of instrument samples that can be customized or built upon, and a step-by-step tutorial available on OpenProcessing. The ultimate goal is to provide a means for people of all ages to dive into the world of machine learning—exploring its possibilities and limitations, through open source technology and creative coding.

TECHNOLOGY, CULTURE, AND SOCIETY

MICHAEL GARDELL

Electrical Engineering B.S., 2023
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Faculty
R. Luke DuBois

Open-Source Audio Technology

When comparing the designs between an audio effect for a guitar and one for a bass guitar, certain design constraints must be kept in mind in order to account for the difference of range and frequency each instrument handles. To simplify the design of an audio effect for a low frequency instrument such as the bass guitar, the use of MaxMSP and the Daisy programmable chip by Electro-Smith were used to emulate popular effects bass players would use. MaxMSP is a visual programmable language for music and multimedia and was the main language used to program these effects. The Daisy chip is an embedded platform for music that can be programmed when connected with a USB and using a programmable language such as C++ or Max to upload any code to the chip. The chip itself is connected on a stomp box where each knob and switch can be programmed through Max depending on the effect created and how many knobs or switches were needed. Effects such as distortion, compression, and other desirable effects can be replicated for the professional bass player to use. The combination of Max and Daisy provides an easy alternative to creating not only effects for bass guitar, but for any electric instrument, and these designs can easily be shared to anyone interested in modifying or creating their own audio effects.

SOPHIE WEISS

Sustainable Urban Environments B.S., 2023
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Alice Reznickova

Sustainability & the Liberal Arts: Transformational Experience for the 21st Century Student

The Association for the Advancement of Sustainability in Higher Education (AASHE) is an organization that supports universities in their sustainability practices and education. The number of universities with memberships has only increased since AASHE's founding in 2005. Given the recent focus on sustainability globally, there has subsequently been a growing presence within higher education institutions. We examined 51 B.A. programs and 25 B.S. programs in Sustainability Studies and Sciences to understand the structure of the degree and the knowledge that students gain when pursuing these paths. Each course within the programs was coded into broad categories (natural sciences, humanities, methods, etc.), disciplines (biology, economics, policy, etc.), and focus (environmental, sustainability, or general). We found that sustainability curricula, in both B.A. and B.S. programs, vary widely, demonstrating a lack of consistency in sustainability education. We recommend that programs reflect the uniqueness of sustainability through the omission of standardization across schools. The programs reflect an interdisciplinary nature that mimics the field of sustainability itself and allows students to gain a broad understanding of the subject. We recommend more interdisciplinary courses, such as "Environmental Justice", that covers topics across multiple subjects. We discover that most sustainability majors are comprised of general courses from other disciplines; among the most common classes offered are economics, political science, ecology, and biology. B.S. programs are dominated by natural science courses and have less variability within social sciences. Among the social sciences, there is a noticeable absence of psychology, sociology, and history, and a collective exclusion of humanities. While the commonly seen disciplines of economics, policy, biology, and ecology reflect the three main pillars of sustainability: social, environmental, and economic sustainability, we may be missing greater insights into human behaviors as well as social paradigms

TECHNOLOGY, CULTURE, AND SOCIETY

ZIYI (CLAIRE) HUANG

Computer Science B.S., 2023
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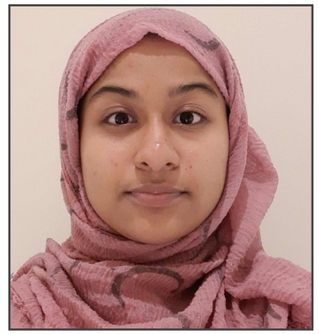
Amy Hurst

Accessible Interpretation in Historic Sites and Museums

Fort Ticonderoga was an important battlefield and plays an important role in representing the history behind the Civil War and the Revolutionary War. There are no interpretation signs or plans to the Carillon Battlefield that could provide educational groundwork. Our research is focused on surveying current battlefields or sites with similar challenges and analyzing how current technologies are used for sharing interpretive content to visitors. Our goal is to design tailored technological solutions to tell the story of the landscape in the way it is accessible and improve the interpretation of the battlefield. In order to enhance and modernize battlefield interpretation, we will design an immersive audio guide system combining with static signage and offline google map embedded trail exploration to create a better interactive visitor experience. A final report and prototypes will be created to allow Fort Ticonderoga to have a mock-up for implementation. While working on the data analysis research, we also worked on two side projects: we are assisting in creating a web application that works on touch sensation from the placement of feasible and affordable tactile materials on the screen. In this regard, our topic of focus is using affordable braille paper on a screen to generate music and/or to create tunes from a web application supported on any touch screen devices, which would bundle up to a research on digital braille music.



MAISHA MAHRIN

Computer Science B.S., 2024
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Faculty
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KATRINA LEE

Integrated Design & Media B.S., 2023
NYU Tandon School of Engineering

Faculty
Amy Hurst

Other Mentor(s)
William Payne

Customization for Blind and Visually Impaired Musicians

Blind and visually impaired (BVI) musicians have usage barriers for existing technology to read and understand music scores. The existing scores are usually only available in braille or large print with no flexibility in customization including understanding the workflows and needs of BVI musicians. From this research, we provide different prototypes using existing technology with the focus of customization. One of the prototypes involves Specdrums which are app-connected rings that convert color into notes. We designed different colored cards with braille labels for BVI musicians to experiment creating music. Another prototype we created is a hybrid version of braille and large print music that allows two users to share the same music score using the Swell Form Machine, which puffs up any black ink to create a tactile music score, and a braille embosser, which imprints the braille onto the paper. In this study, we demonstrate how these prototypes help BVI's familiarize existing music that visually-abled musicians created.

TECHNOLOGY, CULTURE, AND SOCIETY

KYLE LLERAS

Physics B.S., 2023
University of Chicago

Faculty
Jonathan Bain

HERBERT ORTIZ

Physics and Mathematics B.S., 2024
NYU Tandon School of Engineering

Faculty
Jonathan Bain

Black Hole Interior Reconstruction and the Information Loss Paradox

Our project's objective is to evaluate the validity of recent attempts to resolve the infamous Black Hole Information Loss Paradox at a conceptual level. In broad terms, this paradox describes two contradicting theories about whether the evaporation of a black hole can be described as a unitary process. The term, 'unitary' is taken from quantum mechanics which demands that the probability of possible states a quantum system can become always sums to one. In other words, the paradox is a debate on whether information can ever be lost or not. The resolution is based on a duality relation between a region R on the boundary of the spacetime external to a black hole, and a corresponding region in the black hole's interior, called the "entanglement wedge" of R. This duality relation allows information encoded in physical systems inside the black hole to be extracted from information encoded in physical systems located in its exterior. The basis for these claims centers around to what extent can quantum entanglement describe black hole evaporation, and how different notions of entropy (e.g., thermodynamic entropy, statistical mechanical entropy, black hole entropy, and entanglement entropy) both question the assumptions of quantum entanglement and give an alternative explanation to the black hole evaporation phenomena. Thus, our goals for the project are to provide a comprehensive analysis of the Black Hole Information Loss Paradox, generate a conceptual map of the entanglement wedge reconstruction resolution, and evaluate how different notions of entropy relate to both the paradox and resolution.

TECHNOLOGY, CULTURE, AND SOCIETY

ISABELLA LOPEZ

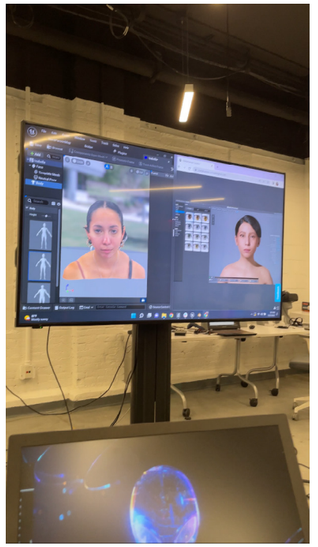
Computer Science, B.S., 2023
University of Maryland, Baltimore County

Faculty
Reginé Gilbert

Visiting Student Fellow

Inclusive and Accessible XR Experiences

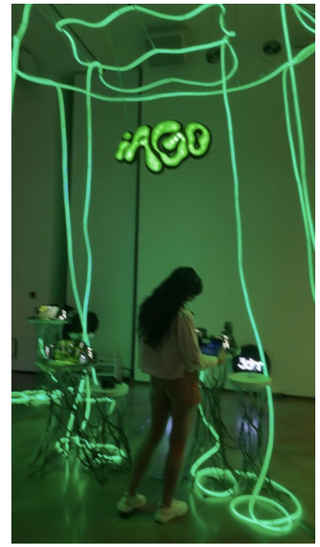
It is said that virtual reality (VR) and augmented reality (AR) is the future, but where do those with disabilities fit into that picture? With one billion people, or 15% of the world's population, experiencing some form of disability, how will this fact be kept in mind as this new technology is developed? Presently, there are no methods of evaluation for usability problems for either VR or AR. This project aims to examine both accessibility and inclusion within these spaces. By reviewing literature and creating AR experiences with accessibility in mind, a heuristic evaluation of VR and AR can be created – one that will help ensure inclusion and accessibility within virtual and augmented reality.



Evaluating MetaHuman Creator for inclusion by attempting to recreate Isabella Lopez.

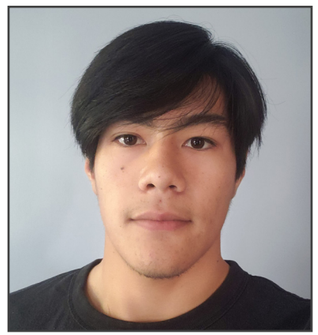
A potential design sketch of a rotating headpiece for an AR filter promoting science, specifically the lunar phases and eclipses.

Isabella Lopez "wearing" a prototype design for the headpiece portion of an AR filter promoting science, specifically astronomy, aeronautics, and space.



"Iago: The Green Eyed Monster" AR experience at Tribeca Immersive 2022.

TECHNOLOGY, CULTURE, AND SOCIETY



HARRY RIOS

Computer Science B.S., 2023
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Faculty
Alice Reznickova

Other Mentor(s)
Wythe Marschall

GLASS Fellow

Sustainable & Equitable Food Systems

According to the Map the Meal Gap Study (MMG) by Feeding America, in 2019, there were an estimated two million food insecure people in New York State (NYS), 600,000 of whom were children (Feeding America, 2019). The same year, the annual budget food shortfall for NYS exceeded one billion dollars. The significant budget shortfall presents a unique opportunity for public-private partnerships to fill this deficit. Funded by the Mother Cabrini Foundation, the objective of FoodMap NY is to develop a white paper and propose strategies for novel private-public pilot programs of market-based solutions to food insecurity in NYS. We began by conducting a landscape analysis of food insecurity in NYS, focusing on understanding conditions of food security, identifying existing barriers, and analyzing case studies. Utilizing MMG, we identified county level food insecurity hotspots with high food insecurity rates (e.g. Montgomery County, 14.4%) and food insecure populations (e.g. Erie County, 104,770 people); followed by a census tract level analysis of household and community characteristics associated with increased risk of food insecurity, according to Feeding America's review of food insecurity drivers, in cities. Currently, we are reviewing and coding organizational reports, peer reviewed literature, and gray literature on strategies to address food access and affordability in NYS. These include Community Supported Agriculture, farmer's markets, healthy corner stores, grocery delivery, and more. We will analyze successful programs to inform our proposed intervention and create a list of stakeholders in NYS who may participate in pilot programs.

LU YII WONG

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Wythe Marschall

TECHNOLOGY, MANAGEMENT, AND INNOVATION

XIYAN (CHRISTINE) WANG

Integrated Design and Media B.S., 2024
NYU Tandon School of Engineering

Faculty
Graham Dove

Other Mentor(s)
Oded Nov

Future of Multiple Sclerosis (MS) Healthcare Work

Human-computer interaction (HCI) is a multidisciplinary field of study that focuses on human's interaction with technology. HCI aims to build beneficial tools, interactive experiences and functional systems to enhance the quality of life. Walking impairment presents a big challenge for patients with Multiple Sclerosis (MS). Among MS patients, 41% reported having difficulty walking, and 70% said that walking impairment is the most challenging aspect of MS. This research explores clinical assessment data captured by wearable technologies both in and out of clinical appointments. The main objective is to examine how wearable sensor data can be best visualized and designed to show patients' long-term rehabilitation progress, considering the clinician's limited review time and the traditional healthcare documentation habits. In this research, I will build upon previous work and prototype, compare literature from HCI in healthcare research conferences with remote moderated interviews of MS rehabilitation clinicians, and analyze and create data visualization and interface recommendations that are meaningful to clinical practices.

TIANYUE YI

Integrated Design and Media B.S., 2023
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Faculty
Graham Dove

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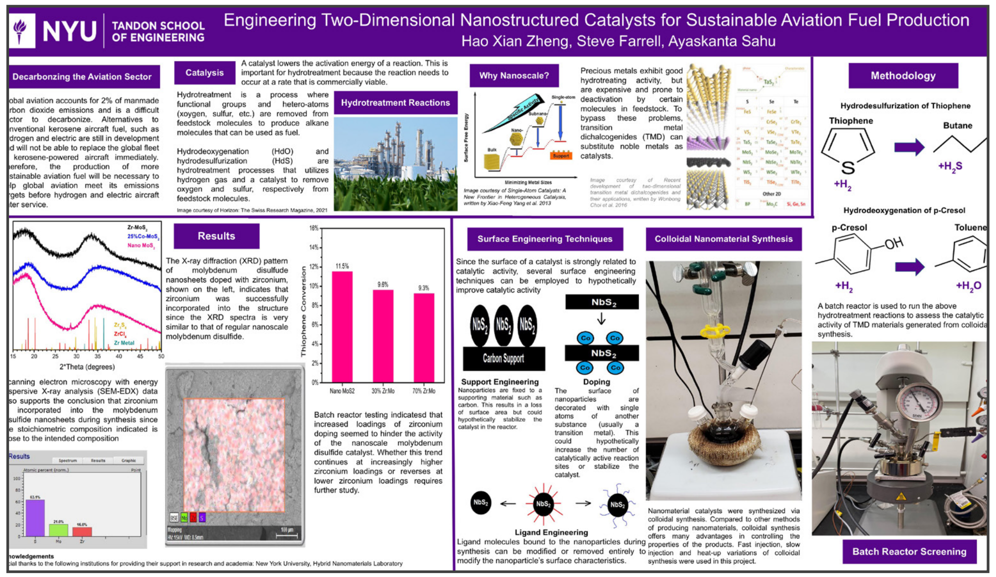
Oded Nov

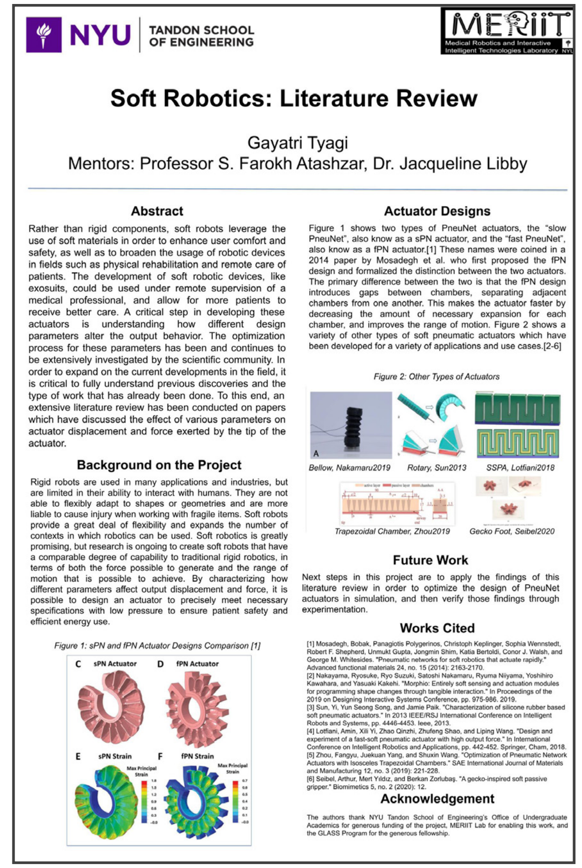
Sounds in New York City

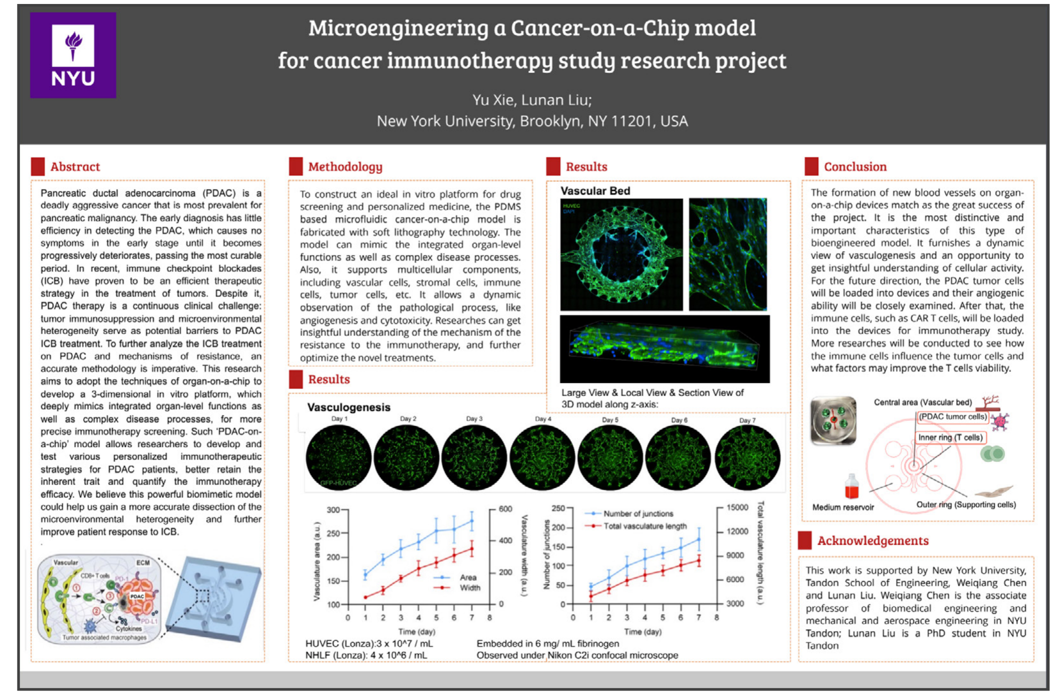
It is probably hard for residents to pay attention to the effect of noise and air pollution in a particular environment they've been living in for a while. With the deployment of sensors, the measurement and monitoring of noise and air quality help non-professionals arouse awareness of the environmental reality. However, personal perceptions, experiences, languages and cultural differences normally play roles in interpreting the data. To make the data more meaningful to Chinese Americans around Sunset Park in Brooklyn, the research team used both quantitative and qualitative research methods. For example, we analyzed and visualized the data we'd collected, guided a community walk and conducted a focus group after a three-week installment of sensors to obtain an empirical understanding of the experiences people have with the noise and air quality data, and come up with design strategies in mitigating environmental quality.

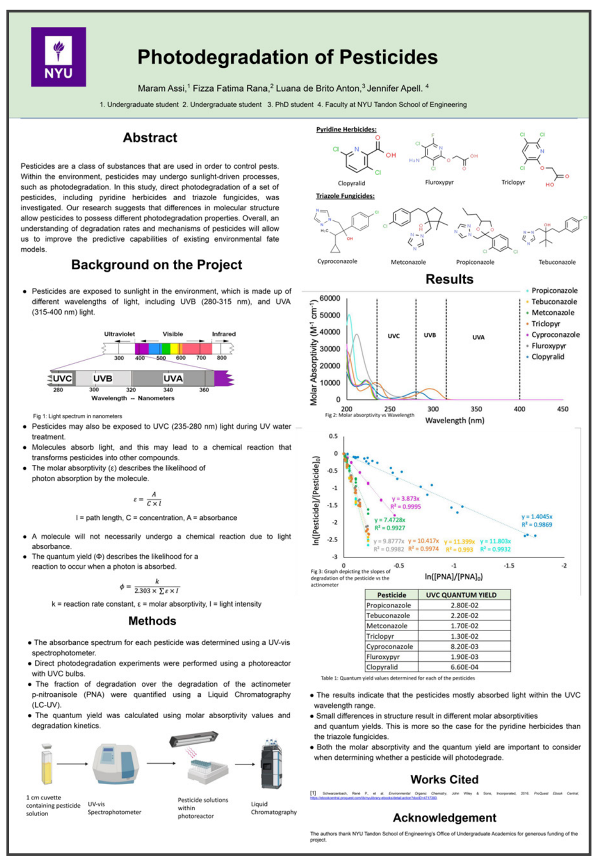
STUDENT POSTERS

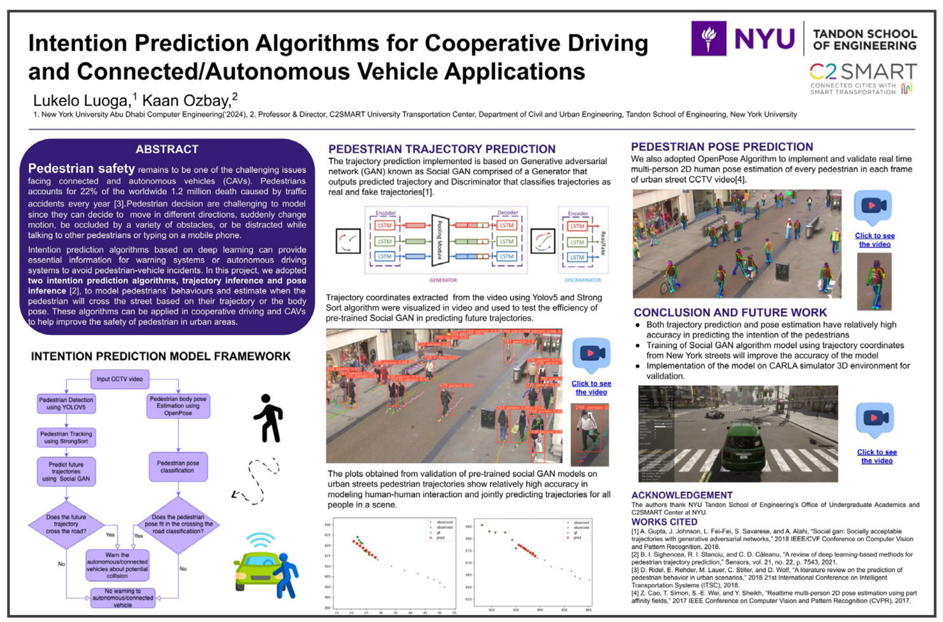
A selection of research posters are shown here.
View all posters here.

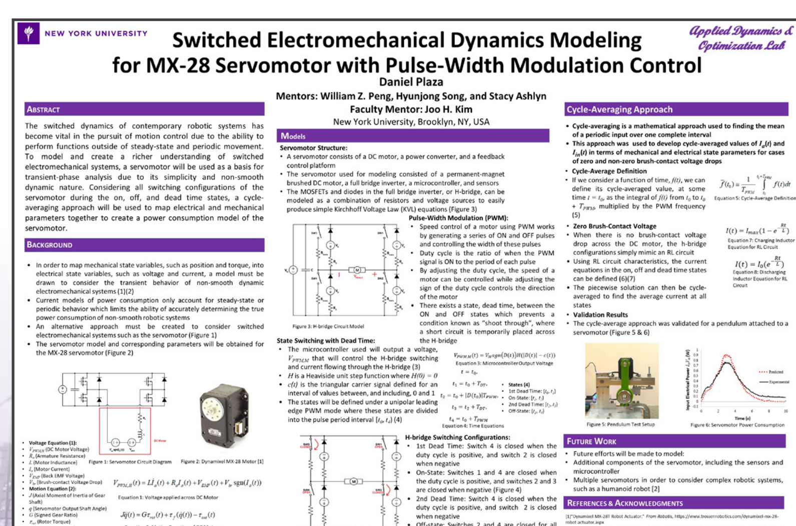


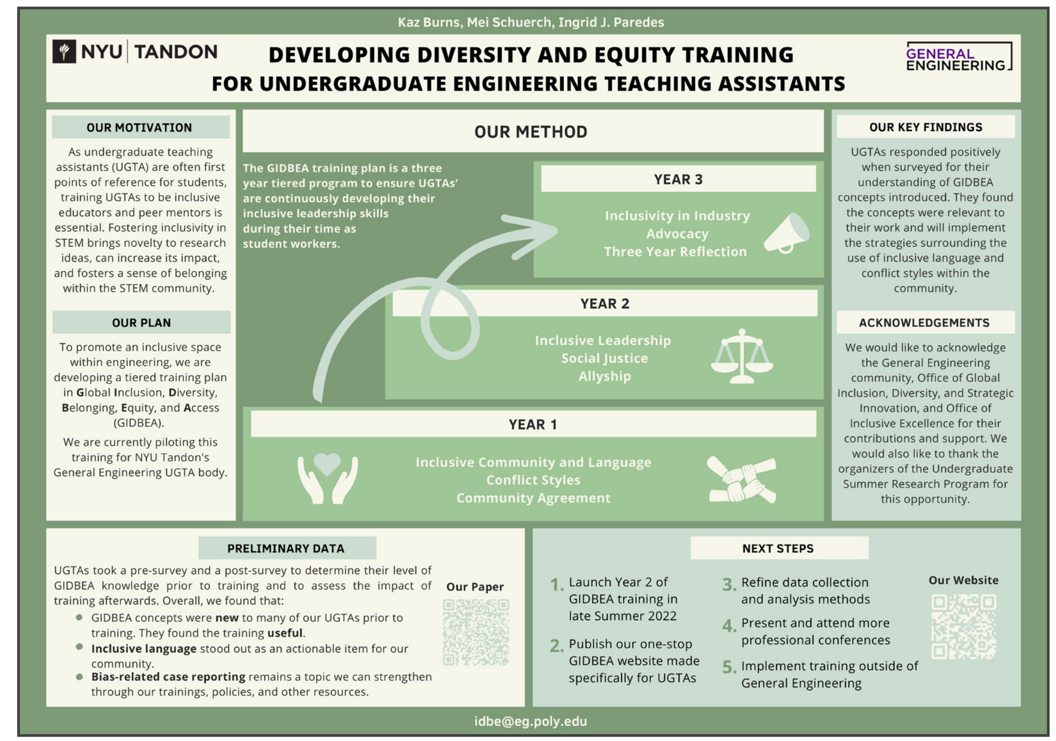


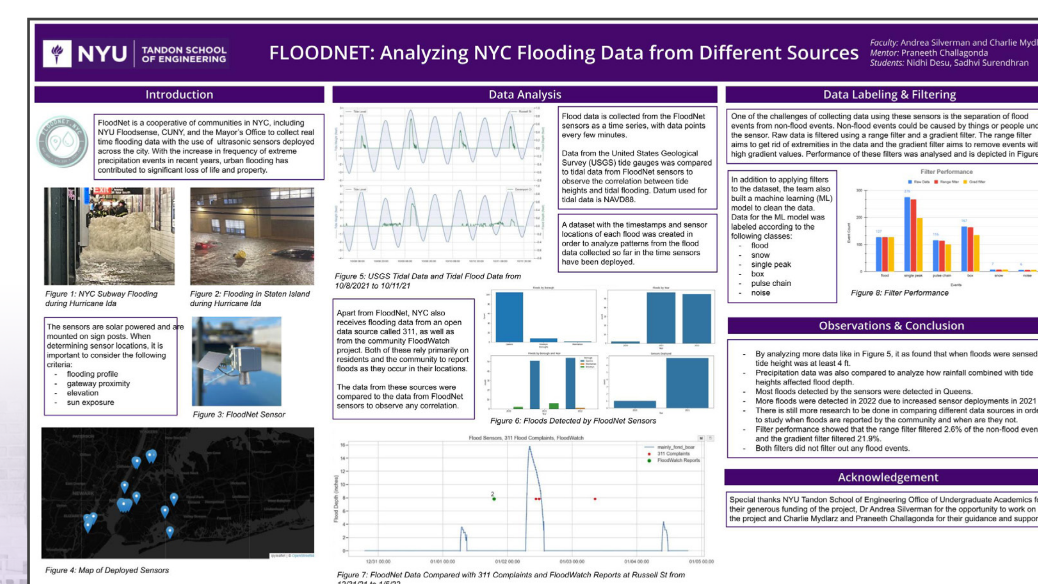


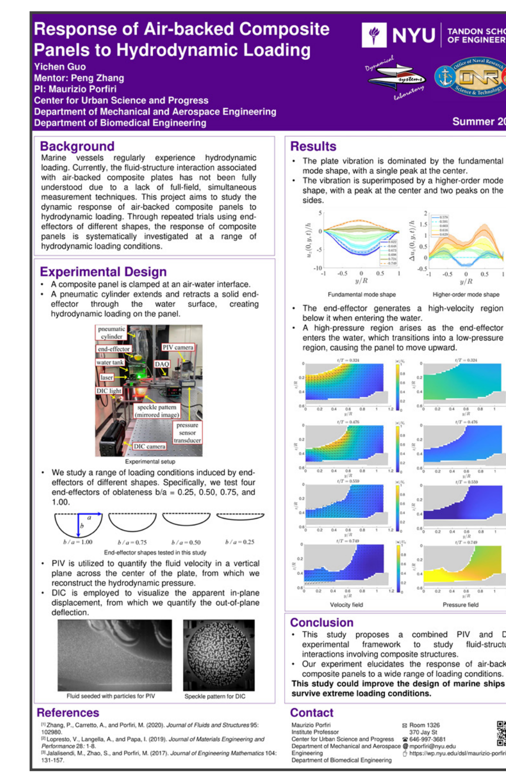












A SPECIAL MESSAGE FROM THE PROGRAM COORDINATORS

The UGSRP was initiated at Tandon in 2007. The Office of Undergraduate Academics has coordinated the Tandon Undergraduate Summer Research Program (UGSRP) since 2011. We are responsible for the expansion of the program from 60 student participants to well over 100 as well as faculty expansion that includes professors and research projects from NYU Wireless, the GovLab, the NYU Center for Urban Science and Progress, the Center of Faculty Innovations in Teaching and Learning, the Makerspace, and various VIP projects. We have worked tirelessly to match the students with their best-suited faculty mentors and research staff in order to ensure fruitful participation. We have also dedicated time and effort to provide academic, career, and personal development seminars, lectures, workshops, and events so that students come out of the program with enhanced knowledge of both their research area and various opportunities and paths as they move forward in their professional trajectories. We have dedicated ourselves to this program and made sure to develop, maintain, and enhance it at every turn. We are thankful for all of those that joined in on this summer's program and assisted us to ensure a seamless program from start to finish. We congratulate all of the student participants on a successful summer and hope you enjoyed our program.

COORDINATORS

SARA-LEE RAMSAWAK
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