

FIFTEENTH ANNUAL

SUMMER UNDERGRADUATE RESEARCH PROGRAM ABSTRACTS

2021

NYU TANDON SCHOOL OF ENGINEERING

2021 SUMMER RESEARCH



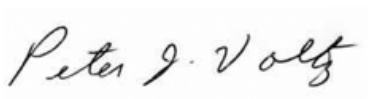
NYU Tandon School of Engineering's Undergraduate Summer Research Program (UGSRP) provides a unique opportunity for NYU Tandon, NYU Abu Dhabi, NYU Shanghai, NYU College of Arts and Science + NYU Tandon 3+2 Dual Degree Program, and other select students to engage in research over the course of the summer 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 and Azure Stewart were involved in the program for the second year through the provision of the Student2Scholar (S2S) Series. A tremendous thanks to both them and 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 presenter is included within this booklet.

Financial support from NYU Tandon, faculty research grants, and outside donors is also essential to the program's maintenance. This year marked the tenth 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. A very special thanks also goes out to Nicole Johnson, who volunteered her time to mentor the TB Fellows, providing them with additional programming and engagement throughout the summer, remaining in contact with these students over time often bringing them back to engage with younger TB Fellows. The program has housed additional fellowships, including the Tandon Scholars Fellowship, The IIIE Fellowship, and the Visiting Student Fellowship. Like 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, Assistant 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. Ishan Krishan, Tandon's UGA Administrator took charge of the program's various modifications and developments, working tirelessly to enhance the application system and other software applications. Johanna Xue created this year's Abstract Booklet.

COVID-19 disruptions provided the group of coordinators with several challenges for the 2021 Program. That said, technology has allowed for it to run hybrid for the summer of 2021. While most students participated remotely and asynchronously, some of our participants worked on their research in person on-campus. All of the seminars, workshops, and events, however, were held virtually. At the end of the program, all students participated in a poster session and select students presented more detailed information at our presentation session. 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 2021 Undergraduate Summer Research Program, thanks to the Research Staff and Dede Bartlett, along with our coordinators. I look forward to future summers of more intellectual and scholarly activities!



Peter Voltz
Associate Dean for Undergraduate and Graduate Academics

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Dane Gambrell
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Anirudh Dinesh
Charlie Mydlarz
Oded Nov
Sinan Ascioglu
Aditi Ramesh

CALENDAR OF EVENTS

COORDINATED BY SARA-LEE RAMSAWAK

JUN - AUG 7 6

STUDENT TO SCHOLAR SERIES (S2S)

Presented by Matthew Frenkel & Azure Stewart

- What is Research?
- Developing a Literature Review
- Writing a Research Statement
- Ethics in Research
- Developing a Research Proposal
- Leadership Management Workshop
- Constructing a Research Poster
- Presenting Research
- Writing for Publication
- General Graduate School Applications + Funding

JUN 14

MAKERSPACE SESSION

Presented by Victoria Bill, Christina Lafontaine, & Elizabeth New

JUN 24

NSF GRFP

Presented by Prof. Vikram Kapila

JUL 7

GLOBAL INFORMATION SESSION

Presented by Colby Hepner

JUL 21

VERTICALLY INTEGRATED PROJECTS (VIP) INFORMATION SESSION

Presented by Amy Dunford

JUL 22

PRECAPSTONE INFORMATION SESSION

Presented by Sara Thermer

JUL 29

WEST FEST

Coordinated by Cindy Lewis

AUG 4

TANDON GRADUATE SCHOOL INFORMATION SESSION

Presented by Wahidah Aziz and Leanna Kowallis

AUG 11

WASSERMAN PRESENTATION

Presented by Shan Meisner

AUG 13

POSTER AND PRESENTATION SESSION

Coordinated by Jen Piro

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.

More details about the different fellowships:

Thompson Bartlett Fellowship

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.

Coordinated by Nicole Johnson - Tandon Assistant Dean for Opportunity Programs

2021 marks the 10th anniversary of this Fellowship!

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 Honors Program and GLASS Program students within the UGSRP

Access to additional funding for supplies and conferences

Coordinated by Jen Piro – Tandon Assistant Director of Undergraduate Programs

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

THOMPSON BARTLETT FELLOWSHIP CELEBRATES A DECADE OF IMPRESSIVE WOMEN



Every summer since 2007, members of the Tandon School of Engineering faculty (with yearly expansion to include several other offices, centers, and labs) have opened spots on their research projects to allow rising sophomore, junior, and senior level undergraduate students to work at a level generally reserved for master's and doctoral candidates through the Undergraduate Summer Research Program. In addition to the work they do on the projects, students participate in programming coordinated by the Undergraduate Academics Office.

Since 2012, numerous outstanding female undergraduates have been eligible for an additional honor: the Thompson Bartlett Fellowship, sponsored by longtime benefactor Dede Bartlett. Bartlett — a former executive with two Fortune 500 companies (Exxon Mobil and Altria) — launched the fellowship in honor of her father, George Juul Thompson, who graduated in 1930 from what was then affectionately known as Brooklyn Poly and returned to teach electrical engineering at the school from 1948 to 1968. "During his two decades of teaching, he had only one female student," Bartlett explains, "and I wanted to help change that."

Summer 2021 marks the 10th anniversary of the first summer the fellowship was instituted, initially sponsoring 3 students. In coordination with her husband, Jim Bartlett, and her son, John Barlett, Dede continues to support high-achieving students. Over the past few years, their sponsorship has risen to annually support 10 students. In addition to the funding these students receive, the Thompson Bartlett Fellows also participate in additional exclusive programming, coordinated by Nicole Johnson, Tandon's Assistant Dean for Opportunity Programs and Director of the TRIO Program. In close collaboration with Dede, Johnson ensures that the students are getting targeted workshops and seminars that suit their needs and speak to their unique chalenges as women in STEM.

Alumni from the fellowship program have enjoyed their experience and have moved on to continue their STEM pursuits in various different fashions, benefitting from this opportunity. Amanda Setiawan confirmed that to this day, she still utilizes many of the engineering skills that she picked up during the course of the research program, especially programming languages and technical writing. Kristen Marventano is working her dream job as a Software Engineer at Google, a position in which she secured prior to graduating. Stemming from this program, Chappel Sharrock Thornton moved on to continue research, currently situated as a Ph.D. candidate focusing on materials science and engineering.

Many of the alumni are thankful for the Fellowship and their experience as Thompson Bartlett Fellows. Chase Rosenberg admitted that the Thompson Bartlett Fellows Program allowed her to connect with other women in STEM and recognize that women all face similar struggles. Similarly, Nandita Kohli was thankful to have a space designed to empower women that felt safe and nurturing. Michelle Ren felt inspired by the other fellows in her group and it opened her eyes to different things. Eve Fishinevich confirmed that the Fellowship helped her secure future research positions and matriculate into her first choice graduate school.

The Undergraduate Academics Office, the Undergraduate Summer Research Program, and the New York University Tandon School of Engineering are extremely thankful to Dede Bartlett for her contributions and support of our women students. We are also grateful to Nicole Johnson for her continued coordination for the fellowship activities and events. Over the years, a large network of exceptional women have developed and have been nurtured through this Fellowship. We are, and continue to be, impressed with them and all that they have accomplished. We look forward to the future achievements of all our Thompson Bartlett alumni!




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ENGINEERING


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OF ENGINEERING

BIOMEDICAL ENGINEERING



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NYU Tandon School of Engineering

Developing an In Silico Leukemia Model for CAR-T Cell Immunotherapy Screening

There's been a lot of progress in acute lymphoblastic leukemia with many new strategies. The current treatments of ALL include chemotherapy, radiation therapy, stem cell transplant, targeted therapy and, more recently, immunotherapy available only for B cell ALL (B-ALL). In spite of these treatment options, children with ALL continue to have dismal prognosis, especially the ones that relapse, due to the absence of better targeted therapies that target leukemic cells without harming normal cells are the need of the hour. A high relapse rate (30-60%) has emerged as one of the major setbacks. A number of mechanisms underlying leukemia relapse after CD19 CAR T-cell therapy have been reported, such as in vivo CAR T cell expansion and/or persistence, targeted antigen-loss related relapses and leukemia lineage switch. Therefore, this project aims to establish an experiment model to explore how CAR T-cell interacts with B-ALL in a microfluidics device, which physiologically relevant 3D tissue and characteristics of the leukemic BM niche. We believe this model can be applied to optimize and predict CAR-T cell therapy, which will finally improve the long-term survival rate in B-ALL patients.



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Exploring the Cellular Mechanobiology of Aging: From Biology to Mechanics

Aging is a complex process that results in permanent cellular decay in living organisms. Cellular mechanobiology, which is the study of how cells apply and are affected by forces, is also impacted by aging which leads to alteration in cellular mechanics, signaling and subcellular cytoskeleton structures. The objective of this project is to determine the cause of mechanobiological changes in the cells during aging and develop different strategies for slowing down and reversing aging process. Micro-fabrication is used to create devices that measures forces applied by the cells in the nN range. These devices called mPADs (micro Post Array Detectors) are functionalized with fibronectin and fibrinogen to facilitate cell adhesion. Image processing and micropillar deflection is used to measure forces applied by the cell. The forces are calculated using Cellogram, a software for reference-free traction force microscopy (TFM). Further, the cells are actuated using ultrasound tweezers and their dynamic response is measured using mPADs. Lastly, subcellular actin in young and old smooth muscle cells is compared after immunostaining by observing the changes in this subcellular mechanotransductive protein.

BIOMEDICAL ENGINEERING



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T-Cell Mechanoimmunology During Immunotherapy

T-Cells are a critical part of the adaptive immune system and are responsible for the detection, targeting, and attacking of foreign and natural bodies that pose a threat to the larger organism. Their activation upon identification of a target antigen produces dynamic forces specific to their cytotoxic immune response. Force analyzation devices were constructed via a micropillar fabrication process that allowed for cell movement and force generation to be tracked and quantified with subsequent computational analysis. Stronger immune responses exhibited positive correlation with higher levels of recorded forces. This aided the project's specific purpose of furthering the definition of mechanotransduction relationships between changes in force and resulting cellular mechano-immunological responses. Through testing designated antibodies with the non-canonical WNT-activating ligand, Foxy-5, the resulting T-Cell signaling and force feedback communicated the most optimal conditions for increasing an immune response. This research furthers the field of immunology by providing a better understanding of the required components for T-Cell activation.



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T-Cell Mechanoimmunology During Immunotherapy

T-Cells are a critical part of the adaptive immune system and are responsible for the detection, targeting, and attacking of foreign and natural bodies that pose a threat to the larger organism. Their activation upon identification of a target antigen produces dynamic forces specific to their cytotoxic immune response. Force analyzation devices were constructed via a micropillar fabrication process that allowed for cell movement and force generation to be tracked and quantified with subsequent computational analysis. Stronger immune responses exhibited positive correlation with higher levels of recorded forces. This aided the project's specific purpose of furthering the definition of mechanotransduction relationships between changes in force and resulting cellular mechano-immunological responses. Through testing designated antibodies with the non-canonical WNT-activating ligand, Foxy-5, the resulting T-Cell signaling and force feedback communicated the most optimal conditions for increasing an immune response. This research furthers the field of immunology by providing a better understanding of the required components for T-Cell activation.

CHEMICAL AND BIOMOLECULAR ENGINEERING



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Faculty
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Improving Organic Photovoltaics Using Novel Croconate Non-fullerene Acceptors as Ternary Additives

In the last 30 years, organic solar cells (OSC) have been studied for their lightweight, flexible, and low-cost benefits from traditional inorganic solar cells. OSCs have reached higher efficiencies following the development of non-fullerene acceptors (NFAs), most recently with the family of Y-series acceptors which increased it to 17% efficiency in a binary system, due to their free charge generation in high-performance blends of donor polymers and acceptors that create multiple charge transport channels and stronger electroluminescence efficiency that allow for higher photocurrents and lower energy loss in high voltage. A ternary system involving two NFAs can also improve device efficiencies by increasing absorptivity and improving film morphology for efficient transport.

While the current Y-series NFAs have been thoroughly characterized, using croconates as an additive for them has not been investigated in detail. For this project, several push-pull acceptors with a croconate core are prepared via a simple Michael addition and systematically incorporated into the bulk heterojunction as ternary additives. Ultimately, the goal is to determine whether croconates can be used to enhance OSC performance.



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NYU Tandon School of Engineering

Python GUI Development on Raspberry Pi Pico

Developing a safe, long-life, short charging time battery has always been a challenger to researchers and scholars. A rechargeable battery consists of a cathode, an anode, and an electrolyte solution with a barrier that prevents molecules and particles from passing through. A coulometric titration method called Galvanostatic Intermittent Titration Technique (GITT) has been used by many researchers to evaluate the diffusion of lithium ions. Since faster diffusion of lithium ions leads to shorter charging time, estimating the diffusion coefficient of lithium ions within the cathode is used to measure the charging time. A shield board on Arduino Uno was developed, and a piece of software on Arduino IDE, but it uses text-based user interface on communication monitor window. It is highly desirable to have graphical user interface (GUI) that replaces the text-based interface to facilitate students' use of the GITT software.
In this project, a graphical user interface (GUI) is developed to ease interactions between user and a microcontroller. For a start, MicroPython was used to collect data from Raspberry Pi Pico (microcontroller) and regular Python to "eavesdrop" the data collection, plot the data, and do other user interface procedures. Currently, the program is able to analyze and plot the real-time data from Raspberry Pi Pico, display results in a scrollable tree view, read and edit local file, and interchanging between different windows.

CHEMICAL AND BIOMOLECULAR ENGINEERING



KEVIN LIN

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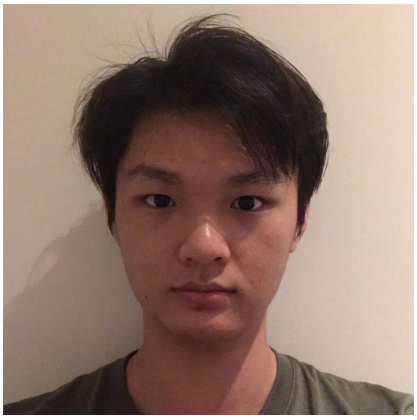
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Developing Redox Flow Battery for Water Purification and Energy Storage

Freshwater scarcity is one of the global challenges faced by the development of modern society. Coupled with increasing freshwater demands, worldwide energy demand is also rapidly increasing. The world today shifts toward renewable sources like solar and wind; however, there are limitations. Redox flow batteries (RFB) on the other hand offered promising advantages over traditional energy storage methods. A RFB is an electrochemical cell where redox species dissolved in electrolytes react at electrodes with the two sides separated by a membrane. RFBs use redox couples in liquid form as charge storage materials for energy conversion between chemical and electrical energy. The electrolytes, catholytes and anolytes are stored in two separate reservoirs. They are pumped through electrode surfaces where electrochemical reactions take place for energy conversion. Methyl viologen and sodium ferrocyanide are used as control electrolytes with Nafion 117 and Selemion as membranes separating between channels. In the study, the electrolytes are to be replaced by other electrolytes to test for better charge capacity as well as energy efficiency, current efficiency, and voltage efficiency.



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Understanding Photo-Accelerated Fast Charging in LiMn2O4 cathodes

The adoption of lithium-ion batteries has allowed for rapid and dramatic development of electric vehicles in the last 10 years, due to their high energy density. However, one of the barriers to adoption of electric vehicles is range anxiety, spurred on by the long times necessary to charge the batteries as compared to refueling a gas-powered vehicle. Recent methods to increase the charging rate usually require nanostructure or low electrode loading. Recently it was shown that interaction of light with $LiMn_2O_4$ electrodes can dramatically increase the charging rate by a factor of 2 or more. The light would induce a microsecond long lived charge separated state with Mn_4+ plus electrons which ejects more lithium ions, created under light. This new discovery can develop better and more efficient fast recharging technology.

CHEMICAL AND BIOMOLECULAR ENGINEERING



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NYU Tandon School of Engineering Tandon Scholars Programs Fellow

Synthesis of Amorphous Selenium Thin Films via Chemical Bath Deposition

Photodetectors based on amorphous selenium (a-Se) have been an area of intense research due to the excellent photoconductive properties of a-Se. a-Se is a wide bandgap semiconductor, amenable to large area deposition on a wide range of substrates, rigid or flexible, and has widespread applications in optical sensors, direct X-ray detection, and in combination with scintillators for gamma and X-ray detection. a-Se is an avalanche photodetector, possessing a unique property of impact ionization, where only single-carriers (holes) are amplified at high electric fields to reach a gain of the order 102 - 103. In order to take advantage of the avalanche properties in a-Se, thin films of high quality a-Se need to be deposited on substrates. In our work, we optimize the fabrication conditions for chemical bath deposition (CBD) of a-Se. CBD is an advantageous technique as it eliminates the formation of poisonous gases like selenium vapors released in physical vapor deposition methods. The process involving CBD of semiconducting a-Se films requires substrates to be immersed in an acidified solution that contains selenium ions. Deposition of a-Se using CBD is based on the principle of nucleation when an ionic product exceeds the solubility product. The advantages of CBD include simplicity of the procedure, increased safety, and the fabrication of large-area thin films. In this work, accurate conditions pertaining to the CBD process were investigated by varying pH, concentration, duration, and temperature systematically. X-ray diffraction (XRD), and Scanning Electron Microscopy - Energy Dispersive X-ray Spectroscopy (SEM-EDS) were used to study the chemical structure and uniformity of the films. Optical studies were done to study the electronic structure. It was found that the thin films were uniform with an excellent deposition. This was possible by not only identifying the most favorable conditions, but also reducing the amount of sodium ion concentration on top of these films that were affecting its functionality, and increasing the uniformity by preventing deposition on the containers used for CBD through plasma cleaning.

CHEMICAL AND BIOMOLECULAR ENGINEERING



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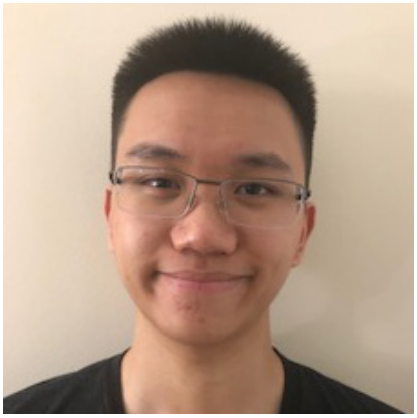
Nanostructuring Two-Dimensional Catalyst Materials for Sustainable Biofuel Valorization

The conversion of oxygen-rich biomass into biofuels via hydrodeoxygenation (HDO) is a chemical process that is gaining traction as a way to produce sustainable energy. In this process, catalysts are employed to facilitate the removal of oxygen atoms from biomass molecules to create high energy density fuels. Although precious metals typically exhibit effective hydrotreating activity, they are expensive and prone to deactivation by contaminants. This problem can potentially be overcome by instead utilizing transition metal dichalcogenides (TMD), such as MoS_2, which are deployed in other industrial hydrotreating reactions. These materials can be grown as stable two-dimensional nanosheets, greatly increasing the available surface area for reactivity in comparison to materials with larger crystals; this yields more catalytic sites and thus greater catalytic activity. We will study the effect of size, morphology, and dopants on catalytic activity; nanocatalysts with varying characteristics will be synthesized. We will then screen the catalysts in a hydrotreating reactor with a model biomass compound to determine the characteristics for optimal HDO activity. We are looking to understand the catalytic and kinetic behavior of these nanocatalysts for possible integration in scaled-up HDO operations.



Benchtop Reactor

CHEMICAL AND BIOMOLECULAR ENGINEERING



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Copper Selenide as a Tunable Nanocatalyst for Sustainable Hydrogen Fuels

Global warming from industrial, commercial, and residential sources are greatly impacting our environment, with carbon dioxide being a large contributor. Transitioning to a carbon-neutral and carbon-free fuel source is vital to counteracting the centuries of climate change caused by using conventional fuel sources such as oil, natural gas or coal. While hydrogen gas has shown promise as a carbon-free fuel source, it is difficult to store and transport safely and efficiently. Formic acid is a potential viable storage option as it is inert in typical environments and can be broken down into hydrogen gas with several different catalysts. Typically, costly precious metals, such as platinum and gold, are used, making industrial scale-up difficult. We are investigating copper selenide as an inexpensive and efficient nanocatalyst that can be used in formic acid decomposition because they have shown promise in carbon-based reactions and their activity is easily tunable for different stoichiometries and structures. By tuning the size, ligands, and the stoichiometry of our copper selenide nanoparticles, we aim to study the effectiveness of our colloidally synthesized nanocatalysts in a low temperature environment.



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Evaluating the Potential of Heterostructured Quantum Dots as Effective Thermoelectric Materials

Quantum dots, which are atomic clusters ~2 - 20 nm in size, have tunable bandgaps that provide scientists a toolkit to manipulate a range of electrical properties depending on their size, shape, and surface. These quantum dots can be doped with additional materials to form heterostructured quantum dots, allowing for precise control over the number of charge carriers, which is particularly useful for thermoelectric materials.

Thermoelectric materials are crucial in absolving the heat waste problem by transforming a temperature difference into an electric potential or vice versa. This phenomenon is known as the Seebeck and the Peltier effect. Materials such as AgsSe and Cu2Se are intrinsic n-type and p-type semiconductors, meaning the majority of charge carriers are free electrons or holes. Thus, this project focuses on synthesizing heterostructured quantum dots such as Cu_2Se/Cu_2S and Ag_2Se/Ag_2S from CdSe/CdS through ligand and cation exchange. Effective thermoelectric materials typically have low thermal conductivity but high electrical conductivity. Current research focuses on increasing the Seebeck coefficient, the change of voltage concerning temperature, and reducing the thermal conductivity by manipulating the nanostructure of thermoelectric materials. However, current thermoelectric materials on the market are expensive to make thus, these heterostructured quantum dots could potentially be a viable alternative.

CHEMICAL AND BIOMOLECULAR ENGINEERING



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Optical Characterization of Polymer Blends for Lithium-ion Battery Applications

Lithium-ion batteries are an integral part of today's society as they power many modern-day consumer technologies such as phones, laptop computers, and other electronic devices. These batteries are considered the most efficient in their class because they are able to withstand prolonged charge cycles. With renewable energy systems on the rise, lithium-ion batteries will play a crucial role in energy storage. These batteries follow the structure of a galvanic cell, containing an anode, cathode, and electrolyte. We are studying the use of polymer blends mixed with lithium salts as possible electrolytes for lithium-ion batteries. A polymer blend is a mixture of two or more polymers. The aim is to find a pair of polymers that are miscible, have high electrical conductivity and low viscosity. Due to the novelty of polymer electrolyte applications in lithium-ion batteries, researchers at both the New York University Tandon School of Engineering and the University of California Berkeley are working to find a polymer blend that possesses the properties needed to store and deliver energy efficiently for renewable energy sources. Polymer electrolytes composed of a polymer blend and a lithium salt were synthesized, and their light scattering efficiency was measured as a function of temperature. This allowed for the miscibility and crystallization pattern to be determined. It is expected that further research in optically characterizing polymer blends will allow for a greater understanding of which polymer electrolytes should be utilized in these lithium-ion batteries, and perhaps, allow the availability of renewable energy for individual consumers to be more accessible in the future.



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Lead Halide Perovskites for Quantum Cutting to Increase Solar Cell Efficiency

Ytterbium-doped cesium lead chloride perovskites have attracted attention as a coating material on silicon solar cells that can increase their power conversion efficiencies via a process called quantum cutting. Quantum cutting is when a material converts one high-energy photon into two photons at half that energy. A quantum cutting layer on a silicon solar cell can improve its efficiency beyond existing limits by converting each high-energy ultraviolet and blue photon to two near-infrared photons to reduce thermal losses due to band edge relaxation. This coating also shifts the absorption to a spectrum region where the silicon solar cells can convert light into current more efficiently. We use physical vapor deposition to synthesize Ytterbium-doped $CsPbCl_3$ thin films. CsCl and $PbCl_2$, and $YbCl_3$ are co-evaporated in vacuum onto substrates to deposit $CsPbCl_3$ thin films. The films are annealed in a nitrogen-filled glove box or air after deposition at temperatures ranging from 200-350 oC. We investigated the effects of film stoichiometry, annealing temperature, and annealing environment on the crystal structure, film composition, photoluminescence lifetime, and photoluminescence quantum yield (PLQY). Yb-doped $CsPbCl_3$ films show near-infrared (NIR) photoluminescence from a Yb transition at approximately 990 nm (1.25 eV) when excited by light with energy greater than the $CsPbCl_3$ bandgap (3 eV). Yb-doped $CsPbCl_3$ thin films exhibited PLQY as high as 62%. PLQY decreases with increasing Yb concentration for Cs-rich films. We investigated the effects of annealing conditions on PLQY for films with different Cs:Pb ratios.

CHEMICAL AND BIOMOLECULAR ENGINEERING



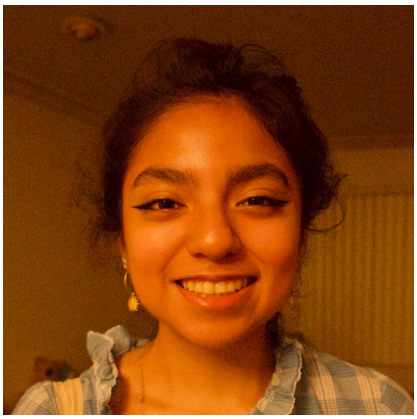
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Physical Vapor Deposition of Cesium Silver Bismuth Halides as a Quantum Cutting Layer on Silicon Solar Cells to Increase their Power Conversion Efficiency

Silicon solar cells dominate the solar cell market, but their efficiencies have plateaued in the last two decades at approximately 26% because of two reasons. First, ultraviolet (UV) and blue light are converted to electrical current inefficiently. Second, much of the energy in these UV and blue photons are converted to heat rather than electrical power, limiting their ultimate efficiency to approximately 33%, called the Quessier limit. Therefore, it is desired to convert these UV and blue photons to near-infrared radiation before entering the solar cell, where silicon solar cells are more efficient. Ytterbium-doped inorganic halide perovskites have garnered attention as a potential coating on silicon solar cells to accomplish this. Such ytterbium-doped perovskites exhibit quantum cutting, generating two near-infrared (NIR) photons (1.25 eV) from each UV or blue photon absorbed at energies >2.5 eV. Coating silicon solar cells with quantum cutting materials has the potential to increase silicon solar cell efficiencies above the Quessier limit of 33% if one can achieve photoluminescence quantum yields (PLQY) approaching 200% (2 near-infrared photons for every high energy UV-blue photon). We are working on a new halide perovskite material, ytterbium-doped Cs_2AgBiX_6 (X= Cl, Br), which may be a candidate for efficient quantum cutting. We deposit thin films of this material using physical vapor deposition (PVD) via co-evaporation of CsX, AgX, BiX_3, and YbX_3. The flux of each precursor is monitored using quartz crystal microbalances, providing direct control of their evaporation rates and thus the film composition. PVD is also a scalable, reproducible, and solvent-free technique and can be easily integrated into manufacturing if a suitable quantum cutting material can be found. We investigate the effects of precursors' fluxes, substrate temperature, and post-deposition annealing conditions on the films' optical properties. Structural and optical properties of perovskite films are characterized using X-ray diffraction, Raman spectroscopy, absorption, and photoluminescence. In addition, we are studying the effects of deposition conditions and film composition on the near-infrared PLQY of perovskite films. The goal is to determine if this new material is suitable for a quantum cutting layer on silicon solar cells and to maximize PLQY. During the summer, we achieved record PLQY from ytterbium-doped Cs_2AgBiX_6.

CHEMICAL AND BIOMOLECULAR ENGINEERING



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Water Responsiveness of Self Assembling Protein Triblock Polymer CEC

Water-responsive (WR) materials exhibit dynamic swelling and shrinking behavior in response to relative humidity (RH) changes in their environment. This allows them to serve as high-energy actuators in a variety of different mechanical systems including soft robotics and sensors.

Proteins are promising WR materials because they are essential components of natural structures with high energy performance levels. However, the design parameters for WR protein materials remain poorly understood.

Our lab has constructed a protein with multiple self-assembling domains composed of an elastin (E) domain fused with two flanking cartilage oligomeric matrix protein coiled coil (C) domains to form CEC. Prior experimentation showed that an $L_{44}A$ mutation in the C domain abolishes the α-helical structure. To investigate the role CEC's coiled-coil domain plays in WR behavior, $C_{L44A}EC_{L44A}$ was used as an unstructured control. Both variants were expressed in *Escherichia coli* and purified. Secondary structure was confirmed by circular dichroism spectroscopy.

The proteins were then cast onto thin polyimide films and exposed to varying RH levels. Energy densities were calculated from curvature measurements of the bilayer samples. Results demonstrated that $C_{L44A}EC_{L44A}$ outperformed CEC with an energy density of 647.9 ± 86.8 kJ/m3 compared to CEC's 119. 4 ± 34.3 kJ/m^3. This suggests that factors other than α-helicity contribute to protein WR behavior. With these results we are now closer to understanding the design parameters involved in WR biomaterial development.



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Modeling Amyloid Protein Co-Aggregation in Neurodegenerative Diseases

The spontaneous aggregation of β-amyloid (Aβ) and α-synuclein (α S) monomers into fibrillar species is the process responsible for neurodegeneration seen in Alzheimer's and Parkinson's disease, respectively. Recent studies show that oligomeric intermediates, rather than mature fibrils, are the most neurotoxic species in the amyloid protein aggregation pathway. Studying the heterogeneity of and classifying these intermediates based on their kinetic and structural properties is thus beneficial in the development of drugs to inhibit oligomeric cytotoxicity. While there exist numerous studies presenting kinetic models for aggregation in Aβ and α S separately, there lacks kinetic data and understanding on the implications of possible co-assembly between these protein species.
This project aims to survey existing kinetic models for α S and Aβ separately in order to identify key features such as: accounting for physical and kinetic heterogeneity amongst oligomer and fibrillar species, and assuming homogeneity of monomeric amyloids. This investigation analyzes the balance between simplicity and accuracy in existing models, and pinpoints gaps in assumptions made or methods used. Overall, this project uses these observations and existing in vitro experiments to develop a unified, cohesive kinetic model that can be fitted to the kinetics of coassembly of A βand α S conjunctly. This is done through generating differential equations that are input and solved through relevant mathematical solver programs.
This developing model of Aβ and α S coassembly has the potential to allow for testing of cytotoxicity at different stages of this aggregation and can further be applied to other amyloid protein assemblies in vitro.

CHEMICAL AND BIOMOLECULAR ENGINEERING



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Directed Evolution of β -Glucosidase from Pyrococcus Furiosus

Through the utilization of Error-prone PCR, this project aims to optimize the β-Glucosidase enzyme for use in industry, in the hopes to facilitate the transition away from fossil fuels, to a more sustainable future. In conjunction with exoglucanase and endoglucanase, β-glucosidase can convert readily available lignocellulosic biomass, unused and discarded plant material, to bioethanol. This project features an in-depth analysis of β-Glucosidase, an enzyme that converts cellobiose, a disaccharide, to glucose. However, since the product, glucose, inhibits the function of β-glucosidase, thereby slowing the catalyzed reaction, such a process has yet to become feasible. The introduction of variation in the amino acid sequence may give rise to a more effective isozyme that would streamline this process. The success of the enzyme was measured through UV-spectroscopy, which provided updated information on the efficiency of the enzyme. Understanding the molecular features that yield an effective enzyme, measured through thermostability, turnover number, inhibitor constant, and Michaelis constant would allow for further work in developing uses for the protein.

A library composed of Escherichia coli that have been introduced to the altered plasmid was constructed, and by using esculin hydrate and ferric ammonium citrate, successful transfers of genetic information were detected.



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Fluorescent Nanoparticles for Exploring Nanoparticle-Neuron Interactions

Encapsulation of pain signaling antagonists within nanoparticles shows potential for prolonging their therapeutic effects due to optimized pharmacokinetics. What remains lacking, however, is knowledge of the mechanism of interaction between nanoparticles and neurons. Thus, new nanoparticle physicochemical design guidelines must be determined to optimize the interaction. This project uses the flash nanoprecipitation assembly process to incorporate highly fluorescent quantum dots into nanoparticle cores. Because of the adaptable nature of this process, we can readily create fluorescent nanoparticles of varying sizes and surface chemistry. We are designing a biocompatible, fluorescent nanoparticle library to discover the influence of polymeric nanoparticle surface characteristics on the routes and kinetics of uptake and trafficking in neurons in the oral cancer microenvironment. By encapsulating quantum dots into nanoparticle cores, we will be able to track nanoparticle uptake and trafficking in neurons over extended periods of time. This new understanding of nanoparticle behavior will inform future nanoparticle design strategies for tumoral administration and accelerate the development of nanoparticle-based cancer pain therapies for oral cancers.

CIVIL AND URBAN ENGINEERING



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A Unique Approach to Viewing and Managing Mechanical Parts in 3D on the Web

This research aims to build a 3D website, where objects can be viewed in 3D, and all the objects are visible on a single map as points in 3D space. Upon navigating to a particular dot, we can see the 3D object that the dot represents pop up, and the dots surrounding it are the similar mechanical parts to that object. It is the first website in this field, that won't be using text search, but will instead use 3D objects to fasten the process of searching and make it more convenient. We have devised a unique loss function by combining the traditional TSNE loss function with that of Convolutional Neural Networks, to cluster similar objects and view them on our website. The website also ranks its users based on the amount of 3D objects they have published on our website. As an extension of this, we are also making our clustering algorithm more dynamic by using human annotations. The users can thus classify or misclassify the objects that are clustered around the 3D object they are currently viewing, which is used to make our algorithm more adaptive and accurate. Down the line, we plan to develop an overall community of researchers and publishers to publish their 3D models on our website and use the existing 3D models for their research purposes. We also aim at devising the idea of using the human annotation for our adaptive clustering algorithm as a captcha for other websites to continuously make our algorithm better.



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Populating a Research Dataset: Machine Intelligence to Understand the Progress of Modular Off-site Manufacturing

Despite the growth in productivity of many industries, the productivity of the construction industry has remained stagnant. In an effort to advance the industry, there have been steps to reinvent the construction process in order to optimize resource utilization. Modular construction, a process in which a building is constructed off-site, produced in "modules" that are put together on site, is an alternative approach to construction which reduces environmental impact and construction waste. Furthermore, due to the nature of modular construction, it is possible to achieve automation and optimization of construction. Advancements in deep learning technology provide the possibility to automate and improve the design process of construction to save cost and time. Our research goal is to train a generative model that can produce valid and diverse design alternatives. We leverage open source large-scale house design data and use BIM as a relational database model for training the generative model. The Graph Neural Networks (GNN) and Generative Adversarial Network (GAN) will be utilized to facilitate learning knowledge and design principles from the existing large dataset in order to generate various designs for housing. The generative model will allow designers and decision makers to do quick design review with valid and abundant design alternatives which can shorten the design process.

CIVIL AND URBAN ENGINEERING



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FloodSense

Numerous reports on climate change have highlighted the increasing urgency of flood events, which are predicted to increase in intensity and frequency in the coming years. These will also continue to affect urban environments, where infrastructural shortcomings (such as old sewer systems) result in urban flooding. Despite the damages caused by flooding, New York City currently lacks a comprehensive flood monitoring system. To better understand the effects of street-level flooding on a hyperlocal scale, the FloodSense project deploys sensors throughout the city, from which data will be collected and displayed on an accessible dashboard. Part of this process also includes data cleaning, data analysis and establishing an alerting system to warn stakeholders of flood occurrences. Doing so will fill the current knowledge gap and effectively provide city agencies with the necessary data to make informed decisions. The insights gained from this research will also help to work towards a more equitable future for communities currently affected by urban flooding and climate change.



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The Environmental Occurrence and Photodegradation of Phthalates

Phthalates, often called plasticizers, are additives used in high quantities to enhance flexibility of plastics. As endocrine disruptors, these chemicals have been proven to affect the reproductive system in animals and current research is being done that links them to infertility and birth defects in humans. Although they are detected in environmental systems, their ability to photodegrade in the environment is relatively unknown. This research uses laboratory studies to investigate the photodegradation of eight different phthalates by direct reaction with light and with intermediate species produced by light in natural waters. Preliminary results indicate that all the phthalates will absorb sunlight in the environment, suggesting that direct photodegradation is possible. A photoreactor and liquid chromatography coupled with ultraviolet absorbance detection will be used to confirm that direct photolysis occurs and to determine the rate of the reaction. Their reaction with intermediate species will also be investigated using model sensitizers, which mimic compounds excited by light found in the natural environment.

CIVIL AND URBAN ENGINEERING



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Composting Plastic in Aquaponics

A simple resolution to widespread food insecurity is to produce more agriculture. However, in a world where climate change is marginalizing arable land, using a traditional approach is becoming less feasible. Aquaponic farming, which cultivates both aquaculture and agriculture in a symbiotic feeding loop that boasts high efficiency and crop yield, can navigate the conditions of the climate crisis. But this process also uses significant amounts of plastic, especially polystyrene (PS), in several components of the system. Thus, in solving one global issue, this method might exacerbate the massive plastic pollution problem that stems from the use of plastics in almost every facet of life.

Recent literature on plastic disposal has suggested that mealworms consume and degrade PS in a vermicomposting system. The goals of this project are to investigate this phenomenon in the context of an aquaponic farm by creating a vermicomposting set up and analyzing the resulting products for the presence of PS, as well as its toxicity to multiple plant species. Regardless of the final outcomes, our findings will contribute more research to a still-developing field of study, aid in creating a protocol for industrial PS disposal, and could even provide policy guidance on the issue of societal plastics consumption.



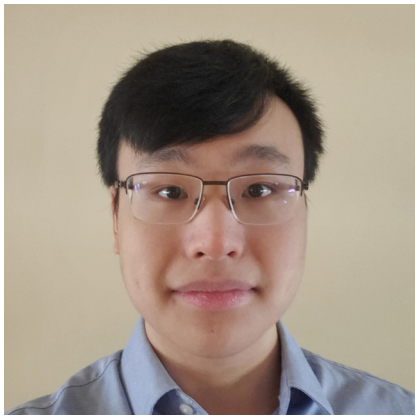
Super worms consuming Polystyrene.

CIVIL AND URBAN ENGINEERING

Waste Audit in Hospitals Literature Review (Multiple Hospital Studies)

Healthcare systems utilize numerous supplies daily in medical procedures and consequently are a large contributor to the production of wastes. Hospitals in the United States are generating over 5 million tons of waste annually, at a rate of more than 29 pounds of waste per bed per day. Through waste audits in medical facilities, the volume and types of waste produced can be better quantified.

This study conducts a literature review analyzing the quantities of waste generated at the hospital level worldwide and how different factors will influence those quantities. Factors considered include the audit methodologies, the type of facility (public or private), the number of patients/departments/beds per facility, the different categorization of wastes (biohazards, pharmaceuticals, radiologic, sharps), the issues in medical waste disposal (greenhouse gas emissions, unregulated waste management), and the adequacy of training provided to waste management workers. From this literature review, we want to consolidate and summarize the current literature available to produce a paper comparing the amount of waste generated in different healthcare facilities at the hospital/system level and another involving waste generation focusing on individual departments/procedures.



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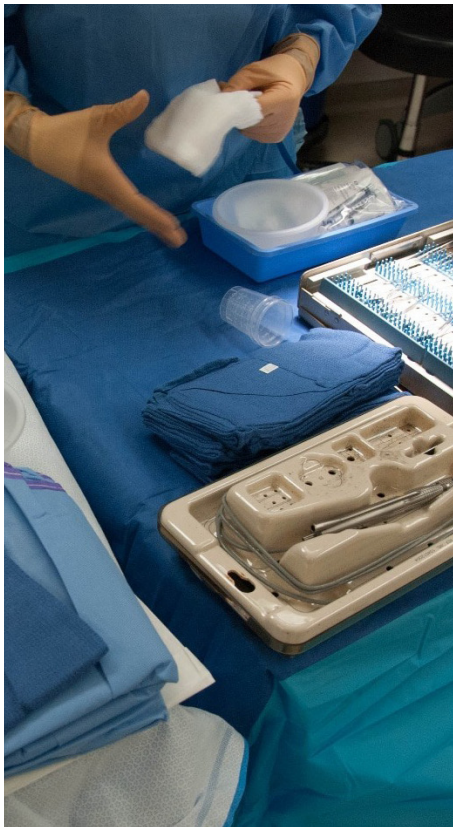
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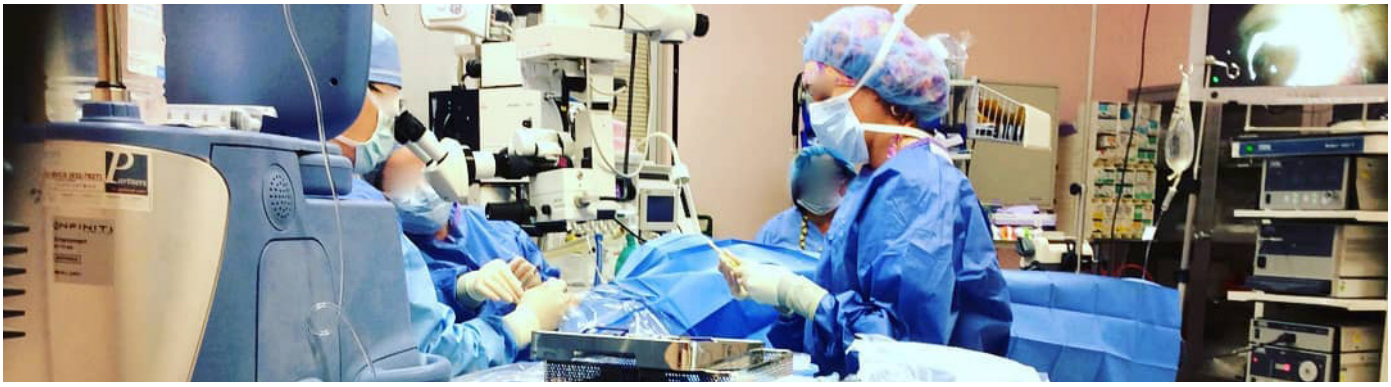


Image relating to "Waste Audit in Hospitals Literature Review (Multiple Hospital Studies)" project.

CIVIL AND URBAN ENGINEERING

Summary of Literature on Transmissibility or Disinfection of COVID-19 to Inform the Debate on Reusable and Single Use Foodware

In recent years, concern over the growth of single use plastics has rapidly grown, even more so after the global SARS-CoV-2 (COVID) pandemic. Federal, state, and local regulations had begun calling for reduction in single-use plastics, particularly in the restaurant or food industries, through bans of single-use plastic bags and polystyrene takeout containers. The pandemic resulted in the quick reversal of these policies, with a number of businesses banning reusable utensils, foodware and containers for fear of spreading the COVID virus. This study was conducted to assess existing literature on COVID and other pathogens to determine whether these concerns are founded or not. Eight inclusion criteria were identified including materials and surfaces commonly used in foodware, contagions associated with foodborne illnesses, and decontamination/disinfection techniques. Using PRISMA guidelines for systematic reviews and Covidence software, the team preliminarily concluded that current research suggests that COVID readily adheres to any material type or fomite, with two experimental studies suggesting better adherence to plastics. Though lab-based studies suggest COVID can be virulent on surfaces for 24 to 84 hours, the sole in-situ study to attempt a culture of COVID samples could find no infectious titers. Only one study tested disinfection via water soaked wipes and ethanol wipes, finding both were very effective (>99.6%) at reducing the infectivity of COVID. There do not appear to be any particular concerns with reusables, though it is not directly studied in existing literature..



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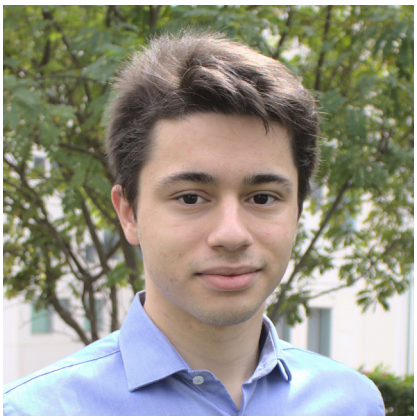
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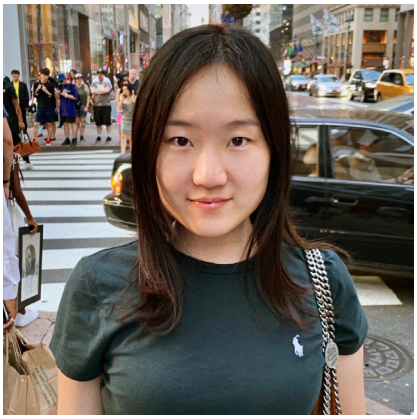
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Neural Network Method for Dendritic Spine Detection

Neural circuit plasticity is key to further understanding experience-dependent changes in brain function like memory formation and sensory refinement. Dendritic spines are small protrusions where most synapses are formed which makes them the major sites where structural changes in the brain take place. They serve as the postsynaptic portion of most synapses in the brain. Dendritic spines have a volume between 0.005 and 1 μ m3 and this volume can change by neuronal activity. The purpose of this project is to use a supervised learning method to improve our established Computer Vision method to detect spines and assess their size. This will improve current arduous manual analysis methods. The final deliverable (in addition to the detection algorithm and the neural network model) will be a distributable software with an easy-to-use interface that will allow for an unbiased, accurate, and rapid analysis of spines and their sizes in large scales and across time points.



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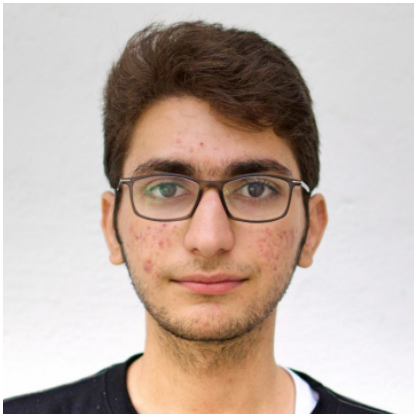
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Image-based Navigation for Self-Driving

Autonomous vehicles have received an unprecedented attention in recent years due to the emergence of highly capable machine learning algorithms in the field of computer vision. Naturally, the performance of such algorithms depends not only on their structural designs, but also the dataset they train on. In order for an algorithm to serve a certain purpose, the algorithm must be trained extensively on a specially designed dataset with an emphasize on the use-case, and the more data the algorithm can be trained on, the better. For this reason, existing datasets always tend to focus on one specific use-case. Different from existing popular datasets, we propose a dataset that contains data from multiple sets of sensors and from multiple vehicles and objects, and therefore covering multiple use-cases. By collecting data from open-source software such as Simulation of Urban Mobility (SUMO) and Carla, we will be able to customize the dataset to obtain sensor data under diverse traffic conditions without being physically outside. The expected dataset will also be tested and benchmarked on existing algorithms for comparison.

CIVIL AND URBAN ENGINEERING



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Deep Learning for Soft Robots

Soft bodies, made from deformable and flexible materials, have shown significant potential in many robotics applications. Thanks to their high flexibility, soft robots can actively or passively change their shapes. This allows them to carry out a range of tasks, such as grasping or manipulation, safely and effectively. However, the high-dimensional deformation of soft bodies has also made their proprioceptive sensing a long-standing challenge, as there has hardly been a method to measure it using internal sensors.

This project is a continuation of our lab's 2019 project which successfully developed a framework using machine learning to measure the high-resolution 3D shapes of soft robots in real-time with embedded cameras. In this project, we focus on extending the current work to soft bodies under a variety of conditions. We simulate the soft bodies with different motions and conditions, such as a ball in free fall or rolling on the ground, and collect their shapes and images from the inside to build a dataset that covers this wider range of soft bodies and their interactions. We aim to further develop and expand the current machine learning model using these datasets, together with testing the model with different data.



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Routing Optimization for Truck Drivers in NYC

The road network of NYC is not one that is friendly to larger vehicles like trucks, for a multitude of reasons. Many roads are fully banned for trucks, with penalties levied on drivers that find their way onto these roads. NYC Department of Transportation lays out designated truck routes within NYC, roads that are large enough to accommodate trucks, and stresses that trucks must remain on these routes unless necessary. Truck routes are mostly only the largest thoroughfares, meaning that most roads in NYC are not classed as truck routes, even though deliveries still need to be made to destinations on these routes.

This project aims to develop an android app that will allow a trucker to input a list of destinations in NYC and receive turn by turn instructions for a route that will ensure that they do not come across a legal or physical obstacle. The app would be designed to easily take in the destination addresses and relevant information about truck size and class. With this information, the app would optimally route the truck using a detailed ArcGIS network, which contains information on potential obstructions for trucks.

CIVIL AND URBAN ENGINEERING



Preprocessing Algorithm to Generalize Public Transit Line Agent Simulator to GIS Zones

A public transit simulation developed in BUILT lab requires preprocessing of realistic dataset to fit the input format. Therefore, this project designs an algorithm converting datasets in general GIS format to the form applicable to simulation. The algorithm reprojects polylines and points from geographic coordinate system to rectilinear plane. While coordinates in the original coordinate system are the longitude and latitude, the new system defines them as relative horizontal and vertical distances. The output can be fed to the simulation and used for conducting experiments on different public transit operations types to find the best form for mobility-as-a-service.

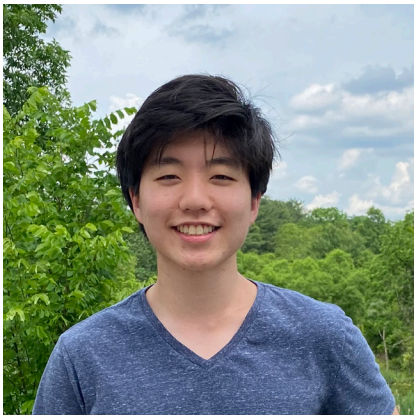
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Modeling Efficient Electric Vehicle Charging Station Configuration Designs for the New York City School Bus Fleet

On February 6, 2020, the mayor of New York City (NYC), Bill De Blasio, signed into effect executive order 53 which declared the city's intent to electrify its fleet of over 30,000 service vehicles by 2040. In order to achieve the goals set in the order, many logistical obstacles will need to be overcome. One such problem is effectively meeting the charging demands of both private and public electric vehicles (EV). EV charging carries unique expenses and difficulties, such as long fill up times relative to conventional gas stations. New charging station configurations must be designed in order to meet city-wide charging demand, balance queue delay, and decrease charger installation cost. In this research, we look at school buses specifically, which the Department of Education committed to being fully electric by 2040. We use open source data on the current NYC school bus fleet to design different charging station configurations assuming all school buses are electrified. Different sharing strategies of chargers between garages and vendors will be evaluated and compared using a proprietary EV assignment tool developed by Prof. Chow's BUILT Lab. This research will help the city's decision-making bodies to create environmentally sustainable and economically viable solutions for charging station configurations that will be necessary in an electrified future.

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Analyzing Construction Worker Attention and Response to Different Safety Notification Characteristics

Researching construction worker safety requires an understanding of complex traffic patterns, neurological reaction times, and spatial awareness. To better understand construction worker safety, we are using a virtual reality environment to simulate various environments and tasks. One such environment is a simulation where the subject has to place a certain number of traffic cones at specified areas on the road while there is active traffic on the road. Using these virtual environments, we are additionally testing various smartwatch alarms by utilizing them to alert the worker of potentially dangerous oncoming traffic. We then gather data using sensors to assess worker response times and reactions to the smartwatch alerts. Using this data, we are able to analyze the workers' heart rate, position, along with other measurements to assess their reactions to the triggers. Using the video feed from the headset, we are able to use eye-tracking to assist with analyzing the workers' reactions to the trigger and their actions and behavior in response. As we further our research, we will be able to determine which alarms were the best triggers to ensure worker safety. Using such methods in real-world scenarios will help ensure construction worker safety and prevent accidents.



Figure 1: Simulating the task of placing cones down a busy street during the daytime while cars pass by and smart watch alerts occur.

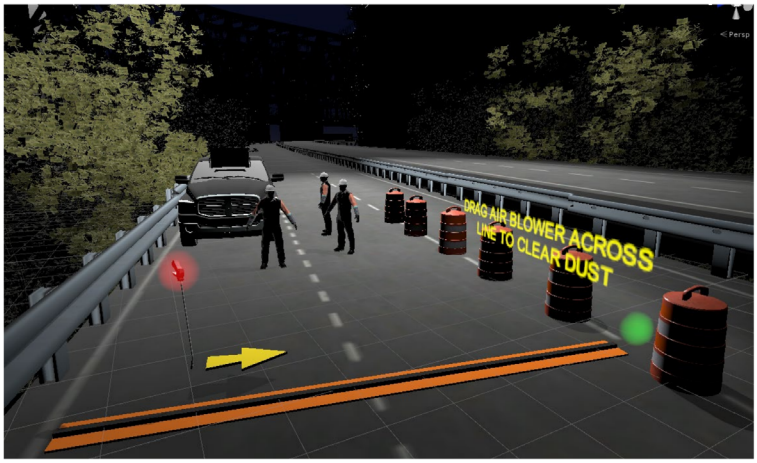


Figure 2: A series of interactive tasks simulating construction on the Brooklyn-Queens Express Highway at nighttime.

COMPUTER SCIENCE AND ENGINEERING

SPARE 3D: Deep Network's Learning of The Unfolding Problem

Spatial Reasoning is a category of reasoning skills that commonly refers to human's capacity to think about objects in three dimensions and to draw conclusions from limited information. Spatial Reasoning is so important that jobs like architects, military squad leaders, and designers are required to demonstrate such ability when applying. While spatial reasoning tasks are always not straightforward for humans, maybe we can train deep networks to perform such tasks. Our research will expand on our previous research on "SPARE 3D" where deep networks are able to select the correct isometric view given the top view, front view and side view. The primary goal of the research is to train the deep network select the correct unfolding drawing of an object. We start our research by selecting cube as our testing prototype. With the only 11 expending forms of the cube, we correspond these edges of the unfolding forms with the original compact cube, and to decide whether the given unfolding pattern is correct or not. Following this pattern, we are researching on designing a new method that takes into account both positive and negative sampling to further solve such folding and unfolding problems for various shapes of objects.



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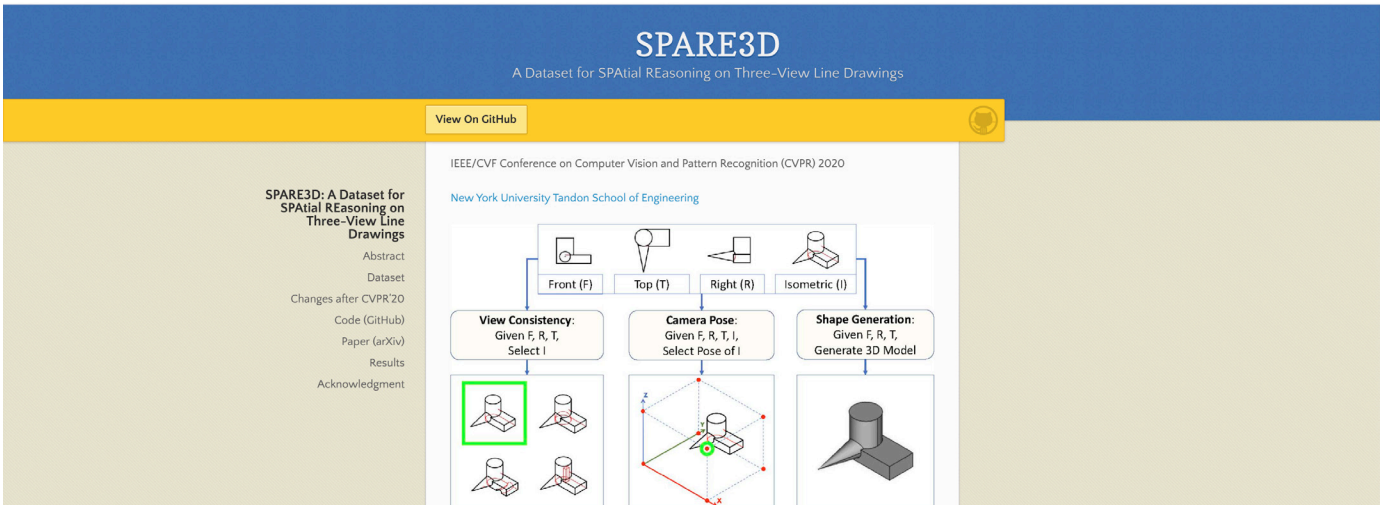
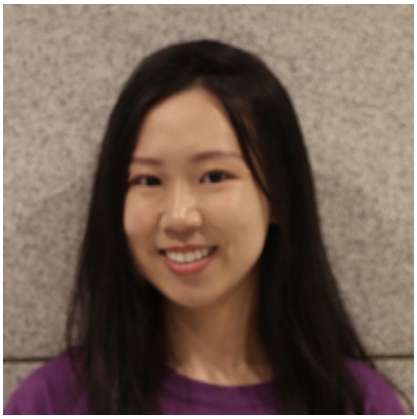


Image relating to "SPARE 3D: Deep Network's Learning of The Unfolding Problem" project

COMPUTER SCIENCE AND ENGINEERING



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Indra Agent-Based Modeling with Applications to Economics

Agent-based modeling (ABM) is a class of computational models that simulate the interactions among independent agents adhering to a set of predefined constraints in an environment. For example, in the retail landscape, an agent in the ABM system can represent a local store, multinational retailer, or consumer. By defining agents with unique preferences, spending power, and transactional utility, and letting them interact with each other in the simulated environment, we can investigate the emergent outcome of the micro behaviors resembling real-world phenomena. With Indra being an open-source ABM system that was built using Python, AWK, Bash, YAML, and JavaScript, we aim to simplify the creation and execution of ABM so that coders only need to write a few lines of code and that noncoders can merely configure the parameters of the built-in-models on the interface. The comprehensive knowledge of the complex system no longer becomes nontrivial so that all users can utilize the powerful functionality of ABM.



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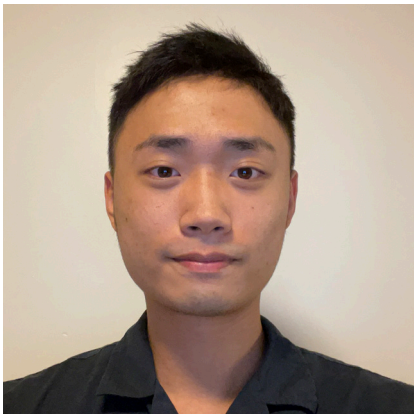
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Perturbation-Based Computation and Visualization of Multidimensional Machine Learning Decision Boundaries

Machine learning solutions have become increasingly prevalent in high-stakes fields such as healthcare, finance, and governance. In these cases, understanding a model's decision space can help users debug the model during production and calibrate their trust in the model when making key decisions. Previous approaches to visualizing machine learning model boundaries have used dimensionality reduction on multidimensional boundaries, which confirm the existence of a boundary but provide little information about how different features affect model output.

We propose a gradient descent-based method for computing exact points along multidimensional decision boundaries of classifier models. We then provide an interactive visualization of the space around these boundary points, allowing data practitioners to explore model behavior in areas where the model has low certainty in its predictions. Our approach creates in situ visualizations of individual boundary points rather than projections of multidimensional boundaries. These visualizations successfully demonstrate relationships between features, boundary distance, and predictions. We also provide automated feature ranking and reordering through which users can quickly and meaningfully configure the boundary visualizations.

COMPUTER SCIENCE AND ENGINEERING



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Faster Candidate Generation using Prefixes of Subqueries

Many search engines generate candidates using a series of cascading rankers for efficiency. They start off with a large number of candidates and trim them down to a fewer (yet more relevant) amount, by gradually increasing the complexity and quality of the ranking function as it goes through each cascading layer.

This research focuses on the first layer of the cascade by building a special initial index structure. Previous research has found that making single-term and pairwise index structures in the first layer led to faster generation of the candidates. Another research has indicated that log-quantile-based prediction methods using triplet index structures performed the best in producing the top-k threshold estimation for disjunctive query processing. Motivated by the previous findings, we now focus on developing more special index structures, such as triplet and quadruplet index structures, in the initial cascading layer and discover whether this will lead to even faster candidate generation.

It is inefficient to go through every single document associated with each index structure because there are millions of them; therefore, we maintain a budget of how much to look up on each index structure using a quality model and select just the prefixes of it for query processing.

The project's query processing using these index structures is done through the open-source PISA (Performant Indexes and Search for Academia) search engine. PISA is a search engine written in C++ for performance and has a lot of tools related to indexing and query processing. Other than PISA, programming files in Python and C++ have been developed for building the quality model and special index structures given a dataset.



Kevin Rho working inside the computer science lab at the 370 Jay street building, writing some code for his project "Faster Candidate Generation Using Prefixes of Subqueries".

COMPUTER SCIENCE AND ENGINEERING



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Patterns in Programming

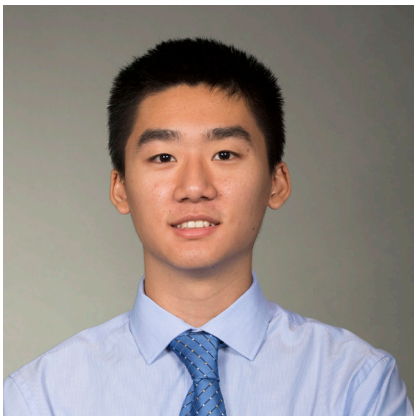
For students learning programming for the first time, the lack of familiarity with the rules of programming languages and the syntax required can make initial efforts to solve even simple problems frustrating and demotivating. Instructors do not always have insight into the types of problems students face and, often, students are intimidated by the idea of asking for help. The series of steps that leads to the students' final submission for a programming assignment represents an evolution of understanding that can prove insightful. Starting from a hypothesis that there are a set of common mistakes that students make when first learning to program, this project is focused on using coding submissions as a dataset for identifying, classifying, and understanding certain recurring patterns of mistakes or misunderstandings first time programmers make.

For the dataset, homework submissions from students that both give consent and took the CS1114: Introduction to programming class in academic year 2020, is used. After removing all the comments and any traces of identification from the assignment, the code from the assignment is converted into byte code using the disassembly module in Python. The diff module is used to reveal the progress a student makes over subsequent submissions in the form of byte code. This data is stored in MongoDB and retrieved to create a dataframe, so that statistical analysis can be performed on the data. Majority of the computation for this project is done over cloud using the Google Cloud Platform services.



Gaurang Ruparelia working on the "Patterns in Programming" research project.

COMPUTER SCIENCE AND ENGINEERING



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Better Clustering for Selective Search

Text search engines contain billions of documents and require hundreds of computers running in parallel to generate results to the user quickly and efficiently. Many search engines employ exhaustive search, where a document collection is split evenly into random clusters, and each cluster is searched in parallel. Selective search is an efficient competitor against exhaustive search because it reduces the resources and time needed for document search. Selective search groups similar documents into the same clusters, allowing for a query to only require the searching of a few relevant clusters instead of all documents. Currently, k-means clustering on document terms is used for clustering for selective search. However, bipartite graph bisection (BP) has been found as an effective alternative to order documents by similarity. In this research, BP is used to cluster documents, and two new types of expansion terms are generated to improve clustering effectiveness. A deep learning transformer model (DocT5) and query expansion using the AOL query dataset are incorporated into the BP clustering algorithm. By comparing search engines using standard k-means clustering, clustering with BP, each with and without term and query expansion, a faster, more effective, and more accurate clustering for selective search can be determined.



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Data Synchronization in Cloud Storage

In cloud storage, some existing files are updated with the majority of their contents staying the same. In order to minimize the data transmitted during the uploading, the concept of file chunking is used to partition two files into multiple chunks for later chunking-level comparison of two files. Then, only unmatched chunks in the new version are transmitted, consequently saving bandwidth in the network.

The current chunking algorithm can be mainly categorized into two groups: fixed-size chunking and content-dependent chunking. The well-known rsync protocol in Linux uses a fixed-size chunking algorithm for synchronizing two files. However, the fixed-size chunking algorithm suffers from the boundary shifting or misalignment problem, where two identical chunks are unmatched because of a lack of alignment. Fortunately, this problem can be solved when the content-dependent chunking algorithm is used to dynamically partitioned files into chunks of different sizes depending on contents. Some examples are Winnowing and 2Min. In the content-dependent chunking algorithm, the rolling hash technique is widely used to assist chunking algorithms to be content-aware for later dynamic chunking.

We build upon previous work on content-dependent chunking algorithms with rolling hash, where each work proposed a chunking algorithm in different balances of deduplication ratio, chunking speed, and the average generated chunk size. Then, we make multiple experiments and design a content-dependent chunking algorithm that has a fast chunking speed and a fast rolling hash, speeding up data synchronization in cloud storage

COMPUTER SCIENCE AND ENGINEERING



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Understanding and Improving Document Reordering Techniques

The primary aim of a search engine is to provide relevant documents in response to a user query rapidly and efficiently. This is especially challenging to do considering the number of documents that need to be considered in queries. In most search engines, the dominant data structure that stores document/term information is the inverted index or some variation. This index structure contains a list of terms, and for each term, a corresponding list of document IDs (referred to as postings). A part of the index structure that is often overlooked but critical towards compression is document reordering. Rather than storing each document ID as is, most compression schemes store IDs relative to each other. Hence it is ideal to have some form of 'clustering' effect where documents with similar inverted indexes can be placed next to each other. Our research will evaluate several such document reordering techniques and differentiate them based on their performances in speed and data size. We will reimplement some techniques to further analyze the current models and functions with some existing datasets of inverted indexes. Lastly, we want to propose and implement new methods that can improve existing techniques for better document reordering results.

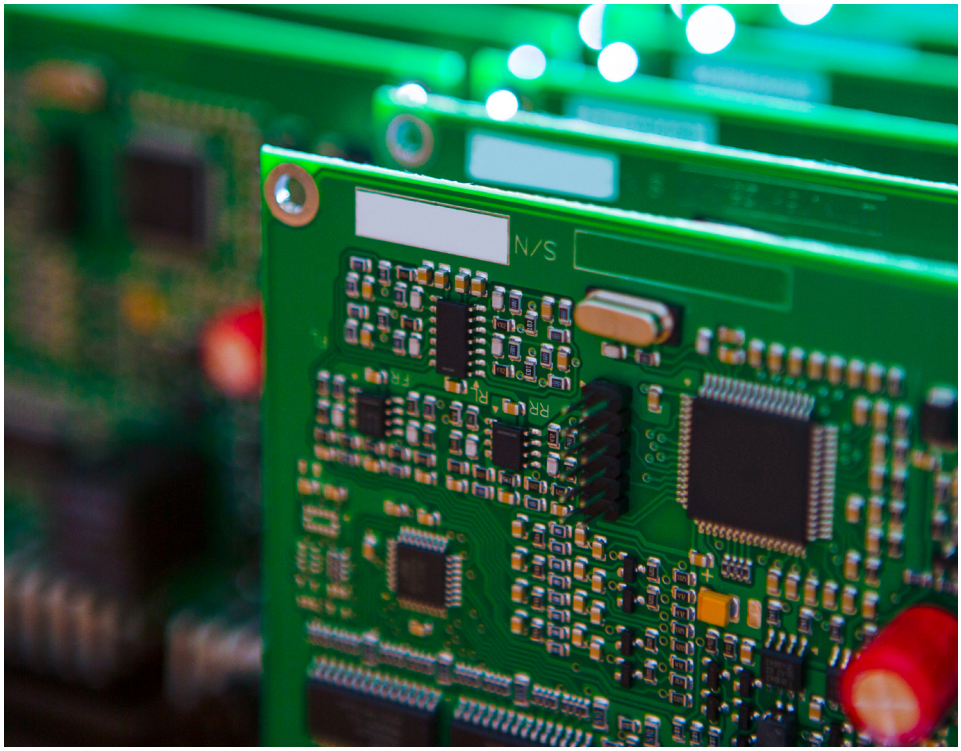


SANDY ZHANG

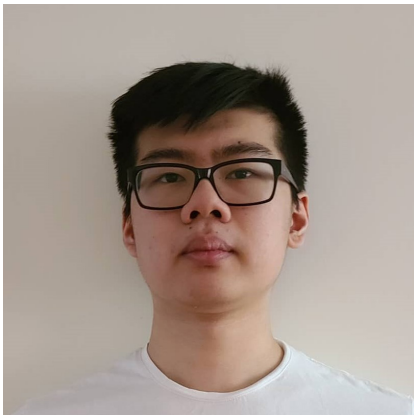
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CUSP & CIVIL AND URBAN ENGINEERING



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COVID-19 Impact on Urban Mobility to Access Essential Services - Sunset Park, Brooklyn

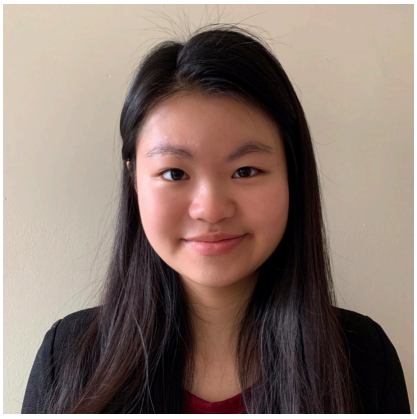
New York City was an early epicenter of the COVID-19 pandemic. In this project, we investigate how the COVID-19 pandemic impacted essential services such as banks, groceries, healthcare, pharmacies, transportation of various communities in the Sunset Park area of Brooklyn. To answer this question, footfall data was gathered from Safegraph and public records. The pre and post COVID-19 schedules of commercial points of interest (POI) for the area were then scoped out. Analysis of the distance traveled by various populations in these periods was done using Google Maps API and web scraping. The study area is from 1st avenue to 9th avenue across 36th street to 65th street, with a focus on the residential area of 2nd avenue to 8th avenue across 44th street to 55th street. The end goal of the project is to shed light on the negative mobility impacts of the pandemic on already under-resourced communities, in terms of both additional distance and barriers encountered. The research will help in laying out an efficient plan of which stores/services should be open in case of a pandemic in the future, leading to less spread of the disease overall.



CUSP & CIVIL AND URBAN ENGINEERING

Tools for Community-based Brownfield Management in Sunset Park, Brooklyn

Despite one brownfield for every 2,500 people in Sunset Park, Brooklyn, community management of these sites is highly hampered by the locations of relevant data. Presently, there are no community-based brownfield management tools. This project aims to overcome this gap by amalgamating data from its different sources and visualizing it in a Geographic Information System. By analyzing contamination types, location, and social contexts, a ranked list of brownfields for priority remediation and redevelopment will be created. The results can be used to inform the community in managing brownfields to reduce risk of further contamination and maximize benefits such as green spaces.



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CUSP & CIVIL AND URBAN ENGINEERING



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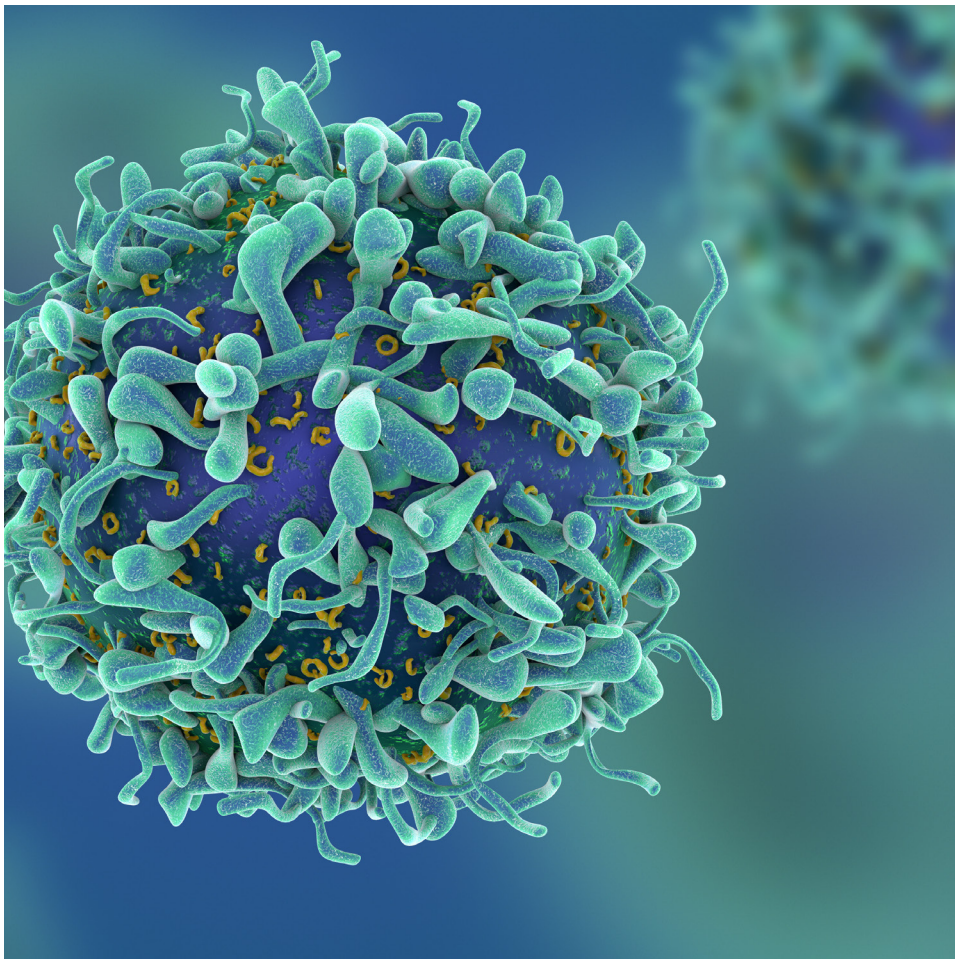
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Three-dimensional Observations Uncovering COVID-19 Health Risks

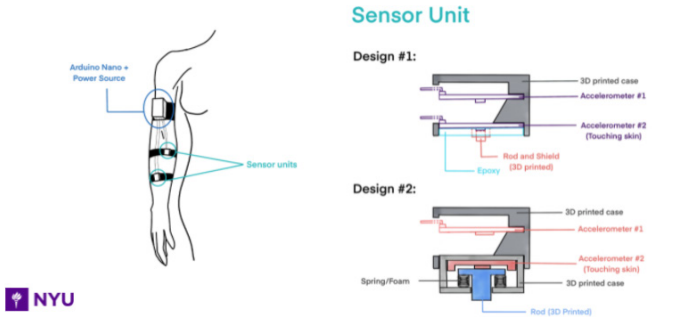
The COVID-19 outbreak has led to the closure of cities due to the rise in transmission of the infectious virus through air and surface contact. With asymptomatic transmission becoming the primary cause of pathogenic transmission, disinfection of all surfaces has become a crucial part of cleaning maintenance in public facilities and institutions. However, disinfection quality control still remains unstructured. To combat this concern, the TOUCH project aims to utilize real-time point cloud data and thermal sensing data to detect unsanitized, touched surfaces by following strict and quality cleaning protocol. A machine learning algorithm will classify the data collected by a thermal sensing camera and broadcast the results to a Microsoft Hololens which will direct the cleaning personnel to unclean surfaces. Once the surface is cleaned by the personnel and a temperature difference is detected, the surface is marked as clean and recorded in the database. The current phases of this project aim to create a working prototype of hardware and while determining its effectiveness and suitability in mitigating the spread of pathogens through surface contact.



ELECTRICAL AND COMPUTER ENGINEERING

Wearable System for Decoding Muscle Activity

It is projected that within the next thirty years that those above sixty-five years of age will outnumber those below eighteen years of age. With this increase in the age in the general population comes an increase in the associated age-related ailments. Stroke and Parkinson's are the leading age-related causes of movement disability leading to paralysis, coordination deficiency, and slowness. Additionally, current inpatient rehabilitation programs such as those for post-stroke disability are both costly and time consuming. Assistive robotics technology will enable inexpensive remote assessments of motor performance and real-time feedback for rehabilitative exercise. Our goal is to design a modular wearable system that can work in conjunction with a prosthetic device to provide an experience which is as close as possible to natural body motion while maintaining control using non-invasive techniques. The wearable system will acquire myoelectric muscle signals through a non-invasive method to predict hand gestures and movements for personalized and immediate feedback using Bluetooth Low Energy. By designing and prototyping a novel wearable system that can decode muscle signals, patients who might suffer from not only physical but neurological damage or disorders will be able to improve their quality of life. Different hand movements can be recognized by applying machine learning algorithms and state-of-the-art signal features. Additional features and uses for this device—such as the ability to visualize data in an actionable way through virtual reality—will be possible due to a modular design.



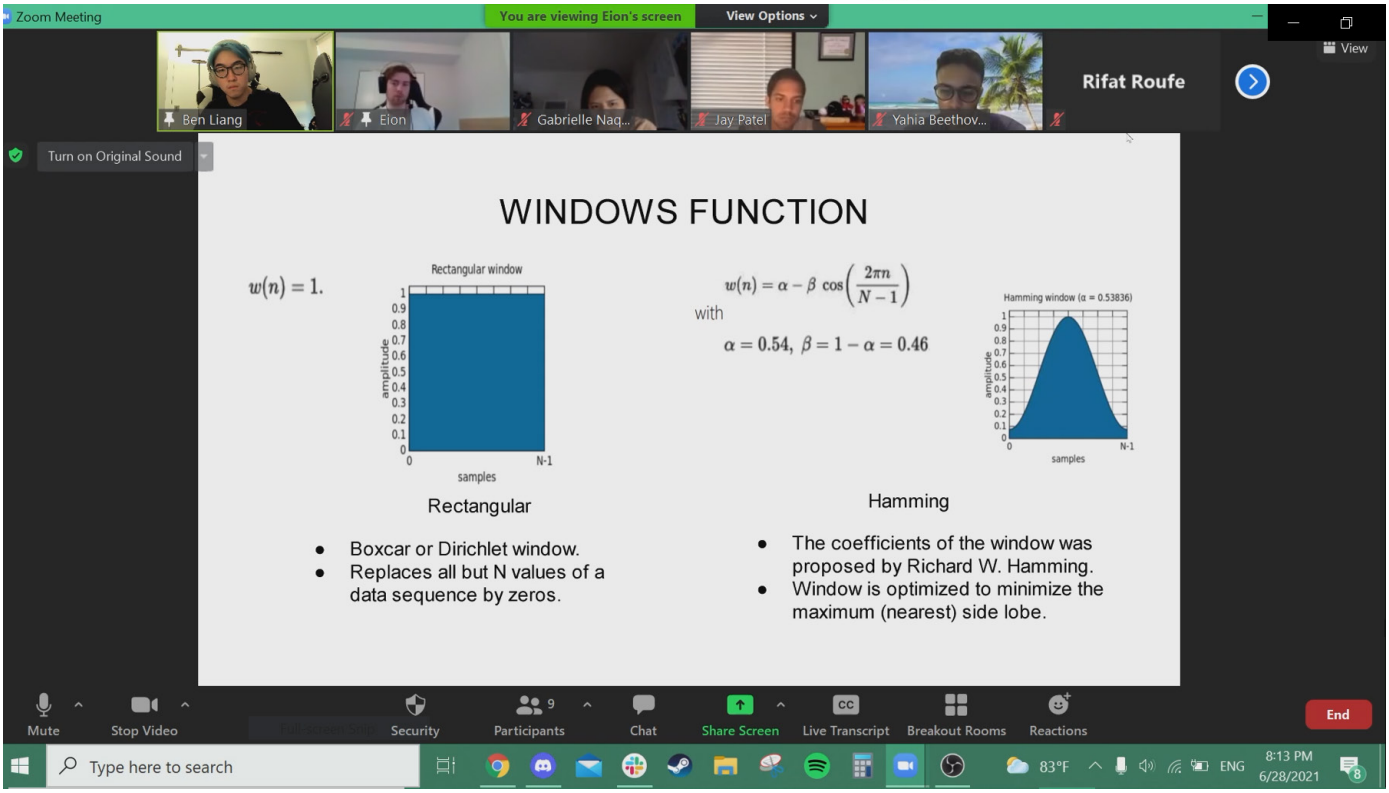


Image relating to "Wearable System for Decoding Muscle Activity" project.



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ELECTRICAL AND COMPUTER ENGINEERING



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NYU Tandon School of Engineering

Full Stack Development for IoT Inspector – A Network Activity Visualizer for IoT Devices

For smart devices like Amazon Alexa and Google Chromecast, the data sent and received are behind the surface of operation and difficult to retrieve from an end-user's point of view. IoT Inspector is an open source desktop application used to visualize the network activities of smart home IoT devices, with the purpose of identifying potential privacy and security threats.

One of the main purposes of IoT Inspector is to crowdsource a sufficiently large dataset of network traffic from smart home devices for empirical research, which means end-users are contributing to the data collection process by submitting their smart home devices' network traffic to a server maintained by Professor Huang. With the intent of bringing IoT Inspector to more consumers, privacy concerns and client-server latency are issues requiring further improvement.

We are currently working on combining the client-server architecture of IoT Inspector into a solely local application, which will eliminate the privacy concerns of
sending network traffic to a server and provide drastic enhancement on performance.



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Noise Filtering Algorithm for Eye Tracking Data Processing Using Convex Function Optimization

Reliable eye tracking can facilitate the detection of eye abnormalities, neurological disorders, and cognitive problems. Noise filtering is therefore a crucial step in the analysis of eye tracking data. There exist many different algorithms for signal denoising, however they may yield unreliable results for unusually slow saccadic eye movements. Previous research models saccadic waveforms as piecewise-quadratic signals and focused on minimizing an objective function of the time series generated by an eye-tracking device. This non-linear smoothing procedure only took individual time series into account. The algorithm would need to be applied twice separately to obtain reliable data since eye-tracking devices often record vertical and horizontal eye movements. We propose an improvement to the previous procedure by using an objective function of two time series, whose relationship is modeled using a mixed L2,1 norm. The algorithm for the minimization of the objective function is then derived using the majorization-minimization approach. Using both simulated data and real data we evaluate the performance of the new proposed algorithm.

ELECTRICAL AND COMPUTER ENGINEERING



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Real-Time Audio Processing using the Fourier Transform

Applications of noise suppression for real-time audio processing are found throughout our day-to-day lives. Whether we are making phone calls on busy streets, holding meetings from our homes while working remotely, or using active noise cancellation to tune out noisy environments; we rely on noise suppression technology for communication and comfort. The purpose of this project is to design a real-time audio processing system in Python and implement different voice activity detection and denoising methods on noisy speech. The short-time Fourier transform, and thresholding is used to analyze and denoise a real-time signal. Voice activity detection makes it possible to identify noise-dominated and speech-dominated sections of the signal. Information gathered from the noise-dominated sections can then be used to denoise the speech-dominated sections while minimizing the distortion of the target speech, resulting in a cleaner and clearer transmission of speech.



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Contact Detection in Legged Robots

Robots with legs have many advantages over robots with wheels, such as being able to traverse rough terrain. However, one disadvantage of legged robots is that they have more complex systems due to their additional moving parts. This complexity causes state estimation to become more complex as well. State estimation is the use of sensors to build a model of the robot in the world. One important part of state estimation is contact detection, which is what this project focuses on. Contact detection is estimating the quality of the robot's contact with the ground. This allows the robot to adjust its movements accordingly. For example, you walk differently when you have a slippery contact, like ice, than a surface with good traction. A flawed solution is adding buttons to the robot's feet. Buttons are not able to detect a slippery contact. The project will investigate the use of sensor modalities from an Inertial Measurement Unit (IMU) along with the robot's perceived effort, or how much torque it is currently applying. This will allow legged robots to move more efficiently and utilize their advantage over other locomotive systems, such as wheels, more effectively.

ELECTRICAL AND COMPUTER ENGINEERING



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An Agent Based Model for the Coupled Spread of Misin-Formation in Social Network and Real-Life Epidemics

The pervasiveness and accessibility of social media across vast networks of people has rendered it a prime target for spreading malicious misinformation. Historically, social bots have often been deployed targeting certain groups of people in a social network, often with a political agenda. The recent spread of the coronavirus pandemic has also suffered from the spread of harmful and misinformed health-related news. In this work, we plan to use agent-based modelling to model the spread of misinformation in a social network, and couple the spread of misinformation with the spread of a real world disease. We create a heterogeneous network to replicate a real social network by accounting for varying node centrality and creating connections based on a shared geographical, political or general interest attributes. We deploy social bots that constantly spread misinformation in the network. Furthermore, we account for varying degrees of vulnerability of the agents based on the agent's political biases, trust with the agent sharing the misinformation, as well as previous experiences with getting misinformed. Finally, accounting for the fact that misinformed agents are less likely to take health precautions in the real-world, we note how the spread of misinformation leads to the spread of real-world diseases.



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Using Human Demonstrations for the Control of a Soft Exoskeleton

Reinforcement learning is a type of machine learning that has demonstrated success in allowing machines to learn to perform a task in a complex environment, using the concept of maximizing reward to train a machine through repeated trials. Policy Improvement with Path Integrals (PI^2) is the algorithm used to compute the optimal path for a machine to take to maximize reward according to a preset cost function. Simulations were studied through a software program called Pinocchio, which allows for calculations of forward and inverse kinematics and dynamics of a robotic machine given its joints and links. STL files were used to construct the model of an arm and exoskeleton in the simulations.

The goal of this research project is to find a way to automate optimal cost functions for a humanoid arm exoskeleton so that it best assists handicapped individuals in their everyday motions. This can facilitate an exoskeleton that automatically performs motions that mimic normal human behavior without a need for external instruction. Through simulations of an arm and exoskeleton, the joint positions, velocity, and torque are studied to find the optimal cost function for different movements to devise a strategy to automate the process.

ELECTRICAL AND COMPUTER ENGINEERING

Integrating Neural Control Systems into the Internet of Things

Due to recent progress made in noninvasive electroencephalography (EEG) technologies for brain-computer interfacing (BCI), such BCIs are now being reconsidered for applications outside of medicine. These devices are capable of streaming live raw EEG signals and translating them into mental commands. Some mental commands include left, right, lift, drop, push, and pull. My research, conducted in the Laboratory for Agilent and Resilient Complex Systems (LARX), focuses on using BCI technology to play games. This is intended to aid and hopefully serve as a testbed for research already being conducted into game theory.

Throughout this research, applications were developed in order for subjects to play simple games such as tic-tac-toe. Neural activities were first learned by training subjects so that EEG signals being produced from their brain could be classified into an intended mental command. Once trained, subjects were able to play games. The actions each subject took in a game mostly corresponded with their intentions. In addition to mental commands, certain emotions such as relaxation, stress, and excitement levels can be interpreted from EEG signals. Hopefully, EEG data associated with a subject's emotions will lead to a greater understanding of the certain advantages and disadvantages players feel within the context of a game.

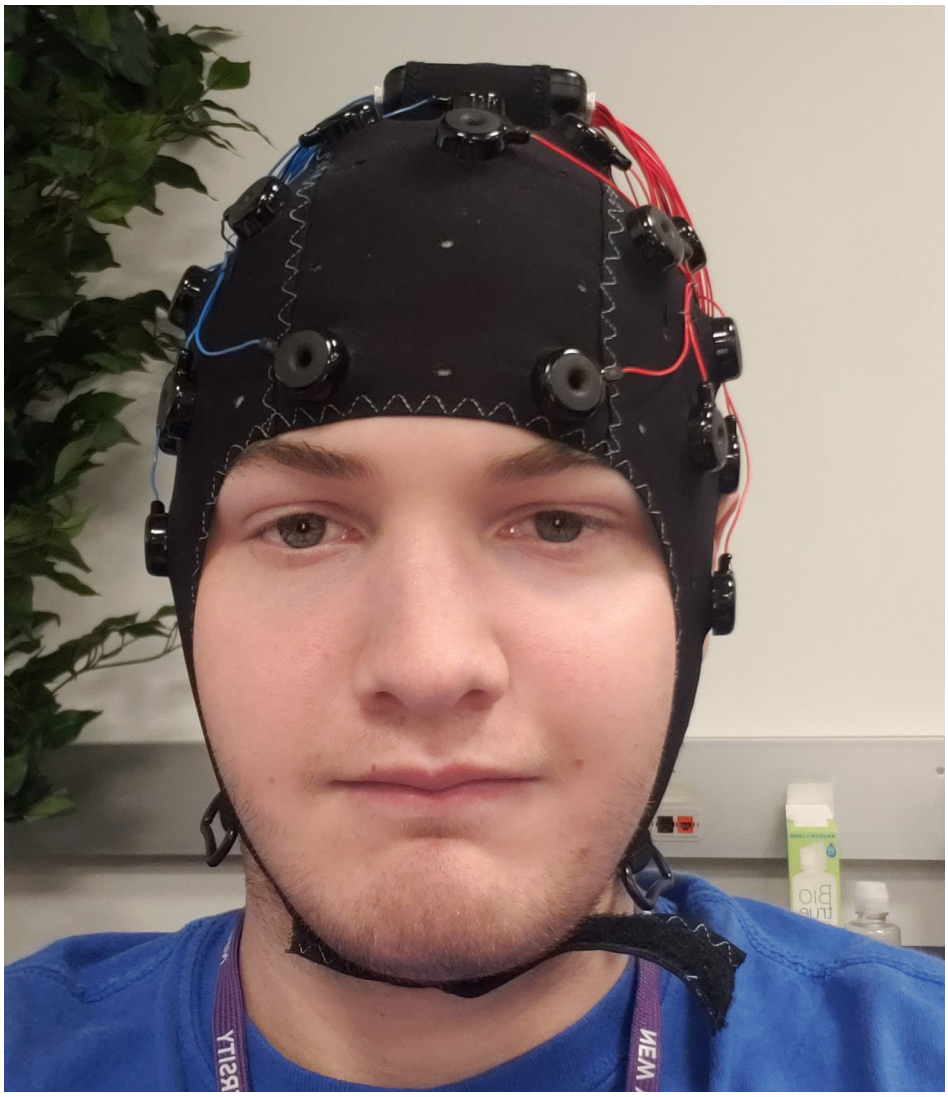


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Andrew Mayer wearing Electroencephalography (EEG) Head Cap

ELECTRICAL AND COMPUTER ENGINEERING



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Developing Data-driven Self-supervised Learning Algorithms for Robotic Manipulation Task

The ability to manipulate arbitrary objects is fundamental for autonomous robots. It is required by daily tasks such as folding the laundry or fetching a beer from the fridge. However, although the past decades have seen significant success in robotic manipulation research, its applications have still been largely constrained in controlled and static environments: factories or labs. To deploy the robots in the real world, we need to equip them with the ability to see, understand and adapt to the unexpected changes in the environment. While such changes may result from various sources, in this project, we focus on regulating the uncertainty of contacts introduced by inaccurate perception and actuation; in particular, we intend to regulate the contact locations and forces to achieve more robust task execution.

One of the most widely used control paradigms in this context is impedance control. It aims to maintain a dynamic relation between the force and the motion. Nevertheless, it is still difficult to adapt this dynamic relation to different task goals—previous research has mostly relied on hand-tuning the corresponding parameters. Fortunately, recent advances in reinforcement learning opened a door for automatically learning and adjusting those parameters. In this project, our goal is to combine this data-driven approach with the classical impedance control technique, to learn a robust controller that can not only execute a single task well, but also adapt to variations of the task through multi-task reinforcement learning. We validate our approach on pick-and-place tasks both in simulation and with real robots.



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Multi-path Multi-tier 360-degree Video Streaming in 5G Networks Demo

As 360 streaming becomes more and more demanding due to the emerging popularity of VR/AR games, technology supporting 360 streaming also becomes more demanding. To provide for this increasing demand of quality and smooth, 360 multi-tier streaming has been introduced. This project works on showing the effects of 360 multi-tier streaming through a demo on the web browser that can be demoed from a computer and a mobile device, showing statistics of such multi-tier streaming. This project will also implement the new HTTP/2.0 + QUIC protocols with the multi-tier algorithm for a better demo. Thorough testing for the protocol will be done to make sure there are improvements for the demo.

MAKERSPACE

Exploring the Cellular Mechanobiology of Aging: From Biology to Mechanics

Aging is a complex process that results in permanent cellular decay in living organisms. Cellular mechanobiology, which is the study of how cells apply and are affected by forces, is also impacted by aging which leads to alteration in cellular mechanics, signaling and subcellular cytoskeleton structures. The objective of this project is to determine the cause of mechanobiological changes in the cells during aging and develop different strategies for slowing down and reversing aging process. Micro-fabrication is used to create devices that measures forces applied by the cells in the nN range. These devices called mPADs (micro Post Array Detectors) are functionalized with fibronectin and fibrinogen to facilitate cell adhesion. Image processing and micropillar deflection is used to measure forces applied by the cell. The forces are calculated using Cellogram, a software for reference-free traction force microscopy (TFM). Further, the cells are actuated using ultrasound tweezers and their dynamic response is measured using mPADs. Lastly, subcellular actin in young and old smooth muscle cells is compared after immunostaining by observing the changes in this subcellular mechanotransductive protein.



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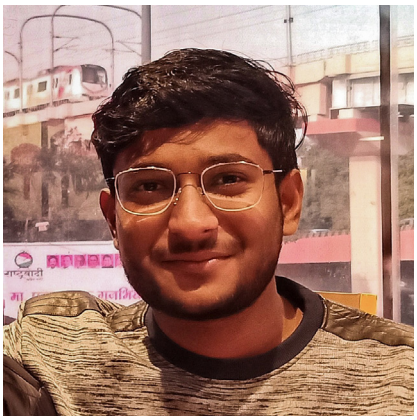
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Image relating to “Exploring the Cellular Mechanobiology of Aging: From Biology to Mechanics” project.

MECHANICAL AND AEROSPACE ENGINEERING



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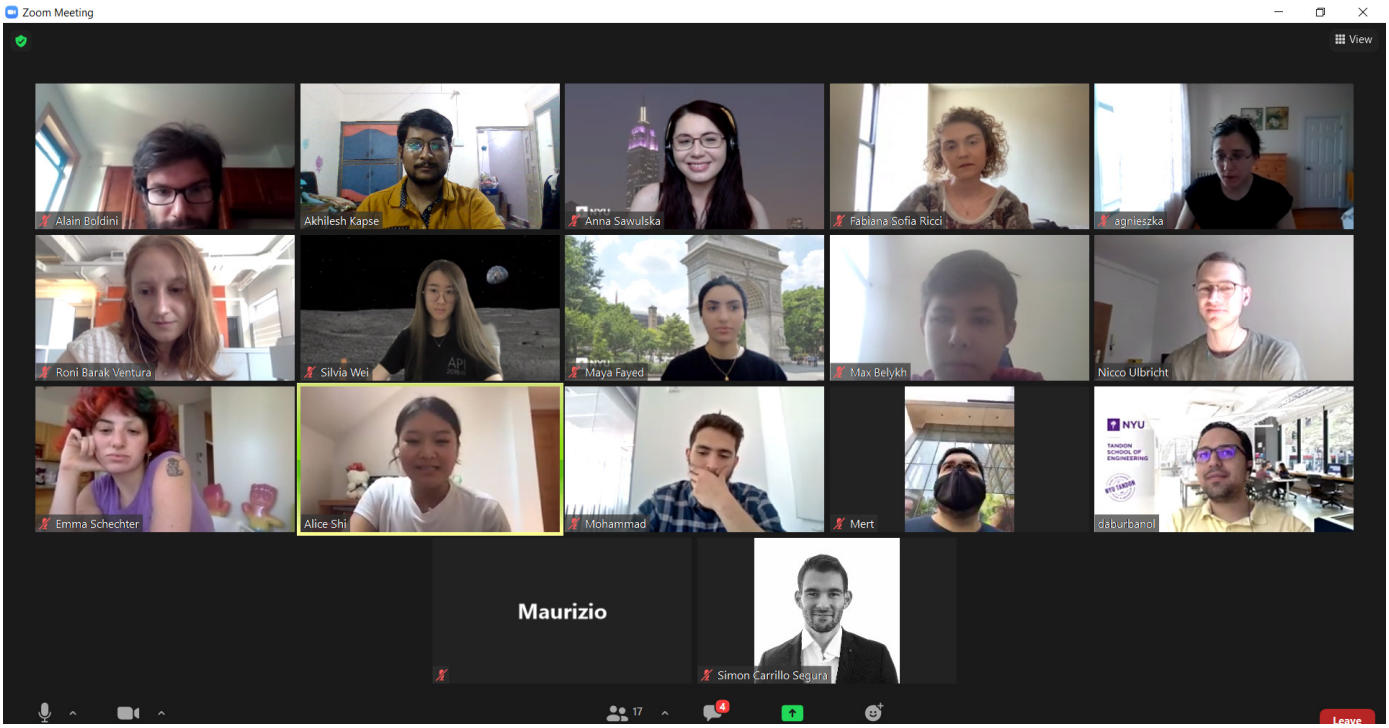
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Machine Learning to Unveil the Fluid Structure Interaction of Air-Backed impact

Understanding the response of air-backed panels to impulsive loading is crucial to the design of marine structures that operate in extreme environments such as warships and submarines. However, full-field quantifications of the structural dynamics and flow physics associated with air-backed impact are hindered by the demanding experimental and computational cost of conventional physics-based approaches, such as particle image velocimetry and fluid-structure interaction simulations. To address this challenge, we propose a data-based approach that incorporates measurements from prior fluid mechanics experiments and a machine learning algorithm. A modified classical encoder-decoder algorithm was developed to unravel the fluid dynamics principles underlying fluid structure interaction. The algorithm was first calibrated through a training phase, where a deep neural network learns the physics through existing particle image velocimetry datasets consisting of spatially and temporally resolved structural motion and fluid dynamics. This innovative algorithm is successful in predicting the velocity field with moderate accuracy for a variety of impact loading scenarios. This approach opens the door to the exploitation of deep neural networks to gain insight in other fluid-structure interaction phenomena, such as fish schooling and the flow through blood vessels.



Researchers in Professor Porfiri's lab meeting remotely.

MECHANICAL AND AEROSPACE ENGINEERING



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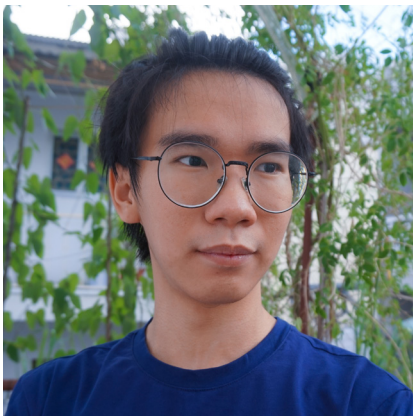
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Determining Volume Fraction of a Fiber Reinforced Composite Material For Additive Manufacturing Through Analyzing CT Scans

Additive manufacturing, also known as 3D Printing, is a revolutionary manufacturing technique which produces parts by gradually extruding materials layer by layer. Currently, the most commonly used materials in 3D printing are plastics, powders, resins, and metal. With plastics in particular, when higher strength is required without increasing the weight of printed parts, composite fiber (i.e., carbon or glass) can be used to reinforce it. Fiber reinforced composite materials offer unparalleled flexibility in achieving various complex geometries and offer high mechanical performance suitable for modern automotive, aerospace, marine, and other industries. However, inadequate fiber reinforcement in the composite will deteriorate the properties of a material, while too much fiber volume may also decrease its strength, therefore it is important to determine the optimal fiber volume fraction in the composite. When this balance is achieved, fiber reinforced composite materials offer high-performing structural properties without the need for any expensive customized molds and post machining processes. Current methods for determining volume fraction include acid digestion, optical microscopy-based techniques, resin burning-off method, SEM, and XRD. This research will explore a different method of determining the volume fraction by analyzing the CT scans (captured using a micro-CT scanner) of the produced parts.



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MECHANICAL AND AEROSPACE ENGINEERING



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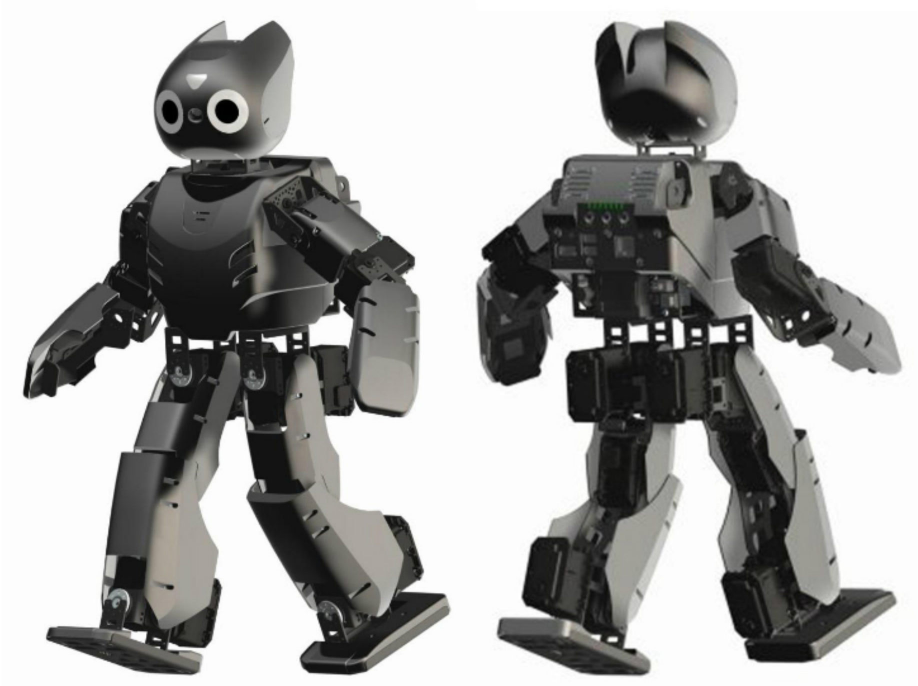
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MX-28 Servo Motor Friction Coefficient Modeling for DARwIn-OP Humanoid Robot Energetics

The optimization of the energy expenditure for a robot is an active area of research as it's development could lead to efficient energy use. To achieve such efficiency, the energy expenditure for the motor controllers within the robots must be optimized. These motor controllers consist of electrical and mechanical components that contribute to the total energy consumed. Current research on the energy expenditure of robots only focuses on one of the mechanical or the electrical components. The omission of either of these components will prevent the controller from being as efficient as possible. A theoretically built motor energy expenditure model was the chosen medium to experimentally validate the physical motor model as a function of the system state, system properties, and control inputs. The experimental setup consisted of a driver and a tester motor to identify the system-related parameters, for both the mechanical and electrical components, of the tester motor and validate the developed model. With this setup, the model was successfully validated by comparing the theoretically predicted and the measured energy consumption. This model could be widely used in the development of energy efficient controllers for various types of locomotive robots by implementing the model as a constraint or an objective function.



MECHANICAL AND AEROSPACE ENGINEERING



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Designing Security Features for Additive Manufacturing

The emergence and success of additive manufacturing in industry and research has not only transformed how products are manufactured, but has introduced novel threats regarding security and safety. Additive manufacturing relies largely on computer aided design models and the skill of the file creator. The additive manufacturing process itself requires little to no supervision by operators. While digitization is a great convenience for companies, it means that intellectual property theft, sabotage, or simple espionage is easier to conduct and be successful. This not only causes financial damage to companies; it can potentially be life threatening to customers if they buy a faulty product. In order to protect files from malicious actors, various methods are being tested and utilized. One of the methods being researched is utilizing machine learning programs to detect anomalies in files. Malicious actors can infiltrate computer files and modify them such that the final result will be compromised despite looking identical visually. Machine learning programs can be trained to recognize patterns present in compromised files and prevent such files from being printed. This work will contribute to the safety and security of products that utilize additive manufacturing and encourage more companies to embrace this new technology.



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MECHANICAL AND AEROSPACE ENGINEERING



Watermarks and QR Codes to Protect CAD from Counterfeit

Additive Manufacturing is one of the fastest growing sectors in manufacturing technology of this decade due to the customizability it provides. Additive Manufacturing relies on software programs that are connected to the Internet to make CAD models for 3D printing which are sent to the cloud. For this very reason, cybersecurity is a major concern as software programs are vulnerable to hackers. CAD files can be stolen, and similar models can be printed using the similar printer. Therefore, it is very crucial to embed security features so that the stolen files cannot be used to produce the same quality as the original parts. Watermarks will be considered to be added into the design file to prevent counterfeit in our research. However, security will still be a concern as there are many software or approaches that can be implemented to sabotage, counterfeit, or steal intellectual property. Therefore, QR codes will be embedded in different ways and will be created into the design files to identify the genuine part and to prevent counterfeit. In our research, watermarking and QR codes approaches and security features will be added in the CAD files to protect CAD files from counterfeit.

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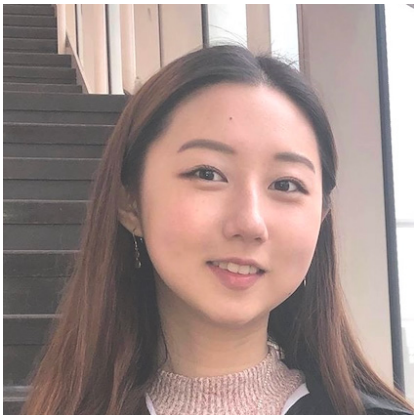
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MECHANICAL AND AEROSPACE ENGINEERING

Applying Artificial Intelligence (AI) in Collecting Data for Material Science

Natural Language Processing (NLP) is the process of analyzing, understanding, and deriving meaning from human languages for computers. Using Artificial Intelligence and NLP algorithms can save time and resources in collecting the material properties in academic papers. The goal of the research is to build a program that can find related academic papers and extract desired information. The research can essentially be separated into two key tasks. Firstly, a program must be designed so as to find and extract all documents from Elsevier publishers that contain certain keywords in the title. The first program uses the Selenium python library to automate this task. Secondly, another NLP program must be designed to peruse each of the extracted papers to find the required information including sentences, numbers, graphs and tables. The second program utilizes spaCy, which is an open-source software python library used in NLP and Artificial Intelligence, to identify sentences containing the desired information. In this research, the program is tasked to search the papers to investigate the mechanical properties of metallic syntactic foams, which are composites that incorporate hollow particles in a metallic-based matrix. The compressive strength and plateau stress of this material type are expected to be extracted

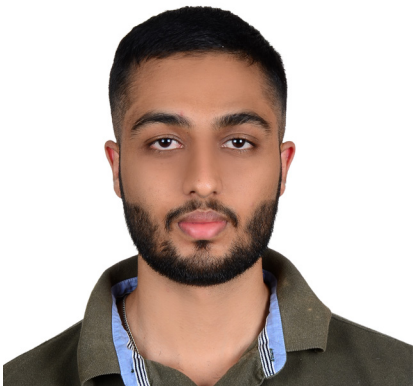


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Sai Sravya Kuraparthi working on her research project remotely.

MECHANICAL AND AEROSPACE ENGINEERING



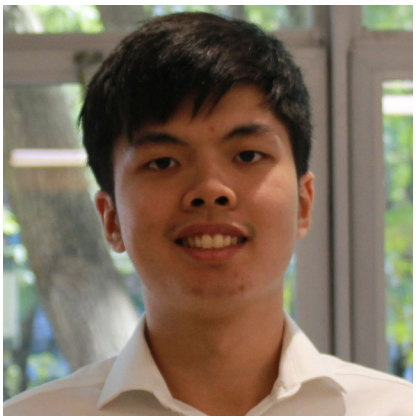
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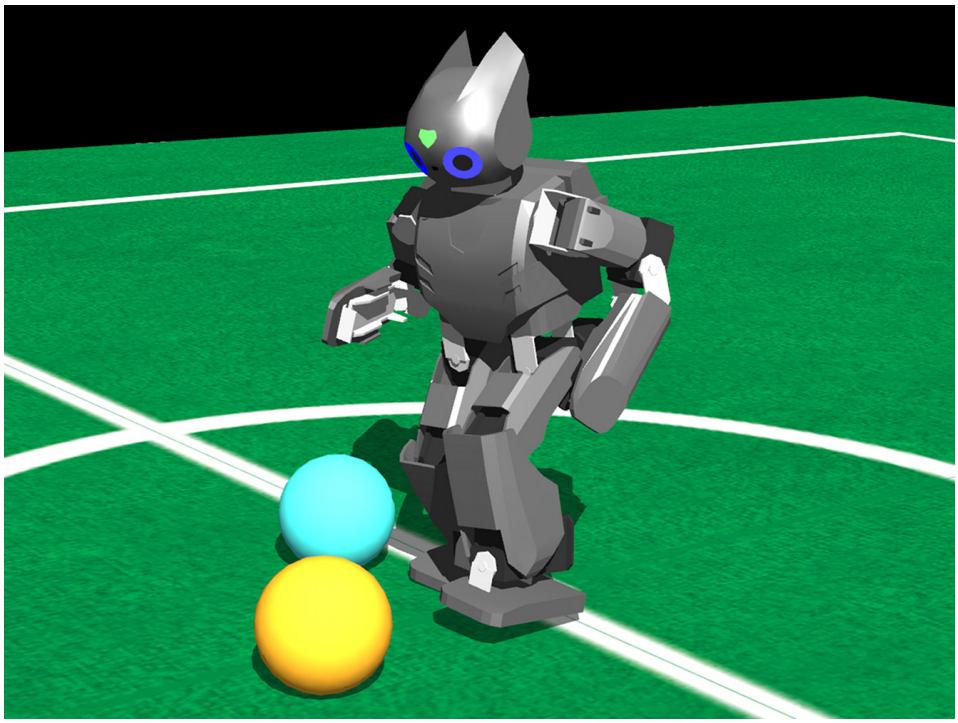
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Validation of Balance Stability Regions for Inverted Pendulum Model and DARwIn-OP Robot in Simulation

In the coming years, humanoid robots are expected to become increasingly popular. As they are capable of interacting with, working alongside and aiding humans, research into their development is on the rise. In order to safely coexist with humans, humanoid robots must be capable of navigating dynamic unstructured environments in a safe manner. Currently, the primary challenge plaguing humanoid research is the development of biped robots that are capable of fall prediction and prevention while also maintaining overall stability while walking. Our research investigates the balanced region of a biped robot for standing push recovery in Center of Mass (COM) state space - the set of initial COM positions and velocities at which the robot can maintain balance while standing. Our investigation is conducted using WeBots, an open-source simulation environment, and a simulated DARwIn-OP humanoid robot. The maximum velocity at which the robot remains stable under varying initial COM states is obtained to determine an estimated boundary for the balanced region utilizing both ankle and hip strategies. The balanced region determined in this research can then be used with a COM-state-based controller to stabilize the robot or prepare the robot to take a step or brace for a fall if it is unable to maintain balance.



MECHANICAL AND AEROSPACE ENGINEERING



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High Fidelity Agent-Based Models of Epidemic Spread

Despite a continued decline in COVID-19 cases across the United States, the enduring effects of the pandemic as well as the possibility of a resurgence in cases due to new variants call for a model that can accurately predict disease spread in cities with varying spatial layouts and demographics. In this effort, we expand a recently developed Agent-Based Model (ABM) that predicts COVID-19 spread in small to medium-sized US towns based on the lifestyles and complex interactions of their residents - agents. The original ABM equipped with the complexity of the disease progression, lockdowns, realistic vaccination, and contact tracing campaigns is now enriched with components related to agents' occupations and mobility. Each employed agent has one of the major professions, all with different risks of COVID-19 transmission. As opposed to the original model, agents can now visit time-off locations that are outside the modeled town, a habit of many relevant populations. We use this enhanced model to study the diffusion dynamics of COVID-19 in three different towns in the state of New York: New Rochelle, Utica, and Colonie. By comparing the spread and the characteristics of infected agents we conclude the impact of each city's structure and demographics on the local COVID-19 toll. Observing the differences, we establish guidelines that yield equal COVID-19 spread in all three towns. Our work provides a general methodology able to ascertain the testing practices, vaccination strategies, and containment policies to counteract the disease spread in urban areas, considering its geographical and demographical features.



MECHANICAL AND AEROSPACE ENGINEERING



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Shocking Developments: CFD Simulations of Shock Waves

Owing to the importance of the fundamentals and applications, considerable effort has been made to investigate shock wave reflections and interactions in supersonic flows. The phenomenon arises from the interaction of two processes – the shock wave reflection and flow deflection. To characterize the reflection, the shape of the reflected waves, Mach stem height, contact discontinuity, transition criteria, and the type of shock wave interaction should be identified. The occurrence of shock interactions may cause a serious increase of the local heat load and severe pressure oscillations on the surface. In some cases, it may result in aircraft damage or a flight failure. Moreover, the downstream flow domain is susceptible to the varying reflection patterns generated over complex geometries e.g., double wedges. The primary objective of this research study is to conduct an assessment of the qualitative nature of the downstream flow field and how it affects the performance of subsequent engine components such as the isolator and combustion chamber. Computational Fluid Dynamics (CFD) will be used to investigate the underlying fundamental principles associated with shock reflections and interactions that occur under different geometrical parameters of the aerodynamic structure and capture any changes in the downstream flow pattern.



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MECHANICAL AND AEROSPACE ENGINEERING



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An Information-Theoretic Study of Fish Swimming in the Wake of a Pitching Airfoil

The fast defensive response displayed by fish to sudden or threatening stimuli, such as predators, is known as startle response. This behavior is crucial for fish survival since it can elicit a collective anti-predatory maneuver via directional transmission of information within the shoal. 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 startle response on zebrafish. 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 +/-8 deg in amplitude with additional random pitching startles at larger amplitudes up to 45 deg. 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.

MECHANICAL AND AEROSPACE ENGINEERING



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Embedded Watermarking as a Cybersecurity feature in Additive Manufacturing Supply Chain

Additive manufacturing allows production of highly customizable parts. However, these parts can be hacked into, or reverse engineered to then be sold as counterfeits. Along side, Watermarking has become a common practice for products, dating back to the 13th century. Its purpose is to make it more difficult for the original product to be copied without permission and to provide the customer with some way of authenticating the legitimacy of the product. Embedding codes into the product is like watermarking, with the only difference being that you wouldn't be able to see it by looking at its surface. Many techniques have been used to achieve this, such as printing QR codes on the surface and manipulating the mesh of the product to embed a morse code into it. We have developed a method that allows for the customer to authenticate if their part is legitimate or not, by using an embedded code. Spherical voids are embedded on a specific plane(the orientation of which is determined by Euler angles, which are passed on as a string to the customer) in the product at a specific location. Finite Element Analysis is conducted on the product and the location which does not hamper the performance of the product is selected. The consumer can take CT scans, perpendicular to the plane on which the code is embedded, to be able to view the embedded code, to validate its authenticity the area of voids present can be calculated using Image Processing and can be compare with the manufacturer's data.



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MECHANICAL AND AEROSPACE ENGINEERING



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Threat Vector Analysis - Finding Fault in the Pile

In the additive manufacturing, AM, supply chain there are numerous factors that a person(s) with ill intentions could take advantage of or exploit in order to affect a specific outcome for themselves or their organization. These people with their ill intentions are commonly known as hackers. Starting from the initial intentions, followed by the method of attack, to the final compromisation of the product, are the potential threat vectors of the AM supply chain. These vectors can result in IP theft, sabotage, or counterfeiting. One such example of attack includes a hacker altering the G-Code files that would lead to damaged parts being 3D printed. In such a scenario, machine learning can be adopted to find the tampered files from the pile. Our goal is to examine the various methods of attacks that people with a criminal intent(e.g hackers) can adopt to impact the cyber and physical systems that companies have in place, to propose certain mitigative measures that companies can focus their efforts towards to prevent as well as counteract these attacks and to suggest potential solutions for the same; with a primary focus on machine learning-based countermeasures to these attacks.



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MECHANICAL AND AEROSPACE ENGINEERING



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Impact of Oxide Layer on Copper Nanoparticles Using Atomistic Simulations

Most metals oxidize when exposed to the normal atmosphere. The presence of oxide can impact various properties of metals. The overall goal of our research is to examine the impact of oxide layer thickness on the melting behavior of metal nanoparticles. In order to achieve atomic resolution, simulations at the atomic level are excellent. In this study we will be using molecular dynamics (MD) simulation to investigate copper (Cu) and copper oxides (CuO and Cu2O). MD simulation is a deterministic method where we solve Newton's equation of motion to evolve the system. The heart of the simulation is defining the interatomic interactions (or potentials) which depends on the bonding scenario of systems. A closer look at our system indicates that Cu has metallic bonding while the oxides have ionic bonding. This difference in bonding needs makes the Cu in the presence of the oxides very complex for MD simulation. Only a few transferable potentials are available to describe this combined system appropriately using MD. After going through the literature, we will be using the COMB3 (Charge-optimized many body – third generation) potential to investigate the Cu/copper oxide system. In order to provide confidence in the COMB3 potential, we will be simulating pure Cu, pure copper oxides, and a combined Cu/copper oxide in the bulk form (3D periodic) and compare this with the literature. The melting points obtained for these systems will be used as reference to justify the impact of the oxide layer on melting behavior of the corresponding nanoparticle systems.



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TECHNOLOGY MANAGEMENT & INNOVATION

Developing a Method for Citizen-Focused Air Quality Monitoring in New York City

Air pollution poses significant health risks to urban populations, notably for the elderly, immigrants, and POC. Many residents of NYC fall into one of these categories, placing them at higher risk for air pollution-related medical issues. The NYC Department of Environmental Protection monitors air quality, but their sensors cannot give individualized data about neighborhoods due to the density of urban living arrangements. The goal of our project is to include air quality monitoring to expand the existing Sounds of New York City (SONYC) community-based noise pollution research Infrastructure. Existing research shows a strong correlation between noise and air pollution. We believe the best way to effectively assess air pollution in urban neighborhoods is to monitor at the residential level and involve local communities in data collection and analysis. We are designing code to incorporate a particle sensor into the existing SONYC research setup that can be placed in a citizen-scientist's apartment to collect data. We are also exploring ways in which Human-Computer Interaction can be used for data visualization in the existing SONYC iOS app, for example presenting PM2.5 information via the number of "cigarettes smoked". Additionally, we built a React-based web app that shows longitudinal air and noise pollution data using d3.js, publishes graphs, and an overview of sensor data visualization research methods and challenges. The web app also summarizes the process of sensor data collection, data analysis and displays the wireframes for the new iOS app.



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Tracking Dietary Trends in China

Vegetarianism is rising in popularity over recent years as more people are aware of the health and environmental benefits of eating less meat. While plant-based diets are growing more popular, vegetarian foods may not be easily accessible in all cities around the world. This may be the result of cultural or religious practices and traditions. Our study aims to employ approaches from machine learning to collect, summarize, and analyze data on vegetarianism in China. Existing team members have collected primary data and used natural language processing techniques to build classification models that predict if a restaurant is vegetarian based on its name and menu items. Our goal this summer is to build on previous work done. We aim to explore various machine learning model architectures, such as LSTMs and BERT, to improve the performance of our classifier, and potentially extend the work to construct a restaurant recommendation model. To visualize the data, we are experimenting with digital online tools such as Tableau and ArcGIS. These visualization tools will help illustrate our work and results in an interactive digital form that can help contextualize observed results and trends that may be useful for this project in the long run.



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Building Orientation and Mobility Tools for Multiple Sclerosis Patients Using Human

Human computer interaction (HCI) is a modern multidisciplinary field of study that focuses on the use of computer technology in everyday human activities. The main goal of HCI is to build tools and systems that enhance the quality of life. Using external sensor technology and data analysis tools, HCI can be used to better understand treatment and recovery in the healthcare industry. Our primary objective is to create a functional system that displays the progression of patients with Multiple Sclerosis (MS) through an aggregate of movement sensors. Rather than analyzing datasets in a very controlled environment, we look deeper into how datasets might look in an uncontrolled environment, outside of clinical appointments. By using a combination of preprocessed data and raw data, we look for different ways to analyze key features in movement such as cadence, stride length and gait speed. Additionally, to reiterate our major goal, we will utilize gait analysis data collected from wearable devices and visualize the data in a manner that might be meaningful to researchers and clinicians in the field helping patients with MS rehabilitation. While our focus is MS, the research is not limited to MS rehabilitation. Rather, we hope to open the path to changing how clinical rehabilitation is conducted in the healthcare industry.



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TECHNOLOGY, CULTURE & SOCIETY



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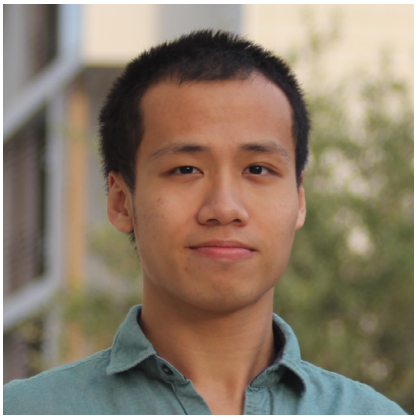
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Sustainability in Higher Education

Education is a powerful tool used to prepare the next generation with critical thinking skills to address ongoing and upcoming global challenges. Sustainability education is on the rise as more and more universities are incorporating sustainability-based undergraduate degrees into their institutions. With recent reports made by The Association for the Advancement of Sustainability in Higher Education (AASHE), over one thousand universities evaluate their sustainability practices and education, a number that has only risen since AASHE's founding in 2005. A previous study showed that sustainability curricula had great variability and very little standardization. Since the study, the number of sustainability programs has more than doubled. We examined 56 current B.A. programs in Sustainability Studies to understand the sustainability degree and the knowledge that students gain when pursuing this path. All courses were coded into broad categories (natural sciences, humanities, methods, etc.), disciplines (biology, economics, political science, etc.), and focus (environmental, sustainability, or general). Sustainability curricula vary widely, demonstrating a lack of consistency in sustainability education, implying that a standardized curriculum would be difficult to propose. However, the programs also reflect a level of unique interdisciplinary nature that mimics the field of sustainability itself and allows students to gain a broad understanding of the subject. Most sustainability majors are comprised of general courses from other disciplines; among the most common classes offered are economics, political science, and biology. We recommend additional interdisciplinary coursework which allows students to build systems-thinking skills necessary in addressing wide-ranging global sustainability issues.



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GovLab's CrowdLaw

Successful governing practices have the potential to significantly improve people's lives. However, in order to successfully govern the public, it is important to incorporate both the public and expert opinions into implementable policy action. CrowdLaw is the practice of using technology to tap the intelligence and expertise of the public in order to improve the quality of lawmaking. With trust in government at an all time low, the traditional model of lawmaking, shrouded in secrecy and distorted political party agendas, is being called into question, now more than ever. Increased public participation in the lawmaking process, in the form of CrowdLaw projects, could help to improve both the legitimacy and effectiveness of government institutions across the globe by introducing more robust data and diverse viewpoints at each stage of the lawmaking process. GovLab is supporting legislative bodies in investigating, designing, implementing, and testing new CrowdLaw initiatives.

TECHNOLOGY, CULTURE & SOCIETY



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MAP NYC: Measuring and Mapping Agricultural Production in New York City

Urban agriculture has the potential to create jobs, provide green infrastructure, and improve food security in New York City. Current urban agriculture data is incomplete and not updated, impacting the accuracy of current and future food production estimates for New York City. The purpose of this research is to conduct an agricultural census for New York City as part of the Invest NYC SDG Initiative by the Stern Center for Sustainable Business which aims to further New York's progress on the United Nations' Sustainable Development Goals. Urban agriculture sites, primarily commercial and non-profit, were identified from a variety of public datasets. The census survey was modeled after the USDA Census of Agriculture and urban agriculture surveys conducted in Los Angeles, Vancouver, and Seattle. The survey was then distributed to each organization, company, and agency that farms in NYC to gather data on their production methods, harvest, product distribution, waste management, finances, labor, barriers for urban food production, and impact of COVID-19.The responses are featured in an online map and a database available to the public. A better understanding of local food production levels will estimate overall production capacity in the city, help to inform policy decisions, and identify potential avenues to improve food security and urban resilience.



TECHNOLOGY, CULTURE & SOCIETY



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Data Science "Bilinguals" Network Analysis

Data has the potential to revolutionize policy-making and current insight and analysis research. The GovLab embodies this through The 100 Questions Initiative, which aims to identify and map the 100 most pressing and impactful questions, by collaborating and leveraging relevant datasets across domains including Migration, Disinformation, Racial Inequality, and more. In conjunction with this initiative, The GovLab also has cohorts of "bilinguals," which are groups of individuals who have both relevant domain knowledge and data science expertise. These "bilinguals" understand the importance of data and its role in decision-making while also knowing how to apply their knowledge to their respective domains. In this study, a network analysis is conducted to determine trends, gaps, and other lessons learned from the cohorts of "bilinguals" contributing to The 100 Questions Initiative. The insights gained from this study will allow The GovLab to advance other upcoming domains while continuing to build networks of experts for peer-learning and cross-collaboration.



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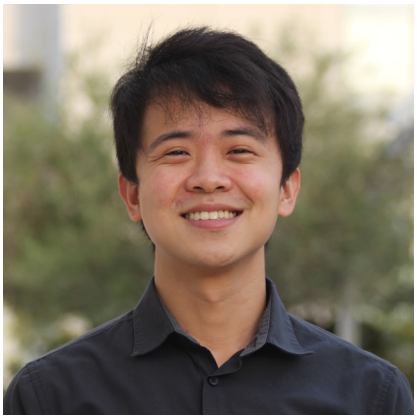
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A Law-Centric View of Emergence

This project seeks to distinguish a "law-centric" view of emergence in physics from a "mechanism-centric" view, mainly through laws of motion. In philosophy of physics, there is a view of emergence being divided into ontological and epistemological, mainly differentiated by emergence being viewed as a theoretical concept vs being viewed as an appeal to our knowledge from the observable world, respectively. In applied physics, there is another view on emergence that is divided into diachronic and synchronic. These two are distinguished by the process of emergence taking place either diachronically which is effectively instantaneously, or diachronically over some period time as demonstrable in an equation. As far as what philosophers and applied physicists agree on, both parties generally accept that emergence arises from common systems, often in a way that involves the breakage of symmetry. A number of views on emergence rely on the concept of a mechanism to explain how exactly a common system becomes emergent, but there are various interpretations on what exactly qualifies as a mechanism and how any particular mechanism is able to bring novelty to a system. In order to establish a law-centric view of emergence that is more clear and coherent than the existing mechanism-centric views, there must be an understanding of what exactly a law is, and how it is distinctive from a mechanism, how equations of motion relate to laws and mechanisms, and analyzing how those laws translate between the common system and its emergent system.

TECHNOLOGY, CULTURE & SOCIETY



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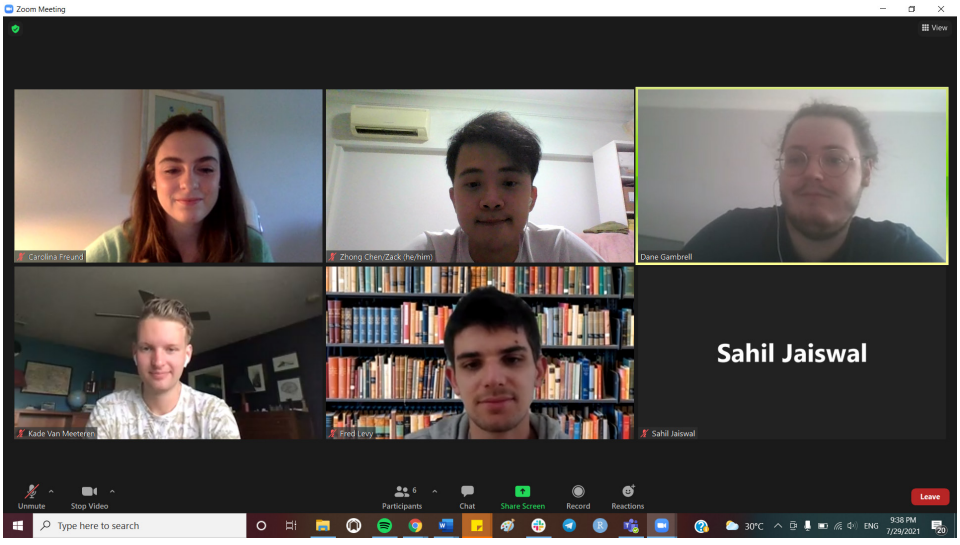
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Innovations in Labor Law Enforcement and Inspection / Continuity of Congress

Given the extensive decentralization of globalized supply chains, it has become increasingly hard to ensure that workers' fundamental human rights are being adequately protected. In a global economy where different steps in the process of producing our everyday goods are outsourced to many different countries, technological innovation (particularly among labor and unemployment inspectorates) can help strengthen workers' rights. This collaborative research project between The Governance Lab and the International Labor Organization (ILO) explores innovative uses of technology and data to create better working conditions worldwide, as well as to identify and prevent labor law violations by employers and recruiters. The end goal is to showcase exemplary case studies of these innovations, with the hope that they can inspire or even be replicated by other labor activists worldwide. The secondary Continuity of Congress project focuses on documenting the most innovative technological approaches to ensure legislative continuity. The onset of the COVID-19 crisis has meant that many legislatures have adopted new technologies that allow them to remotely convene, deliberate, and vote. The project is a subset of the broader examination of CrowdLaw – the practice of using technology to tap the expertise of the public in order to improve the quality of lawmaking.



The end of one of the team's weekly stand-up meetings for the Innovations in Labor Law Enforcement and Inspection collaborative project with the International Labor Organization (ILO). In these meetings, participants provided quick check-ins and updates on their progress with their respective tasks, to get a sense of the team's status.

TECHNOLOGY, CULTURE & SOCIETY



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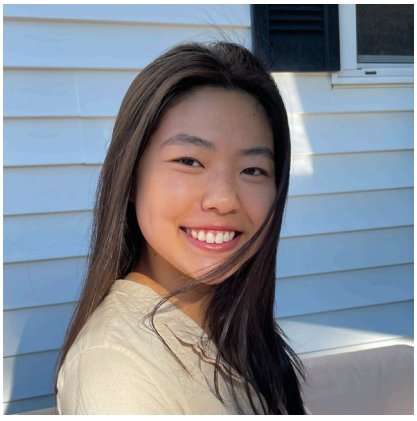
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Open Source Audio Effects for Guitar Pedals

Electrosmith is a company that creates a low-cost ($25) microcontroller called a Daisy Seed that can synthesize and process digital audio in real time. Initiated as a Kickstarter campaign, the company was started to develop technology to improve the DIY music experience, and their main product can be used as the brain of a hardware synthesizer, a guitar pedal, or any other digital music device. Their Daisy Petal is a guitar pedal that includes the Seed which can be programmed to process a musical instrument with whatever effect the developer desires. It can be programmed using several software toolchains, including Arduino and Max/MSP, and includes various knobs and switches which can all be used to alter the effects. We are creating a collection of example software for the Daisy platform using Max/MSP, an industry standard visual programming language that allows for the prototyping of digital signal processing (DSP) algorithms, among other things, to recreate some of the simplest and most common guitar pedals, including EQ, dynamics, distortion, modulation, and delay, and all the effects that those categories encompass. These will be published to GitHub with documentation as an open source repository.



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Coin Operated Wetland

Wetlands have often had a rocky relationship with humans. After spending years filtering dirty water and making it safe to drink and use again, they are only met with being called “nasty swamps”. Coin Operated Wetland is an artwork and research project that examines the relationship between humans and wetlands by looking at how the two may co exist. It directly connects human actions with environmental health while posing questions on ecology and the culture of engineering. The project takes the form of an off-grid water treatment system that partners a laundromat with a wetland system. A user may put their dirty clothes in the washing machine and add detergent like normal. Water from the washing machine cycle flows out and into a wetland ecosystem next to the washer. As the gray water flows through the wetland, it will slow, allowing any pollutants and chemicals to be filtered by the plants and the soil, cleaning the water and making it usable again. This water then flows back to the washing machine to be used again and again. Throughout the project, I have been amassing resources on each wetland species in the installation and developing educational materials and visual assets about these species’ lifeworld. Coin Operated Wetland will be installed in the Smithsonian Museum Arts & Industries Building in the Futures Exhibition that opens in November 2021.

TECHNOLOGY, CULTURE & SOCIETY



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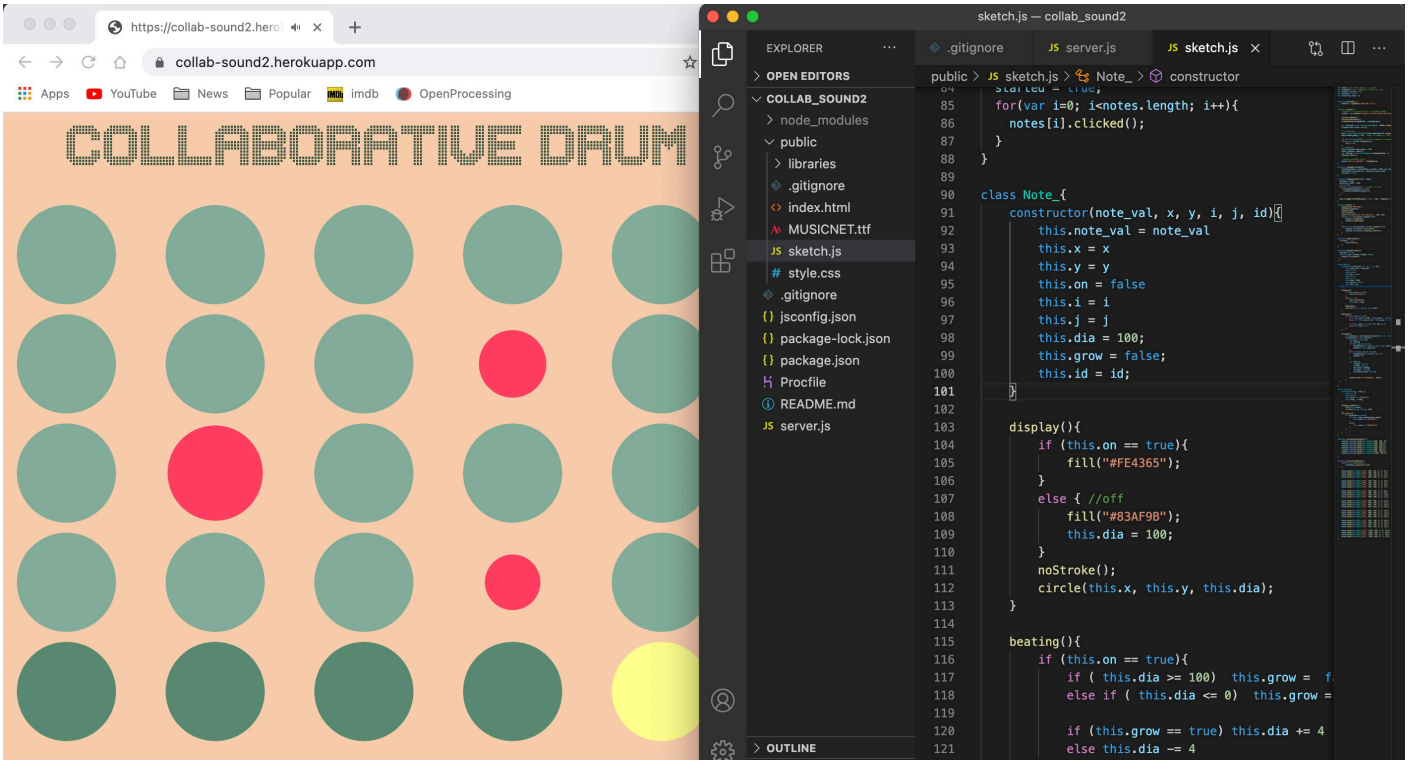
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Other Mentor(s)
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NYU Tandon School of Engineering

Audio Generation on the Web with Creative JavaScript

p5.js is an open source Javascript library that is used for creative coding; it is focused on making programming accessible for not only engineers but also designers, artists, and educators. Using sketching as a metaphor, p5.js has a lot of drawing functionalities. However, its functionalities go beyond visual applications and also allow for working with sound. p5.sound is a core library of p5.js that extends the framework with Web Audio functionality, including audio input, sound analysis, and synthesis. OpenProcessing is an online community for developers and educators that allows for users to create and share p5.js sketches, interact with other creators, and learn from the tutorials published by other users or the administrator. In order to explore audio and music making on the web, tutorials that combine p5.js with p5.sound, as well as related APIs such as Tone.js, p5.func, ml5.js, and the core Web Audio API were created and shared on OpenProcessing. The aim of these tutorials are to test the audio capabilities of p5 and help beginners gain a better understanding of working with sound.



Display of a demo of the Collaborative Drum Machine that Murat Ledin Barlas developed as a part of his research. One side displays the application's demo and on the other side displays a section of its code.

TECHNOLOGY, CULTURE & SOCIETY



KARL WU

Integrated Digital Media, B.S. 2023
Nanjing Foreign Language School
Nanjing, Jiangsu, China

Faculty
Beth Noveck

Other Mentor(s)
Andrew Young, Aditi Ramesh

NYU Tandon School of Engineering Tandon Scholars Programs Fellow

The GovLab's #Data4COVID19

The #Data4COVID19 program hosts (1) a repository of data collaboratives responding to the pandemic; (2) a repository of data collaboratives using mobility information to monitor and respond to COVID-19; (3) a governance framework to help actors use and reuse data for public good; (4) a project to identify high value open data for COVID-19 response; (5) the Data Stewards Network; and (6) the Data Assembly to get public input on data (re)use; and (7) the #Data4COVID19 Africa Challenge.



RICARDO SHELER

Sustainable Urban Environments, B.S. 2024
August Wilson High School
Washington, DC

NYU Tandon School of Engineering Tandon Schoalrs Program Fellow

Research Intern working on Solving Public Problems Program

Worked to strengthen the Solving Public Problems course through course participant analysis and the development of a newsletter intended to facilitate greater participant engagement with the course and fellow participants. Analysis into newsletter best practices created an informed process for operationalizing the newsletter tailored to our intended audience and to best accomplish our content, brevity, and social media integration goals. We were able to create several informational memos to guide the newsletter process as well as a draft newsletter to act as a guide for content quality and curation.

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. The UGA Office is 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, as well as the Center of Faculty Innovations in Teaching and Learning via the Undergraduate Academics Department, and the Makerspace. 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. In addition, we worked to ensure that the program could continue to run hybrid during a global pandemic. 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.



SARA-LEE RAMSAWAK
Director of Undergraduate Academics & Global Programs



JEN PIRO
Assistant Director of Undergraduate Programs



ISHAN KRISHAN
Undergraduate Academics Administrator



JOHANNA XUE
UGSRP Assistant
NYU Tisch
BS Film & Television 2022

TANDON UGSRP



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