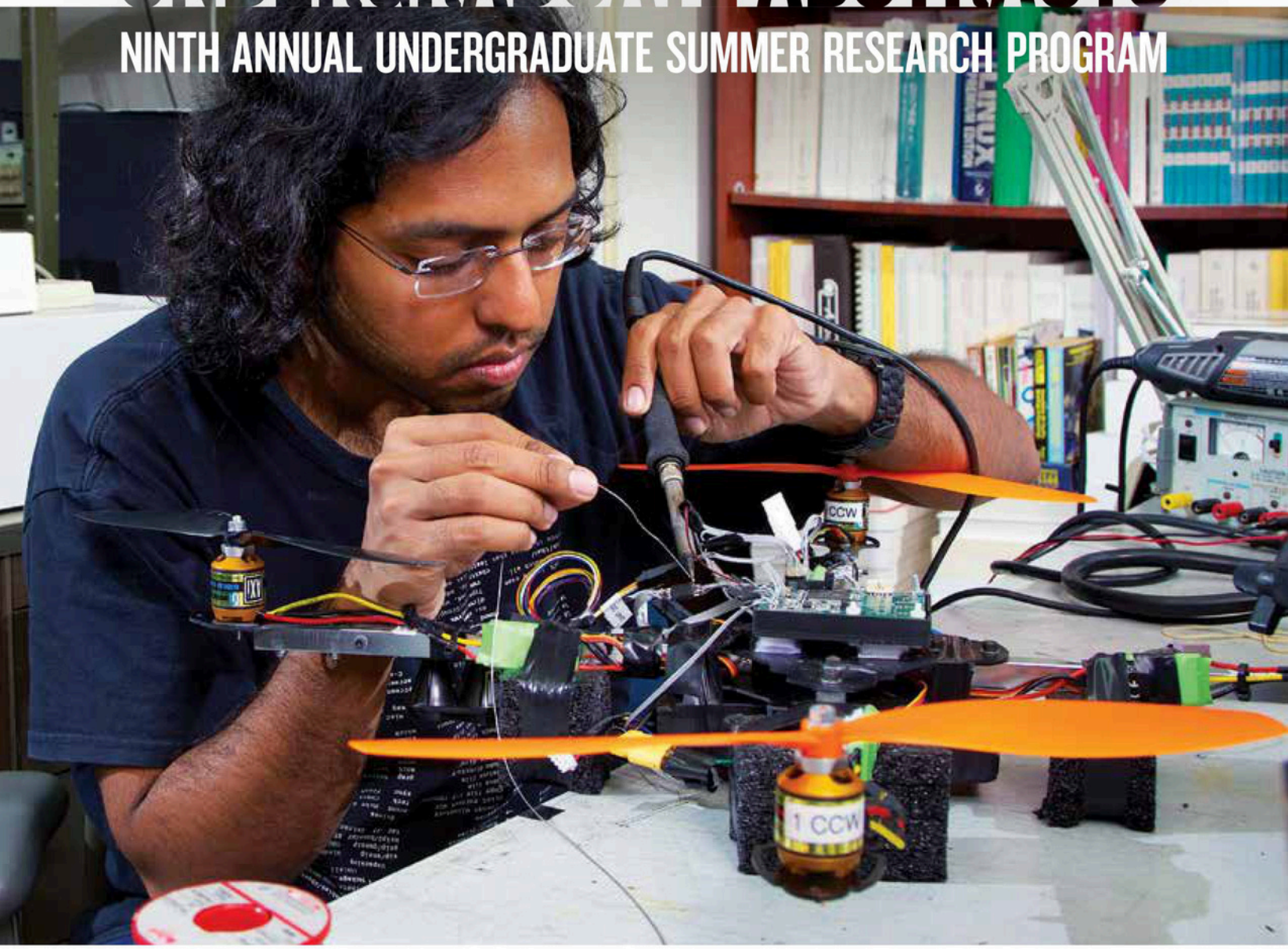
2015 SUMMER RESEARCH PROGRAM
UNDERGRADUATE ABSTRACTS

NINTH ANNUAL UNDERGRADUATE SUMMER RESEARCH PROGRAM



NYU | POLYTECHNIC SCHOOL OF ENGINEERING



INTRODUCTION

NYU School of Engineering's Undergraduate Summer Research Program provides a unique opportunity for NYU SOE, NYU College of Arts and Science, NYU Abu Dhabi, and other select students to engage in research over the course of the summer. This program offers students far more than the traditional classroom experience; it allows them to work alongside faculty mentors on cutting-edge research projects. Close interaction with faculty and research staff promotes an educational experience that advances the i2e model of invention, innovation and entrepreneurship. Undergraduate students are afforded the opportunity to conduct research as paid interns during this 10-week period. The program aims to enhance and broaden student's knowledge base by applying classroom learning to solve practical and contemporary problems and to better prepare them for lifelong learning.

Summer 2015 marked the ninth year of the Undergraduate Summer Research Program. Since its inception, 484 students have participated in and a number of faculty members have contributed to the program. In addition to their work in labs, students attended seminars on entrepreneurship, research panels, and diversity in STEM. Additionally, students presented their work-in-progress to other members of the research cohort at a special presentation event dedicated to practicing presentation skills and fostering inter-group collaboration on current and future projects.

The School of Engineering's faculty participation in this program was essential, as was the financial support provided by faculty mentors. The gifts from several alumni donors have also propelled the program's success. I would like to thank Dr. Joseph G. Lombardino '58Chem, James J. Oussani, Jr. '77ME, and Dr. Harry C. Wechsler '48CM, for their generous support of this year's program. Additionally, this year marked the fourth year of the Thompson Bartlett Fellowship. Ten of this summer's researchers were graciously supported by this fellowship made possible by Mrs. Dede Bartlett whose father, Mr. George Juul Thompson, was a graduate of the Polytechnic Institute of Brooklyn in 1930. Donors' gifts allow us to engage more student researchers, faculty mentors, and further strengthen this truly unique summer experience. I would also like to acknowledge Sara-Lee Ramsawak who coordinated this year's Undergraduate Summer Research Program and ensured the programs daily operations ran seamlessly.

The abstracts published in this volume are representative of the research done over the summer and celebrates the accomplishments of the undergraduate researchers.

I congratulate all of the student researchers who participated in the 2015 Undergraduate Summer Research Program and look forward to future summers of intellectual and scholarly activities.



Iraj Kalkhoran

Associate Dean of Undergraduate Academics

CONTENTS

INTRODUCTION i

APPLIED PHYSICS
TomasSoltis 2

CHEMICAL AND BIOMOLECULAR ENGINEERING
SarahBiscardi 2
Marissa Albanese 3
Natalie Noll 3
Timothy Charlton 4
Jing Chen 4
Alyssa D'Apice 5
John Ritten 5
Alex Chew 6
Daniel Luci 6
Maria Andreea Dimitriu 7
Audrey Goh 7
Isabella Hung 8
Chanwoo Ji 8
Teeba Jihad 9
MD Kabir 9
Joy Kim 10
Hannah Mitchell 10
Hassan Nahas 11
AnkitRaghuram 11

COMPUTER SCIENCE AND ENGINEERING
Joseph Bieselin 12
Steven Wong 12
Urs Evora 13
Chandrika Khanduri 14
Patrick Kingchatchaval 14
Cynthia Krejczman 15
Bingcan Xu 15
TalhaJaved 16

ELECTRICAL AND COMPUTER ENGINEERING
Franky Chen 17
Vasily Rudchenko 17
Abhimanyu Ghosh 18
Waisan Gu 19

MATHEMATICS
EmanuelAzcona 19
Kye Drageset 20
Maximilian Kantor 20
Monika Filipovska 21
Naqibur Rahman 21
Avigael Sosnowik 21
Danielle Leong 22
Kalana Gamlath 22

MECHANICAL AND AEROSPACE ENGINEERING
SaidAbdallah 23
Ahmed Alady 23
Leanne Block 24
Jie Li 24
Howard Chien 25
Brooke Colon 25
Laura Donnelly 26
James Carrington Gardner 26
Hyun-Jun Choi 27
Kristen Marventano 27
Lanqi Gong 28
Nasir Iqbal 28
Allison Johnson 29
Nicholas Kumia 29
Shelly Lo 30
Zed Lucienne 30
Jimmy Lu 31
Aditya Soni 31
Aimee Nogoy 32
William Peng 32
Steven J. Osma 33
Sukhgewanpreet Singh 33
Katarzyna Somszor 34
Christopher Sosnofsky 34
Miguel Vazquez 35
Thais De Meneses Vital 36
Steven Zeltmann 36
Sam Zhao 37

TECHNOLOGY, CULTURE AND SOCIETY
HindAltantawi 38
Shearyar Khan 38
Luciana Jaalouk 39
Andreína Vivas Thomas 39
Mahamitra Jagadheshkumar 40
Stanford Mendenhall 40
Luis Ramirez 41
Griffin Teed 41

TECHNOLOGY MANAGEMENT AND INNOVATION
Hong-GyuLee 42

FACULTY

APPLIED PHYSICS
Lorcan Folan

CHEMICAL AND BIOMOLECULAR ENGINEERING
Bruce Garetz & JaniceAber
Tommy Lee & Alexandra Seidenstein
Kalle Levon
Jin Ryoun Kim
Rastislav Levicky
Abhijit Mitra
Charles P. Martucci
JinKim Montclare

COMPUTER SCIENCE AND ENGINEERING
Justin Cappos
Haldun Hadimioglu
Nasir Memon & Tzipora Halevi

ELECTRICAL AND COMPUTER ENGINEERING
Farshad Khorrami
Quanyan Zhu

MATHEMATICS
Luciano Medina
Lindsey VanWagenen,RachelJacobovits,Michel Lobenberg

MECHANICAL AND AEROSPACE ENGINEERING
AleshaCastillo
Weiqiang Chen
Emilie Dressaire
Vittoria Flamini
Nikhil Gupta
Iraj Kalkhoran
Joo Kim
SangHoon (Nathan) Lee
Maurizio Porfiri

TECHNOLOGY, CULTURE AND SOCIETY
JonathanBain
Dana Karwas
Christopher Leslie

TECHNOLOGY MANAGEMENT AND INNOVATION
Oded Nov

APPLIED PHYSICS



TOMAS SOLTIS

BS PhysicsandMathematics 2016
Knightdale High School
Knightdale, North Carolina

Faculty

Lorcan Folan

NYU School of Engineering

RELATIVISTICCORRECTIONSTOMOSELEY'S LAW

X-ray fluorescence (XRF) is the emission of characteristicx-rays from a substance. These characteristic x-rays are produced when a sample is excited and inner shell electrons are ejected from some of its atoms. This leaves vacancies in the inner orbitals, known as holes, allowing electrons from higher orbitals to make transitions into the unoccupied states of lower energy. This process releases energy in the form of an energetic x-ray photons. Since the energies of these x-rays are unique for each element, XRF is a power tool in chemical analysis.

In 1913 Henry Moseley discovered a simple linear relationship between the square root of the frequency of a characteristic x-ray and the atomic number Z of the emitting element. This relationship quickly became known as Moseley's Law and provided support for Bohr's model of the atom which relied on the principle of quantized energy and angular momentum. However, substantial deviations from Mosley's Law begin to develop as one moves to higher Z elements. This project explored the possibility that these deviations could be explained by relativistic effects (i.e., relative motion of the electron with respect to the nucleus).

We measured the energies of K and L transitions in the spectra of a series of elements between Titanium and Lead using solid state x-ray spectrometers (CZT & CdTe). We are applying a series of relativistic corrections to Moseley's Law, each of which can be derived from the fully relativistic Dirac equation. Initial results confirm that the basic deviations are due to relativistic effects.

CHEMICAL AND BIOMOLECULAR ENGINEERING



SARAH BISCARDI

BS ChemicalandBiomolecular Engineering 2016
Lake Mary Preparatory School
Lake Mary, Florida

Faculty Rastislav Levicky

Other Mentor

NYU School of Engineering

*Thompson-Bartlett Fellow

Hao-Chun(Howard)Chiang

METHODS OF ANALYZING BIOREACTIONS IN NANOLITER VOLUMES

Surfacecharacterization is predominantly affected by the chemical nature of a surface and is used to determine properties such as wettability, adhesion, and hydrophobicity. Multiple theories have been developed to determine surface energy based on the characteristics of the surface and the solvent. Surface energy is best visualized by determining the equilibrium contact angle between a nanoliter droplet and a solid surface, known as the Sessile Drop Method. A simple procedure was created from a camera and drop stage area. In this process, a droplet is printed onto a slide surface, where an image is taken of the droplet edge and is then processed and analyzed with programs such as ImageJ or an ImageJ add-on called DropSnake to find the angle at which the solvent contacts the surface. This process is repeated for multiple droplets to determine an average angle. The accuracy of this simple set up was determined by comparing results to literature of similar experiments. Polymer solvents such as Poly(methyl methacrylate) (PMMA), Polystyrene (PS), and Polytetrafluoroethylene (PTFE) are used because of their stabilities with water droplets. Measuring surface energy is directly applied to represent the influence of surface modifications on wettability and other characteristics as well as to determine suitable modifications for other processes. Multiple solvents are used to determine the surface tension of the modified surface by taking into account the polar and dispersive components of the liquid (Owens/Wendt Theory). From these studies, we will apply this process to DNA hybridization by similar modifications of gold surfaces for better immobilization characteristics.



MARISSA ALBANESE

BS ChemicalandBiomolecular Engineering/MS Biomedical Engineering 2017
Our Lady of Mercy Academy
Syosset, New York

Faculty Kalle Levon

NYU School of Engineering

*Thompson-Bartlett Fellow

ENGINEERING STRUCTURAL ALGINATE GELS FOR PC-12 CELL DEVELOPMENT

Theadrenal medulla is the innermost region of the adrenal gland constructed of neuroendocrine cells responsible for the secretion of the catecholamines epinephrine and norepinephrine to the circulatory system; these cells are also capable of paracrine signaling, producing changes in differentiation and behavior of closely neighb pheochromocytoma is a tumorous growth of the adrenal medulla which produces unwarranted paracrine signaling and secretion of these catecholamines. Because of their signaling properties, cells derived from the pheochromocytoma (PC-12 cells) can be substituted for primary neuron cells to study the processes of neuronal differentiation. The of the extracellular matrix can be manipulated by securing the cells to an electrospun nanofiber layer. The proper environment is needed to seed the cells; this is achieved throu use of biodegradable gels.

Alginates are naturally occurring polysaccharides elicited from brown seaweed, composed of the unbranched binary copolymers α-L-guluronic acid and ß-D-mannuronic acid. When combined with divalent cation solutions, such as calcium chloride, crosslinking of the unbranched binary copolymers, and ultimately gelation, occurs. The effects of molarity of the calcium solution used for gelation and the concentration of alginate on the mechanistic properties and biocompatibility of the gel were analyzed using microscopy and swelling ratios. Our goal was to encapsulate PC-12 cells in long thin fibers of alginate gel that continuously held their shape and did not denature in vitro due to prolonged heat exposure. DAPI and Alexa Fluor 488 Phalloidin dyes were used to stain the nuclear DNA and the actin filaments respectively of PC-12 cells; staining was observed through florescence microscopy. We intend to combine encapsulated PC-12 cells in alginate gels with electrospun nanofibers to construc dimensional sheets.



NATALIE NOLL

BS Biomedical Engineering2016

McLean High School McLean, Virginia
Faculty

Virginia Commonwealth University

KalleLevon



▲2% alginate fibers in 0.05M CaCl2 died red in food coloring.



TIMOTHY CHARLTON

BS ChemicalandBiomolecular Engineering/MS Chemical Engineering 2017

Walt Whitman High School
Huntington Station, New York

Faculty Jin Ryoun Kim

Other Mentor

NYU School of Engineering

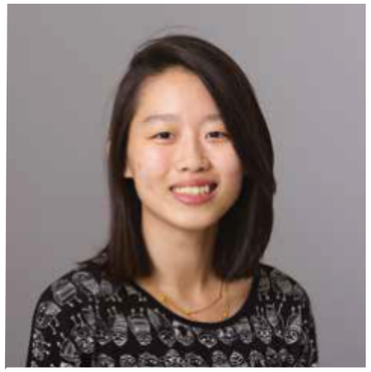
Vandan Shah

PROTEIN STABILIZATION

Enzymes areextremely usefulbio-catalytic proteins to various industrial applications. Many industrial processes could be performed cheaper, faster, or in more environmentally friendly ways if enzymes were to replace reagents that are currently used. Enzymes are highly selective, however, only catalyzing specific reactions, so only very select enzymes could be used for a process. Additional to their selective catalytic activity, enzymes have optimal operating conditions, such as temperature and pH. As such, successful applications of enzymes are frequently limited by their instability and tendency to aggregate at harsh environmental conditions (i.e. high temperature or acidic/alkaline pH or under mechanical stress.)

Bacillus Circulans Xylanase (BCX) is an enzyme that breaks down beta-1, 4-xylan into the sugar xylose. This enables it to facilitate in the bleaching of wood pulp during the production of paper by cleaving the bonds between lignin and xylan. This leaves lignin, the compound that gives the wood pulp an undesirable off-white color, more easily accessible to bleaching agents. This paper making process requires BCX to be functional at too high temperature and alkaline pH. However, BCX is a mesophilic protein and denatures at such harsh conditions. The objective for this research is to increase the BCX stability without changing its intrinsic properties, such as kinetic activity.

BCX (guest protein) was inserted at various locations of highly thermophilic Pyrococcus furiosus maltodextrinbinding protein (PfMBP) (host protein) through a combinatorial approach. Previous research has shown that guest protein stability is highly dependent on host protein stability and the insertion location. In our study, a library was generated for BCX insertion into PfMBP at various locations. A high throughput screening method was developed and employed to select active and stable PfMBP-BCX variants. Selected PfMBP-BCX variants were purified and further characterized for kinetic and thermodynamic stability and analyzed compared to WT BCX stability.



JING CHEN

BS BiomolecularScience2018

Stuyvesant High School
New York, New York

Faculty Jin Kim Montclare

Other Mentor

JosephFrezzo

NYU School of Engineering

ENGINEERED PROTEIN BLOCK COPOLYMER FOR HYPERTHERMIC DRUG DELIVERY

Cartilage oligomeric matrix protein (COMP) is a protein found in cartilage, tendons and ligaments. The coiled-coil domain of COMP (C) assembles into a homopentamer that naturally recognize various small hydrophobic molecules demonstrating potential as a drug delivery system. Alanine scanning mutagenesis studies have been done to characterize the residues responsible for structure, stabilization, oligomerization and binding to small molecules. C is integrated with a temperature sensitive elastin-like peptide (E) motif to form CE2, a self-assembling protein block copolymer. The C domain can be engineered to bind certain small molecules and the E domain allows for temperature-controlled release of small molecules. Studies have demonstrated that by changing the E domain size, a range of protein transition temperatures can be obtained in the physiological range, which calls for further biomedical applications in hyperthermic drug delivery.

The goal of this project is to engineer a targeted and controlled delivery system for therapeutic agents such as doxorubicin, a chemotherapy drug. One of its most adverse side effects is congestive heart failure. We hypothesize that rather than being administered intravenously, a tumor-targeted delivery system can minimize its side effects. Certain peptides such as arginine-glycine-aspartate (RGD) have been shown to have strong affinity forαVß3 integrin, where over-expression of this protein plays a major role in tumor angiogenesis. We therefore engineered a CE2-RGD protein, which bears selectivity for tumors for thermoresponsive drug delivery.



ALYSSA D'APICE

BS ChemicalandBiomolecular Engineering 2016
Carmel High School
Carmel, New York

Faculty CharlesP. Martucci

NYU School of Engineering

*Thompson-Bartlett Fellow

CALCIUM AND CARBON DIOXIDE EFFECTS ON THE VISCOSITY OF MUCIN

Mucin is a glycoprotein involved in theproduction of mucus. Itis essential in various defense and cleansing mechanisms, but mucus that is too viscous can be detrimental to one's health. We hypothesize that carbon dioxide and cross-linking calcium ions are involved in changing the viscosity of mucin. We aim first to prove that mucin can hold
various amounts of calcium and then determine whether or not calcium ions affect the viscosity.

Initially, two-chambered dialysis cells separated by a semi-permeable membrane were set up allowing calcium ions to pass freely between the chambers. One chamber was filled
with a porcine-derived mucin solution, while the other was filled with different calcium chloride solutions. The samples were allowed to diffuse overnight and the calcium concentrations were measured by a titration method. This method was not sensitive enough to quantitatively measure low calcium concentrations.

Fluorescent calcium indicators, Fura-2 and Indo-1, promised to be more sensitive and also have high selectivity for calcium. Our goal is to obtain a graph of calcium concentration as a function of the dye's fluorescent intensity; however, this is made difficult by the spectrometer's sensitivity to indicator concentration. Once the data produces a curve, it will serve as a reference to accurately measure the unknown calcium concentrations in the mucin samples.

In the future, our fluorescence technique will be used to measure calcium ion concentration in mucin after equilibrium dialysis with various calcium solutions. A rheometer will be used to measure the viscosity of mucin when it has bound to various amounts of calcium. Mucin samples will also be exposed to varying concentrations of carbon dioxide to determine its effect on viscosity.



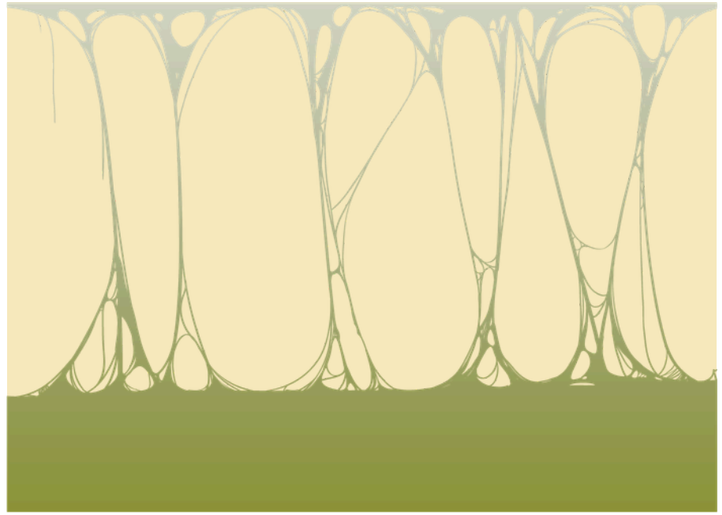
JOHN RITTEN

BS Chemical andBiomolecular Engineering 2016
Rockford High School
Rockford, Minnesota

Faculty

Charles P.Martucci

NYU School of Engineering





ALEX CHEW

BS Chemical andBiomolecular Engineering/MS Chemical Engineering 2016
Edward R. Murrow High School
Brooklyn, New York

Faculty

Abhijit Mitra

NYU School of Engineering



DANIEL LUCI

BS Chemical andBiomolecular Engineering/MS Chemical Engineering 2016
Hunter College High School
New York, New York

Faculty

Abhijit Mitra

NYU School of Engineering

CHEMICAL SHIFT AND STEREOELECTRONIC EFFECTS

Chemicalshiftis an important parameter in nuclear magnetic resonance (NMR) spectroscopy that gives an insight into the electronic environment around a nucleus. It results from diamagnetic and paramagnetic field effects that are influenced by structural features within the molecule.

Bond anisotropy and hyperconjugation are two important theories that explain the structural effects on chemical shift. In the former, local circulation of electrons, such as a carbon-carbon bond, causes a directional dependent magnetic field effect that result in extensive shielding to surrounding nuclei. In the latter, orbital overlap causes shift in electron density and elongation of bonds resulting in deshielding effects of the participating nuclei. This computational study uses these two theories to understand the hydrogen chemical shifts of cyclohexane and piperidine as a precursor to understanding the hydrogen chemical shifts of larger cyclic molecules containing the piperidine moiety.

This study uses the Gaussian '09 (G09) software package, which can accurately compute hydrogen chemical shifts but lacks the ability to distinguish the contributions of neighboring orbitals that make up a particular chemical shift. Therefore, Natural Bond Orbitals 6.0 (NBO6) is used in conjunction with G09 to calculate natural atomic orbital (NAO) and natural bond orbital (NBO) populations, second order delocalization stabilization energies, natural Coulomb electrostatics (NCE), and natural chemical shifts (NCS), to find the major contributors to the chemical shielding tensors. In addition, three-dimensional isotropic surfaces are plotted using the Nuclear Independent Chemical Shift (NICS) NBO-NCS method, which provides a more thorough and visual analysis of the shielding fields surrounding the hydrogen under scrutiny. From these tools, we are able to accurately analyze the shielding effects produced by bond anisotropy and hyperconjugation.



MARIA ANDREEA DIMITRIU

BS Biomolecular Science 2018
Colegiul National "Mircea celBatran"
Constanta, Romania Faculty Bruce
Garetz and Janice AberNYU School
of Engineering



AUDREY GOH

BS BiomolecularScience/
MS Chemistry 2016 Bronx
High School ofScience
Bronx, New YorkFaculty
Bruce Garetz and Janice Aber

NYU School of Engineering

LASER-INDUCED CRYSTALLIZATION IN THE PRESENCE OF GOLD NANOPARTICLES

In1996,Garetzand coworkers discovered that supersaturated solutions can be induced to crystallize when illuminated with a high-intensity laser beam and named this process non-photochemical laser induced nucleation (NPLIN). Although many other ways of causing supersaturated solutions to crystallize were already known, NPLIN is especially significant because it represents a non-chemical way of forcing different polymorphs of the solute to emerge for some substances, such as glycine. Since different polymorphs of a substance exhibit differences in properties such as solubility, density and bioavailability, the ability to select a particular polymorph of a substance bears great importance in the pharmaceutical industry.

What determines which polymorph is formed in NPLIN is the polarization state of the laser beam, a process called polarization switching. To explain this phenomenon, Garetz et al. hypothesized that NPLIN was based on an optical Kerr alignment: the electric field of the electromagnetic wave (light) induces a certain kind of alignment in the molecules, causing them to organize and eventually form the crystal. This hypothesis suggests that if one can enhance the strength of the electric field, one could observe NPLIN at lower light intensities. This idea constitutes the basis of our current experiment, which studies the effect that gold nanorods have on solutions of 1.5 supersaturation of glycine dissolved in aqueous sodium citrate when they are shot with linearly-polarized light of wavelength of 1064 nm in the near-infrared spectral region. The gold nanorods exhibit plasmon resonances near this wavelength (resonance wavelengths ranging from 660 to 980 nanometers) that magnify the strength of the local electric field. Around 100 such solutions for each [illegible] were prepared by dissolving glycine powder in 50°C until completely dissolved, allowed to cool to room temperature until a metastable supersaturated state is reached, aged for a few days, and finally shot with 5 laser pulses of [illegible] 12 ns pulse width from a high-energy Nd:YAG laser.

NONPHOTOCHEMICAL LASER INDUCED NUCLEATION OF SUPERSATURATED GLYCINE SOLUTIONS IN AGAROSE

In2009, Alexander etal illustrated that spatial controlled laser induced nucleation was possible in supersaturated potassium chloride-agarose gels. [1] To determine whether this phenomenon is found in gels with organic solutes, but also molecular structure glycine was chosen due to its ability to form different polymorphs with different polarizations of laser light. [2]

Supersaturated glycine-agarose gels were prepared by dissolving 0.5% w/w powdered agarose in supersaturated (c/c_0 =1.45-1.55, where c is the solution molality and c_0 is the solubility). The gels were aged for one week. Considering the small sample size of 21 gels, preliminary results indicate that about 50% of the samples nucleated within the aging period. The gels that did not spontaneously nucleate were illuminated at the air/gel interface with a single laser pulse of the 1064 nm wavelength, linearly-polarized output of the Victory 2A Nd:YAG laser. The laser produced a 12 ns laser pulse with a peak intensity of MW/cm_2. Approximately 90% of the gels instantaneously nucleated after the laser exposure. Crystal growth began at the air/gel surface with thin, feathery branches extending downward. This type of morphology, the overall shape of the crystal, has not been previously seen in any of the three polymorphs of glycine: α, ß, and γ. Through powder x-ray diffraction, these dendritic crystals were found to be α-glycine; an unusual morphology of α-glycine was observed.

The next step is to expose the gels with laser light through the glass/gel interface to examine whether crystals can be induced to nucleate in the bulk of the gel to confirm whether the surface effect played a role in the nucleation of previous gels.

1 Alexander, A J; Duffus, C; Camp, P J. *J. Am. Chem. Soc.* 2009, 131, 11676-11677
2 Sun, X; Garetz, B A; Myerson, A S. *Crystal Growth & Design* 2006, 6, 684-689



ISABELLA HUNG

BS ChemicalandBiomolecular Engineering/MS Chemical Engineering 2018
Benjamin N. Cardozo High School
Bayside, New York

Faculty Rastislav Levicky

Other Mentor

SadeRuffin

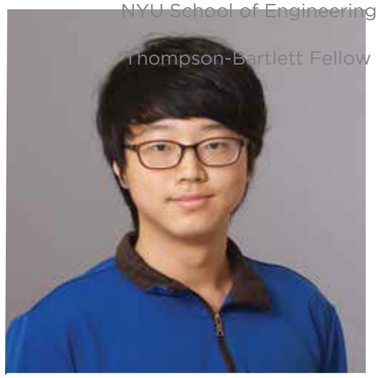
NYU School of Engineering

Thompson-Bartlett Fellow

DNA ELECTROCHEMICAL SURFACE HYBRIDIZATION

DNAmicroarrays and biosensors are becoming a popular diagnostic tool in various bioanalytical contexts, ranging from pathogen detection to genomic cancer identification. However, much of the fundamental properties of biosensors is still not completely understood. Much of the uncertainty is due to forcing hybridization of the DNA “target” to the uncharged Morpholino “probe” under tolerable but less than ideal conditions, which result in incomplete, delayed, or unusual hybridization trends. If optimal hybridization conditions can be found, then the application of this biosensor can be used most efficiently and consistently.

Using electrochemistry, DNA’s innate negative charge can be utilized to explore the most ideal hybridization conditions. A Rotating Disk Electrode (RDE) can be used to closely monitor surface hybridization. The RDE also applies either a positive or negative charge to a surface to promote or discourage hybridization of the DNA target to the Morpholino probe. In order to use this method, however, the probe must be initially immobilized on the surface. Immobilization of the Morpholino probe begins with polishing a gold electrode surface to clean it, binding the Morpholino to the gold surface, then immediately placing it in 6-mercapto-1-hexanol (MCH) for 2 hours. The MCH creates a passivation layer on the surface to prevent non-specific binding of the Morpholino to the gold surface. After this, the immobilized Morpholino is introduced to DNA to begin hybridization. The two ideal parameters this experiment attempts find are optimal salt concentrations for both the DNA and Morpholino and – in the near future– find optimal temperatures to promote competitive hybridization.



CHANWOO JI

BS Chemical andBiomolecular Engineering 2018
West High School
Torrance, California

Faculty Tommy Lee and Alexandra Seidenstein

NYU School of Engineering

3D MODELING ACTIN AND MYOSIN

Heart conditionslike hypertrophic cardiomyopathy (HCM), which causes blood clots and possible myocardial infarction and is also the leading cause of sudden deaths from cardiac issues, are more likely to affect individuals with sarcomeric mutations, though how the anomaly of the muscle cell is connected to the condition is still an enigma. As such, muscle cells, despite being the most useful tools in animal motility, are far from being completely understood. To gain a more practical understanding of the interaction between sarcomeric proteins and the function of the sarcomere, one must create a
3D visual image for the sarcomere. This process is done through AutoCAD, a vector-based software that generates three-dimensional images that can be optimized at a cellular level for scrutiny. The thick and thin filaments, two main components of the sarcomere, which is the contractile unit within the myofibril, are designed separately and attached
to one another through actin and myosin binding sites located on the myosin and the actin, respectively. The 3D model is divided into sections of different muscle striation, including the I-Z-I complex, the space that becomes narrower as the sarcomere contracts. The 3D model must accurately reflect these components in order to display in detail how a muscle contraction occurs and how an abnormality in the sarcomere can
cause muscle failure.



TEEBA JIHAD

BS BiomolecularScience2017

Sheepshead Bay High School
Brooklyn, New York

Faculty Jin Kim Montclare

Other Mentor

NYU School of Engineering

Lindsay K. Hill

MAGNETIC NANOPARTICLE-FUNCTIONALIZED PROTEIN BIOMATERIALS

Magneticnanoparticles, such as iron oxide-based magnetite and maghemite, exhibit unique features that facilitate a variety of medical applications. Their nanoscale size and superparamagnetic properties allow them to be localized and directed to desired anatomical regions by a magnetic field. The functionalization of proteins to such magnetic nanoparticles enables for potential control and monitoring of their delivery.

In this work, we aim to synthesize proteins capable of directing iron oxide templation for monitored drug-delivery applications, specifically, for cancer treatment. Our system is base the pentameric coiled-coil domain of the Cartilage Oligomeric Matrix Protein, COMPcc. This non-collagenous extracellular matrix protein is composed of a hydrophobic pore capable of carrying small molecule chemotherapeutic agents. One variant of this protein, dubbed Q, further self-assembles into fibrils resulting in functional nanofibers. Here we take advanta of residue-specific incorporation of an unnatural methionine analog, Azidohomoalanine (AH using the methionine auxotrophic cell line M15MA. The azide group of this residue is capable [3+2] alkyne-azide cycloaddition to attach it to an alkyne-functionalized iron oxide-templat peptide. The C-domain of the Mms6 protein (CMms6), found in magnetotatic bacteria, is capable of binding and organizing iron oxide nanoparticles. By performing click chemistry between our protein Q and alkyne-functionalized CMms6, we aim to create a magnetic nanoparticle-functionalized protein for monitored drug delivery.

We have successfully synthesized our wild type control proteins, containing natural methionine. Future work includes residue-specific incorporation of AHA into the Q protein. AHA-incorporated Q will then be clicked to CMms6 and further used for iron oxide templation.



MD KABIR

BS ComputerScience2018

Brooklyn Technical High School
Brooklyn, New York

Faculty Tommy Lee and Alexandra Seidenstein

NYU School of Engineering

3D TETRIS GAME

Inrecent years, educational and government institutions generated many 3D virtual learning environments to educate students and members of the community in fields of science, mathematics, history, health, and many others. There is rather an increase in applications that render a 3D learning environment because it is an effective teaching method and students find it both appealing and entertaining. Therefore, due to an increase in demand for these virtual environments, the 3D Tetris project was initiated, where the popular 1984 2D tile matching puzzle game, Tetris, will be recreated in 3D. The integrity of the original Tetris game pieces and rules will be kept, while properly demonstrating how the 2D figures will function in 3D by adding additional features such as 360 degrees rotation in the X, Y, and Z-axes, and Z-axis movement of the Tetris pieces. This game will also serve as a learning environment by encouraging users to figure out how to solve the intriguing 2D puzzle game in 3D. It is coded using the Libgdx framework and Java programming language, and it will be published for Android mobile devices. For future use, this game will serve as an ideal model for creating other learning environments, specifically in the field of Chemistry, where developers will be able to show how chemical bonds are formed using the various methods of interaction with 3D models of the game that will be created. Students will be able to gain a better understanding of the shapes of organic molecules from this environment.



JOY KIM

BS Biomedical Engineering2016

Veterans High School
Kathleen, Georgia
Faculty Jin Ryoun Kim

Georgia Institute of Technology

EFFECTS OF SMALL MOLECULES ON AGGREGATION OF BETA AMYLOID 42

Alzheimer's disease is the one of the most common types of degenerative dementia. It is known to cause memory loss and loss of other intellectual abilities. The formation of
neurotoxic plaque composed of beta amyloid fibrils has been found in a relatively high portion of patient's brains. Investigation about the mechanism of beta amyloid protein aggregation found that the initial beta amyloid monomer structure misfolds to form oligomers and fibrils as the disease progresses. Beta amyloid 40 and beta amyloid 42 are the most common proteins. It was found that beta amyloid 42 aggregates faster than beta amyloid 40. By controlling the aggregation due to the misfolding of the
protein, it can be possible to control the development of the disease. 3,4-Dihydroxymandelic acid and normatanephrine hydrochloride are metabolites of norepinephrine, a neurotransmitter. These chemicals are found in the brain. Their effect on aggregation of beta amyloid proteins has not been examined yet. For this project, monomeric beta amyloid 40 was incubated with these chemicals. Samples from the solutions with the protein and 3,4-Dihydroxymandelic acid and solutions with the protein and normatanephrine hydrochloride were taken out every day for 7 days to gather data.



HANNAH MITCHELL

BS BiomedicalEngineering2016

Nanuet Senior High School
Nanuet,NewYork
Faculty

KalleLevon Binghamton University

GOLD SURFACED EXTENDED GATE MOSFET USAGE FOR ANALYSIS OF ORGANIC MOLECULES

Anextended gate metal oxide semiconductor field effect transistor (MOSFET) model, with gold gate surface, allows for continuous quantitative monitoring of biological processes. Electrochemistry can detect changes during a redox reaction and therefore monitor reactions as they occur. This model includes an extended gate MOSFET (BSS138N), which allows for the device to be partially submerged in a liquid without damaging the electrical components. The simplest model involves the surface of the extended gate is submerged into a vial with the varying organic molecules and a reference electrode in the liquid as well. Other methods, which are more difficult due to the placement of reference electrode, include drop casting onto the gold surface and creating a reaction chamber above the gold electrode. A diagnostic method is developed to test the effectiveness of the electrode setup with two control groups; dry electrode and submerged in PBS buffer solution. Bovine serum albumin (BSA), a protein derived from cows, effectively adheres to gold nanoparticles and is used to test the gold surfaces. Different concentrations of BSA;

3 mM, 3 µM, 0.3 µM, 0.003 µM, 3nM, 3 pM, and 3 fM, are tested with the model to determine the limit of detection, saturation concentrations, and the effect on voltage threshold of the MOSFET. In the future, this model can be used with polyaniline for electrical ELISA tests, detection of dopamine secretion from PC12 cells, gas detection of certain molecules, and detection of pleural mesothelioma cancer biomarker.



HASSAN NAHAS

BS Electrical Engineering,Premed2017

The English Academy High School
Hawalli, Kuwait Faculty Rastislav Levicky
NYU Abu Dhabi

DNA MICROARRAYS

DNA micro-array technology is currently a tool employed in biological research to quantify DNA expression or determine DNA sequences present in an environment of interest. This tool relies on the hydrogen bonding between complementary bases in DNA st
By fixing DNA "probes" with the complementary sequence on a substrate surface, one can quantify the presence of certain "target" DNA sequences of interest in an environment by monitoring the hybridization that occurs between the target and the probe.

This mechanism however is hindered by the negatively charged nature of the DNA backbone, which results in electrostatic repulsion between the probe and the target reducing the free energy of the process and thus making it a less favourable or effective tec

This project attempted to improve this technology by examining a non-charged substitute to DNA. After reviewing current literature, Morpholino (MO) was selected
as it satisfied such requirements. Various configurations of the target DNA were studied along with their corresponding melting and cooling curves to obtain information about the free energy
of the process. Microarray printing techniques were employed to prepare the probe-substrate and TIRF microscopy was used for imaging along with the fluorescent dye, ATTO 647N. Data analysis of the microscopy images was carried out using a homemade software. The project faced challenges with an unexpected overshoot in activity in the cooling curves with DNA suggesting the label might be hindering the reversibility of the reaction. This was tackled by controlling the label concentration to determine the interaction resulting in this phenomenon.

It is hoped that the optimum conditions and configurations that can allow DNA microarray technology to improve with the use of MO could be determined. This is particularly beneficial in aiding research in biology and medicine.



ANKIT RAGHURAM

BS BiomedicalEngineering2015

Biotechnology High School
Freehold, New Jersey
Faculty Rastislav Levicky

Other Mentor
Hao-Chun (Howard) Chiang
Georgia Institute of Technology

THERMAL CONTROL OF MICROARRAY PRINTING

DNAmicroarray printing is a powerful tool that uses a fine-pointed pin to administer droplets of DNA. The printing process can be programmed to place droplets close or far away from each other. However, it would be advantageous to have the droplets close to one another to make printing faster and more efficient. Problems arise regarding evaporation of the droplets and wetting of the droplets with the surface. From literature, it was determined that with reducing temperature, the wetting of solutions on surfaces decreases. It is also imperative to note that colder temperatures reduc kinetic energy of the droplets, thereby reducing evaporation.

We tried to determine the contact angle of droplets at different temperatures to determine which temperature produced the greatest contact angle (the higher the contact angle, the smaller the wetting). This was done by creating a cooling/heating system out of a temperature controller, Peltier devices, a stainless steel base and an aluminum heat sink. The temperature controller was programmed to control the Peltier devices to heat or cool down the steel base, which in turn would heat or cool the microscop with the droplet. The aluminum heat sink had a pipe that cold water was pumped through to remove any excess heat. In addition, a simulation of the system on SolidWorks was created to compare empirical values to those generated in silico.

COMPUTER SCIENCE AND ENGINEERING

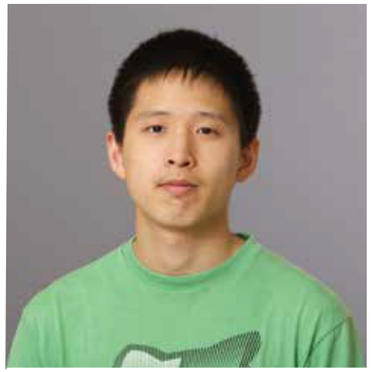


JOSEPH BIESELIN

BS ComputerEngineering/MS Computer Science 2016/2017
St. John's Preparatory
Astoria, New York
Faculty

HaldunHadimioglu
Other Mentor

VenkataH.Parimi
NYU School of Engineering



STEVEN WONG

BSMS ElectricalEngineering2016

Brooklyn Technical High School
Brooklyn, New York

Faculty

HaldunHadimioglu

Other Mentor

MICROPROCESSOR-BASEDDIGITALSYSTEMDESIGN

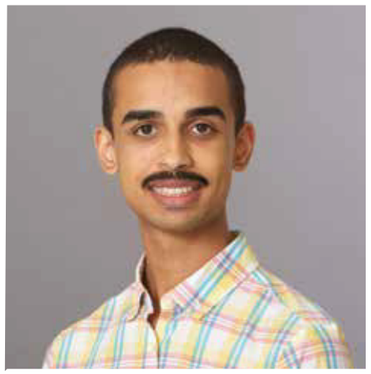
Reconfigurable chips known as field programmable gate array (FPGA) chips provide hardware programmability and speed, offering hardware implementation of applications as an alternative to software implementation. While hardware implementation leads to massive improvements in the speed compared to software, hardware design is a much lengthier process even for industry professionals. As a consequence, the hardware implementation alternative is less attractive. Our goal is to develop new features and explore new concepts to supplement the current tools so that students increase their interest in hardware development and are eager to use FPGAs after graduation.

Traditionally, hardware and software have had their own distinct places for education. Designing a project using hardware requires a greater depth of knowledge than what is needed for software. This is because software development tools have matured rapidly allowing people of all ages to easily pick up new technologies. This has not been the case with hardware; design tools for hardware are not user friendly nor intuitive, and usually have poor documentation.

New hardware development tools allow cores, i.e. processors, to be placed on FPGA chips as soft cores. For example, the MicroBlaze softcore runs on the Xilinx FPGA chip. One develops a C or C++ program on the Xilinx ISE tool and runs the code on MicroBlaze. The processor can be placed in a schematic design and interact with the rest of the hardware on the FPGA chip. The soft core capability gives the user the option to implement an application part hardware and part software which is never explored by students when they take hardware courses.

We also develop a graphical user interface (GUI) where the user interacts with the GUI, rather than the FPGA board, increasing the effectiveness of hardware development and the application when it is run. The GUI is created by using the Qt framework. Qt code makes use of serial communication to exchange data with the FPGA board and to display data in a user friendly way.

Overall, our work targets fostering students' interests in the hardware and making hardware a viable option to develop applications. The main projects include 1) different adaptations of the game "Pong" running completely on the FPGA board and displayed on a computer monitor, 2) a number game called the "PPM" which originally runs purely in hardware but is being adapted to include software and a GUI interface, and 3) a project which implements a more complex application.



URS EVORA

BS Computer Engineering2016

Keaau High School
Keaau, Hawaii

Faculty Nasir Memon and Tzipora Halevi

Other Mentor

NYU School of Engineering

Hossein Siadati

DATA LOSS PREVENTION USING MACHINE LEARNING AND NATURAL LANGUAGE PROCESSING

Dataloss is becoming an increasingly expensive issue. In a study conducted by the Ponemon Institute, the cost of data breaches to companies worldwide grew from an average of $3.52 million to $3.79 million between 2014 and 2015. [1] To address this problem, there are Data Loss Prevention Systems (DLP) which detect and prevent unauthorized access to data.

Currently, most DLP tools implement regular expression, file-matching, statistical/machine learning, or tagging techniques to detect sensitive data. Regular expression and file-matching techniques tend to be limited in the range of data they detect. Tagging techniques are dependent on the accuracy of the user to label data and statistical/machine learning techniques struggle with false positives and negatives. All of these techniques require a clear definition of sensitive data, which tends to be company specific. Furthermore, none of these approaches take into account that data may vary in sensitivity level and may require different security protocols.

Our objective was to change the DLP model with the addition of sensitivity levels. This was achieved by implementing a machine learning based system that classifies data into several topics. Dividing data in this way enables a user to quickly recommend different levels of sensitivity for a topic. We used the ENRON dataset to evaluate our approach. The set consisted of real emails from the former ENRON corporation were then classified using several classification algorithms such as Naive Bayes, SVM, and Logistic Regression. Our approach would allow for more effect DLP , but also minimize the complications of defining sensitive data.

1 2015 Cost of Data Breach Study: Global Analysis. 2015. [Internet]: Ponemon Institute LLC; [cited 2015 July 17]

▼ Joseph Bieselin examines ways to improve hardware using an interactive graphical user interface with his research partner Steven Wong.





CHANDRIKA KHANDURI

BS Computer Science 2017

The Shri Ram School-Aravali
Gurgaon, Haryana, India
Faculty Justin Cappos

NYU School of Engineering

HIDE AND SEEK: AN INERTIAL NAVIGATION SYSTEM

With the inclusion of various types of embedded sensors in smartphones, tablets and various other portable devices, interacting and providing location based information to users has become an integral part of the modern lifestyle. The information from these sensors may be used for a myriad of applications, including using embedded sensors such as the accelerometer, magnetometer and gyroscope, to not only navigate outdoors, but within a building, in a subway—any form of navigation determined with an inertial position.

Hide and Seek is an application for Android devices that is based on the principles of indoor navigation. Using the previously developed Sensibility Testbed, a sandbox that maintains user privacy, Hide and Seek collects data from these various sensors to backhaul to a website-Sensevis- to be collected and analyzed for purposes such as monitoring worker movement in the Hudson Yards Project in New York. The goal is to embed various features in the application to assist construction workers in their daily jobs, reducing various risks on construction sites.

Reduced cellular reception can impede real time analysis, but by installing femtocells or wireless routers in problem areas, the application may continue data hauling leading to safer construction sites and accurate navigation systems. Being an inertial system, Hide and Seek does not require external references in case of lack of network coverage.

Some of the access control features include mapping paths taken by workers frequently to determine gaps in the site's perimeter from where unauthorized personnel could enter. Keeping in mind the hazardous surroundings of a construction site, we also aim to embed safety features such as anonymous reporting of problems at the site for immediate processing, RFID tags attached to equipment to alert a worker to use it appropriately, detecting occurrences of unsafe events such as slips and high noise levels.

The potential for this project is great in the sense of failure detection, immediate updating and constant feedback and data analysis. Once employed successfully on construction sites, it could potentially save many lives.



PATRICK KINGCHATCHAVAL

BSMS Computer Science 2017

Ronald Reagan High School
San Antonio, Texas

Faculty Nasir Memon and TziporaHalevi

NYU School of Engineering

PICTURE GESTURE AUTHENTICATION

Onthe Windows 8 operating system, Microsoft has introduced picture gesture authentication as an alternative to text passwords. This picture password feature requires the user to upload a picture and set up a sequence of three gestures, each being a tap, a line, or a circle. An entered password is considered successful if the gestures entered are within the error threshold when compared to the stored password. This feature boasts a high number of possible password combinations, comparable to text passwords with a length of six characters.

There are several types of attacks that can be used on this authentication scheme. One such attack is based on user behavior. Most users base their passwords on points of interest in the picture so it would be more memorable. By studying a sample set of picture passwords, a password list can be made ranked by the frequency of a gesture and point of interest combination. Any unseen picture can then be attacked by identifying the points of interest in the new picture and comparing them to the password list for matches. Another method of attack is "shoulder surfing," which involves observing users while they are entering their passwords, and trying to guess what they entered from what was observed.

Our approach to mitigate these attacks is to blend two images together. The users will still be able to differentiate the two images from each other easily. However, it would be more difficult for a computer to identify points of interest in a blended picture. It would also be harder for someone observing a user entering the password, because they would not know which of the two images the user based the password on. Future work will include conducting a user study to test the effectiveness of this method.



CYNTHIA KREJCZMAN

BS Computer Science 2018

Polytech High School
Woodside, Delaware

Faculty Justin

NYU School of Engineering
*Thompson-Bartlett Fellow
Cappos

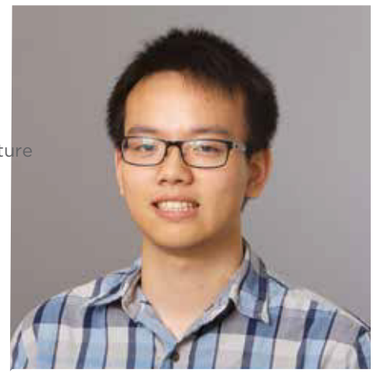
DETERMINING CDN FUNCTIONALITY WITH THE SEATTLE TESTBED

AContent Delivery Network (CDN)delivers web content—such as videos, cat pictures, and that one uncle from West Virginia's rants about how the government is simultaneously too stupid to function and capable of hiding the existence of a superior reptilian race—to users. This is done via geolocation: the CDN locates the closest server to the user in order to deliver content at the fastest speed possible.

Seattle Testbed is a platforms made for students and researchers to deploy test programs to multiple systems around the world. The programs are coded in Repy—Restricted Python—for use in the Repy sandbox environment in order to run code. This sandbox allows code from students and researchers to run on other systems without compromising the safety of said systems.

A way to determine the effectiveness of a CDN is by measuring both latency and packet loss. Latency is the amount of time it takes for data to get to one system to another. Obviously, the lower the latency, the faster the connection will be, but another factor for determining latency is how many systems resolve to a web address. Packet loss is when a piece of data gets lost in transmission and has to be resent again, which eats up time and resources.

This research aims to measure the latency and packet loss rates of Google's CDN, and how these two measurements are affected by (a) time of day in each system's time zone, and (b) the location of each of the tested systems, via code deployed on Seattle.



BINGCAN XU

BS ComputerScience2017

Stuyvesant High School
New York, New York

Faculty Justin Cappos

NYU School of Engineering

DEPENDENCY RESOLUTION IN PIP PACKAGE MANAGEMENT

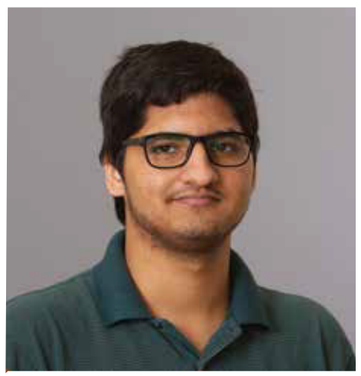
Modules and packages are Python's wayof organizing a programmer's code. A module is a simple file that contains Python code and a '.py' extension. A package is a folder of modules. The unique thing about modules is that one can import code from an This allows code to be reused by multiple projects.

Pip is a package management system that installs and manages Python software; many of the packages that pip installs can be found in Python Package Index(PyPI), which is an open source software repository for Python packages.

When a package needs another package to function, we call this a dependency. There can be a chain of dependencies as one may be depend on another. Installing a dependency may disrupt the chain as different versions of a package may be required. Th called a dependency conflict. As a package manager, pip does not resolve dependency conflicts. At the moment, pip simply installs the first package it finds that satisfies the dependency.

There are currently three suggested solutions to pip's dependency problem: simple, backtracking, and SAT solver. Simple dependency resolution does not resolve the problem, but it does alert users and enable them to try to resolve it by using the requirement file. The requirements file is an option that allows users to specifying their own dependencies. Backtracking looks back at previous dependencies to try to find a compromise between the conflicts. SAT solver uses Boolean equations to try find the solution.

It's still debatable which response is most fit for pip's dependency problem. This project's examination of the dependence of Python packages and determination of the amount of possible conflicts will be useful in determining the solution.



TALHA JAVED

BS ComputerScience2017

Lahore Grammar School for Boys
Johar Town, Lahore, Pakistan

Faculty NasirMemon and TziporaHalevi

NYU Abu Dhabi

EMAIL DATASET ANALYSIS USING MACHINE LEARNING AND NATURAL LANGUAGE PROCESSING

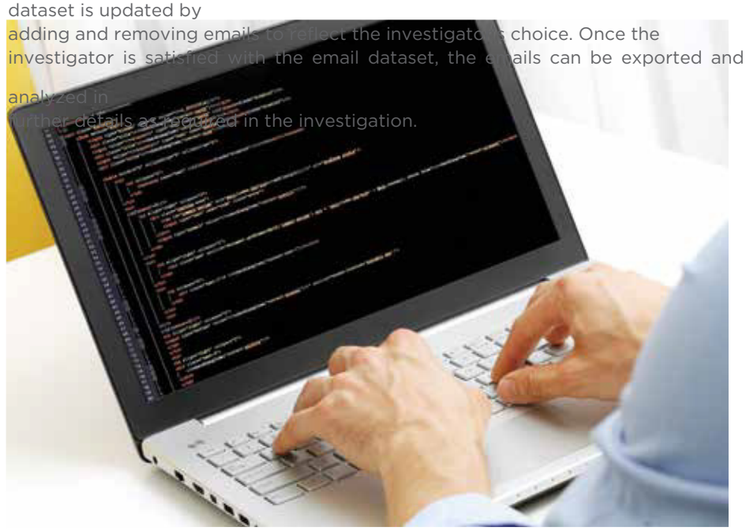
Criminal andcivilinvestigations often involve large email datasets, which usually contain many emails irrelevant to an investigation. This forces investigators to manually comb through information contained within these large datasets in order to find relevant emails, a process that is costly in terms of both time and money.

Current forensics tool in the market do a good job of analyzing content on a computer storage drive but they do not offer similar functionality for email analysis.

The aim of this project is to develop a tool that aids the investigation by offering an interactive visual analytic alternative to the current, manually intensive methodology.

The project makes use of Apache Lucene and Stanford NLP libraries for Java to index and tag the email content according to their parts-of-speech. After pre-processing the data, machine-learning algorithms are applied on noun-verb-noun phrases of the email content to try to filter out important entities and highlight the relevant emails. Once an initial email dataset is determined, it is presented to the investigator in a browser-based interactive interface. The interface shows the email with their contents and maps the geo-location of the origin and destinations of the email using IP-information from email headers to help the investigator. A temporal analysis is also carried out on the dataset to create a timeline for the email activity, a very important tool for an investigation.

The investigator can go through the presented email dataset, highlighting or removing emails from the set according to his needs. Any input by the investigator will be used for supervised learning on the selected email dataset. The email dataset is updated by adding and removing emails to reflect the investigator's choice. Once the investigator is satisfied with the email dataset, the emails can be exported and analyzed in further details as required in the investigation.



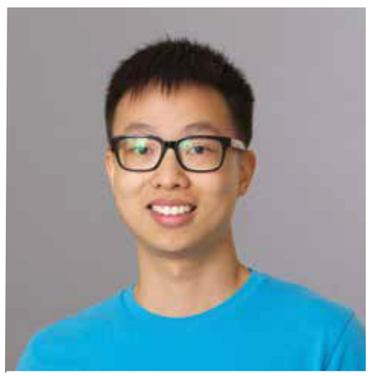
▲ Using Apache Lucene and Stanford NLP libraries, summer research participant Talha Javed creates time-saving technology solutions to aid criminal investigators.

ELECTRICAL AND COMPUTER ENGINEERING

DECEPTIVE BEHAVIOR WITHIN AUTONOMOUS CLOUD-ENABLED ROBOTIC SYSTEMS

Robotic motion, obstacle avoidance, and interaction are topics that have been most relevant to autonomous robotic system development, but those alone are not always sufficient in a shared human-robot environment. While typical robotic and autonomous systems are not expected to deceive as part of the tasks that they were programmed to accomplish, real life human-robot interactions may require the use of deceptive robotic behavior. The need for such capabilities can inspire a new dynamic between humans and robots. Since deception is already utilized in many autonomous agencies, natural deceptive behavior is taken as a model for developing robot movement algorithms.

This project explores the possible ways in which humans can be deceived by a physically-implemented autonomous multi-robot system that computes behavior on a simulated cloud environment. The cloud enables data accumulation and fast execution of algorithms, while prebuilt Quanser ground robot systems provide both necessary sensor data and a movement platform to develop a real-world testing environment for the algorithms. The ability to deceive is tested in an encl environment, where the two autonomous robots must corner (i.e. strategically force into the wall and therefore disable) the one human controlled robot. Effectiveness of the algorithms is measured by the success rate of the autonomous robots in achieving their collective cornering task and evaluated further by the comparison time taken as well as computational efficiency.



FRANKY CHEN

BS Computer Engineering2017

Stuyvesant High School
New York, New York

Faculty Quanyan Zhu NYU School of Engineering



VASILY RUDCHENKO

BS ElectricalEngineering2017

Kyiv International School Kyiv, Ukraine

Faculty QuanyanZhu

NYU Abu Dhabi



ABHIMANYU GHOSH

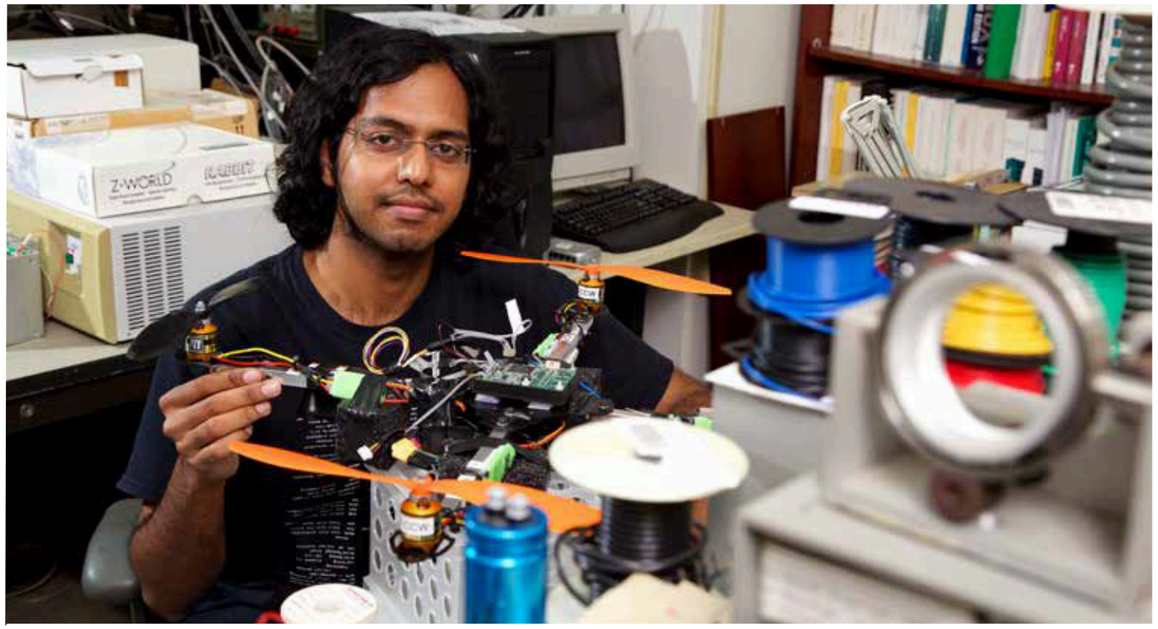
BS Mechanical Engineering/MS Computer Engineering 2016
Stuyvesant High School
New York, New York
Faculty Farshad Khorrami

NYU School of Engineering

UNMANNED AERIAL VEHICLE (UAV) APPLICATIONS IN ROBOTICS

Quadrotorsare a class of UAV (Unmanned Aerial Vehicle) with four propellers that are highly-maneuverable and well-suited to a variety of tasks ranging from mapping to surveillance. However, they are inherently unstable, and thus require active stabilization through control of individual motor thrusts. Although basic attitude control can be accomplished using a basic 6 degree of freedom (6DOF) IMU (Inertial Measurement Unit), pure attitude control significantly limits the scope of application of a quadrotor UAV, and makes the vehicle more difficult to fly for pilots with limited UAV flight experience. Knowledge of the current position of such a vehicle is critical in
its ability to carry out missions where it is imperative for a pre-determined trajectory to be followed. Position estimation is particularly difficult, yet important, when navigating indoors and in other GPS-denied/degraded environments. Additionally, the ability to determine position and/or velocity is useful for SLAM (Simultaneous Localization And Mapping) in an unknown environment.

The primary objective of this project is to integrate optical odometry as a viable method of determining velocity over the ground and thereby position. To do this, an optical flow sensor module is integrated onto the vehicle, and supplies velocity and height data to a custom-designed Autopilot. The Autopilot then integrates these measurements over time to obtain an estimate of position, and maintain a commanded lateral position and height. Furthermore, various approaches to processing the optical
flow sensor data are investigated, to minimize errors in the positional estimate obtained by integrating its data over long periods of time. The end goal is to obtain a versatile and robust approach to position estimation that works very well in both indoor and outdoor environments to augment/replace GPS-based position data.



▲ Abhimanyu Ghosh performs hardware modifications on a quad-rotor UAV to ready it for flight as a research platform for testing of advanced navigation, control and mapping algorithms.



WAISAN GU

BS Electrical Engineering2017
Stuyvesant High School
New York, New York
Faculty Quanyan Zhu

NYU School of Engineering

MOVING TARGET DEFENSE FOR LARGE-SCALE RESILIENT URBAN INFRASTRUCTURE

There are forty cities in the United States, including New York City and Los Angeles, as well as nine other countries that use the Sensys Networks VDS240 wireless detection system. The system consists of sensors embedded in roadways that send data about traffic flow to access points and repeaters. Those devices then pass along the information to traffic signal controllers that controls the traffic lights. While the Sensys system has improved traffic flow, it lacks basic security protection such as data encryption and authentication. Since the wireless communication is being transmitted in clear text, it would not be difficult for a hacker to send malicious commands to the devices through a drone, for example. As a result, increased traffic flow, gridlocks, or even accidents can occur.

The objective of the research is to develop an application that uses information from local t databases to help the user determine the best route to take. Therefore, if the Sensys system was compromised, instead of the driver following GPS commands that lack incoming traffic information, the driver could use this application that considers incoming delay to the destination. The delay is determined by an algorithm which examines and velocity of the traffic lanes. Simulations have been made from the program Simulation of Urban MObility (SUMO), a traffic simulator, to analyze desired traffic information in detail. Another program called Veins implements both SUMO and OMNeT++, a network simulator, to analyze information from vehicular communication.

MATHEMATICS



EMANUEL AZCONA

BS Electrical Engineering2017 HighSchool for Construction Trades, Engineering, & Architecture Ozone Park, New York

Faculty Luciano

NYU School of Engineering

Medina

DYNAMICAL TUMOR GROWTH MODELS

Acommon problem we are all touched by in our society's life is cancer – if not personally, then through family, colleagues, or friends. There have been countless studies in the pursuit of treating and potentially eliminating this threat from affecting more people today and in our future. Our studies are focused around understanding the behavior and interaction between a tumor mass and its provided nutrition through the development of a new mathematical growth model. Such line of research has real-world applications allowing us to approximate the mass of a tumor over time and develop more effective cancer treatment schedules.

Our approach stems from the pioneering work of West et al. modeling the ontogenetic growth of organisms derived from fundamental principles for the allocation of metabolic energy. It was then, Guiot et al who extended the model of West et al to account for the growth of tumors which involved a single nonlinear differential equation with a dynamic fractional exponent. To incorporate nutrition into the tumor growth model of Guiot et al, we use the classical Lotka-Volterra Predator-Prey model together with a "Flower-Pot Model", which treats vegetation pattern formation as a function of biomass density and water resources. Such an approach leads to a coupled nonlinear system of equations with fractional

exponents
whose analysis is challenging and requires computational simulation.



KYE DRAGESET

BS Mathematics 2017

Mid-Pacific Institute
Honolulu, Hawaii
Faculty Luciano Medina

NYU College of Arts & Sciences

NUMERICAL SOLUTIONS OF ELLIPTIC PDE WITH POINT SOURCES

Thebranch of mathematics known as partial differential equations (PDE) has numerous applications to varying fields of science and engineering. Ranging from theoretical physics to weather prediction, partial differential equations plays an integral role in the mathematical modeling of various physical phenomena. Our particular interest is on the numerical computation of a 2nd order nonlinear elliptic PDE with delta point sources defined over a doubly periodic domain. Our encounter, with such a PDE, stems from the study of the two-Higgs electroweak model of Bimonte and Lozano governing two electroweak Higgs doublets and possessing vortex-like solitons representing a system of non-interacting particles. The existence and uniqueness, up to an additive constant, of solutions over a doubly periodic domain and over more general surfaces has been established by Aubin. However, analytic solutions, even in the one-dimensional case are non-trivial. We explore integral representations, Green's functions, and Fourier
series approaches to the numerical solutions of the PDE over a periodic domain.



MAXIMILIAN KANTOR

BS AppliedPhysicsandMathematics 2016
Xavier High School
New York, New York

Faculty Luciano Medina

NYU School of Engineering

DYNAMICAL MODELS OF DNA: EXISTENCE OF DNA BREATHERS

DNAmolecules form the familiar doublehelix that has been knownfor decades.While studying the dynamics of the DNA molecule, an interesting problem arises, where the appearance of localized finite-amplitude oscillations of the strands suggest the existence of DNA breathers. Developing a rigorous mathematical theory for the existence of DNA breathers would add to the understanding of the DNA and important processes such as denaturation, which is when the double-strand of the DNA molecule unzips into two single strands.

Our focus is on the pioneering work of Englander et al, and Peyrard and Bishop

modeling
DNA dynamics. The proposed Hamiltonian encapsulates the interactions due to hydrogen bonding between the nucleotides or bases within a base pair and the stacking force between the base pairs. The resulting Hamiltonian equations, governing the DNA dynamics, are a coupled system of nonlinear differential equations. Using modern techniques in the calculus of variation and global functional analysis, we propose to find necessary conditions for the existence of localized solutions. Additionally, we develop numerical solutions to the Hamiltonian equations and simulate the DNA dynamics using a MATLAB environment.

THE MAHALANOBIS TAGUCHI SYSTEM: TOWARDS A CULTURE OF SUSTAINABILITY

TheMahalanobis Taguchi System (MTS)is a methodthatcombines multivariate statistical pattern recognition with industrial engineering practices for a binary classification of variables. The MTS method is relevant for various applications while providing flexibility of implementation.

MTS can be applied to analyze multiparameter problems that arise in organizational settings. MTS is applied to University of Michigan cultural sustainability data which includes in faculty and student conduct in and attitude towards topics including waste prevention, healthy environments, climate action, and community awareness. Experiments with differing independent variables are run to identify underlying factors involved in creating sustainable' vs 'unsustainable' behavioral indicators. These factors, now identified indicators, will be applied to create a more sustainable campus at NYU. An automated program has been created to streamline the data analysis process.

Another field in which the effectiveness of MTS is being explored is education. Using the power of MTS, we can determine what are the best indicators of a successful school, and what variables help distinguish a proficient school from a deficient one.

Finally, MTS is explored theoretically with an emphasis on the analysis of orthogonal arrays. An extensive understanding of MTS methodology is necessary to recognizing not only its applicability, but its underlying mathematical significance and functionality. The orthogonal arrays as a theoretical foundation of the Taguchi method are studied in order to optimize their effectiveness in MTS. Furthermore, the Mahalanobis distance as a crucial concept in multivariate statistics is studied in order to understand how it ameliorates the Taguchi method.



MONIKA FILIPOVSKA

BS Mathematics|BSEngineering2017

II. (druga) gimnazija Maribor Maribor, Slovenia

Faculty Lindsey Van Wagenen

Other Mentors Rachel Jacobovits and Michel Lobenberg

NYU Abu Dhabi



NAQIB RAHMAN

BS Mathematics|BSComputer Science 2018 The Bronx High School of Science Bronx, New York

Faculty
Lindsey Van Wagenen

Other Mentors
Rachel Jacobovits and Michel Lobenberg

NYU College of Arts & Sciences



AVIGAEL SOSNOWIK

BS Mathematics|BSMechanical Engineering 2018
Stella K Abraham High School for Girls
Hewlett Bay Park, New York

Faculty
Lindsey Van Wagenen

Other Mentors
Rachel Jacobovits and Michel Lobenberg

NYU 3+2

MECHANICAL AND AEROSPACE ENGINEERING



DANIELLE LEONG

BSMS MechanicalEngineering2016

The Queens School of Inquiry
Flushing, New York

Faculty Luciano Medina

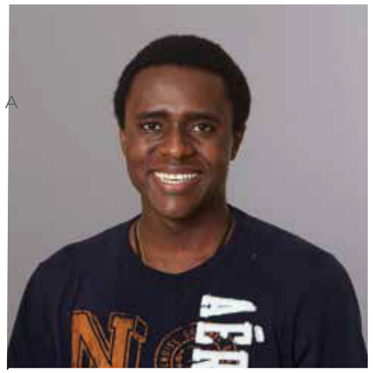
NYU School of Engineering
*Thompson-Bartlett Fellow

AUV FLIGHT PATTERN OPTIMIZATION

Search and rescue operations have always been costly in terms of manpower, resource, and capital investments. An approach that has been—and continues to be—used is deploying search parties on foot as well as sending out helicopters to survey a region of interest. A more novel approach utilizes autonomous aerial vehicles (AUV's) in order to survey a given area; this approach suggests using two vehicles which cover the area by one flying in horizontal lines and one flying in vertical lines across a rectangular region.

AUV's are far less costly to deploy then a helicopter and can be deployed for longer periods than a human. Through use of AUV's, an operation's manpower and capital expense can be significantly reduced. Our interest focuses on the optimization, implementation, and simulation of AUV's flight path as well as initial formation in geometries with real world applications. As a consequence, we hope to be able to reduce surveying time or even decrease the number of required AUV's for such search and rescue operations. Additionally, optimizing the flight pattern of AUV's can further reduce cost and hopefully become a more affordable solution.

Our approach first optimizes the flight pattern and initial formation in 'toy' regions with the hopes of later using the collected data at this stage of exploration to further investigate more optimal solutions to more complex regions.



SAID ABDALLAH

BS MechanicalEngineering2017
International School of Tanganyika
Dar Es Salaam, Tanzania Faculty
Nikhil Gupta

NYU Abu Dhabi

LIGHTWEIGHT METAL MATRIX COMPOSITES

Lightweight structural metals, such as Magnesium and its alloys, are playing a vital role in a wide variety of industries from aerospace to automobile because of their good prospect for weight reduction. They have a wide range of economic and social benefits i Lightweight metal matrix composites implants, fuel efficiency, automobiles, and aerospace applications. Furthermore, they have applications in maritime technology such as deep-sea vehicles, boat hulls, and thermal insulations for submerged marine pipes.

Magnesium alloys have high specific mechanical properties and a very low-density around 1.8 g/cc. The aim of this study is to characterize the mechanical properties of Magnesium matrix composites containing SiC (silicon carbide) hollow spheres of 50 mm diameter and micro-tubes. AZ91D, a commonly used Mg alloy, was the primary focus of study. Specimens are polished using standard metallographic procedures and then the images of their microstructures are taken using an optical and a Scanning Electron Microscope (SEM). The hardness and quasi-static compression tests are conducted in order to study the mechanical properties of the Magnesium alloys. The results from the Vickers hardness test showed that, among the four samples tested, the composite that had SiC hollow spheres of 50 µm diameter had the highest value (116 HV) and showed a decrease in density by 18% with respect to the Magnesium alloy (AZ91D). The results obtained from this study are important in improving and expanding our understanding of the importance of lightweight structural metals, and this knowledge is critical for the success of various industries such as aerospace and automobil



KALANA GAMLATH

BS ElectricalEngineering and Computer Science 2016
Baulkham Hills High School
Baulkham Hills, New South Wales, Australia
Faculty

University of New South Wales Parshad Khorrami

GROUND VEHICLE LOCALISATION AND MAPPING

Autonomous vehicular control has manyapplications,spanning from disaster relief to automated agricultural equipment. A fundamental prerequisite to autonomy is the ability for the vehicle to be able to map an area, whilst localising itself within that map. Using interoceptive and exteroceptive sensors in the vehicle, such as encoders and LIDAR, the vehicle is able to analyse its surroundings and develop a map, whilst iteratively estimating its position as it traverses the environment.

This project explored implementations of solutions to this class of problems, known as SLAM
(Simultaneous Localisation and Mapping). Using an Extended Kalman filter (EKF) approach, extraction techniques were developed, which allowed the vehicle to identify suitable landmarks and use them for navigation. These extraction techniques involved rasterizing the LIDAR data as an overhead image, and then using pattern recognition techniques from the OpenCV library to find landmarks. Other techniques, including scan-matching data and visual landmark extraction were also explored.

Once these landmarks are identified, subsequent sensor data can be used to associate these
landmarks with the vehicle's current position, enabling more accurate position estimation than possible with independent sensors. This produces a vehicle that is able to
autonomously navigate previously unseen environments.



AHMED ALADY

BSMS ChemicalEngineering2016
William L. Dickinson High School
Jersey City, New Jersey Faculty
Weiqiang Chen

Other Mentor
Caroline Kopfler

New Jersey Institute of Technology

ACOUSTIC TWEEZERS FOR MECHANICAL REGULATION OF OSTEOGENESIS OF PERIOSTEAL CELLS

Generally we view biological structures as a whole and measure the changes that occur to a system based on stimulation of tissues or organs. In this study, we focus on changes that occur on the microscale level of periosteal cells. Depending on the environmental factors surrounding the cells, periosteal cells can differentiate toward osteoblasts, giving rise to new bone tissue. One of these factors is mechanical stimulation, which is the focus of this p We wish to effectively stimulate the mechanotransduction pathways of periosteal cells to differentiate them into osteoblasts for in bone regeneration therapy. Before we use periosteal cells, we test the theory of mechanical stimulation of cells by ultrasound tweezing using 3T3 fibroblast cells.

To carry out the experiment using the 3T3 cells, we first fabricate a micro-array device from PDMS. The device is then coated in a layer of fibronectin protein in order for the cells to be attached to the device. After attaching the cells, we attach lipid micro-bubbles o When the acoustic wave is applied to the cells, the micro-bubbles will cause the cell's traction force to increase on the PDMS micro-array device, which is measured using MATLA Brightfield and Fluorescence imaging is then used to take images of the cells after the acoustic force is applied. The overall goal of this research is to demonstrate successful differentiation of periosteal cells into osteoblasts using acoustic tweezing cytometry to aid in the development of bone regeneration therapies.



LEANNE BLOCK

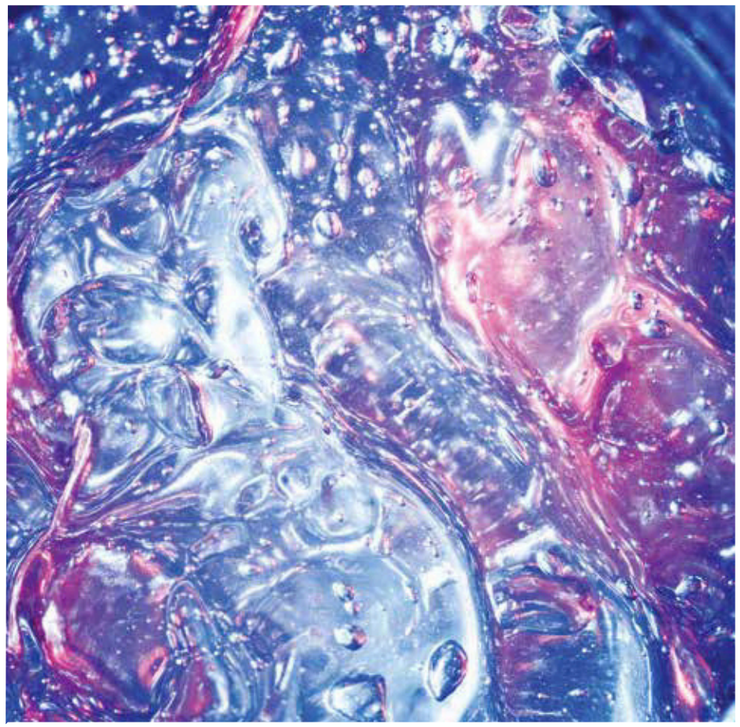
BS MechanicalEngineering2017
Watchung Hills Regional High School
Warren, New Jersey Faculty Maurizio
Porfiri Other Mentor Filippo Cellini

Brown University

MECHANICAL AND OPTICAL CHARACTERIZATION OF PYRENE-BASED MECHANOCHROMIC GELS

Mechanochromic polymersareluminescent solids whose optical properties change with mechanical deformation. The ability of a fluorescent material to change colors as a response to a mechanical stimulus can be leveraged to the design of sensors, especially with applications in experimental mechanics, fluid mechanics, and biological fluid mechanics. This project focuses on the fabrication, mechanical properties testing, and emission testing of mechanochromic hydrogels, in order to further develop their usage.

The hydrogels are created by combining inorganic clay and polymer. A fluorescent dye, pyrene, is attached to the polymer chains to give these hydrogels their mechanochromic properties. An in-house developed testing setup is used to measure the stress-strain relationships of the gels, as well as the changes in emission spectra of the gels during stretching and swelling. Experimental characterization will enable better fabrication techniques, as well as a better understanding of the properties of mechanochromic gels. Already, favorable gels have been produced which show significant emission spectra change when deformed or when swelled with water. This study aims to continue to contribute to the general knowledge on these materials so that they can be used effectively in future applications.



▲ Leanne Block and Jie Li assess the range of use, strength, efficiency and construction techniques of hydrogels to discover new benefits.



JIE LI

BA Physics2016
Manhattan Comprehensive Night and Day High School New York, New York Faculty Maurizio Porfiri Other Mentor Filippos Cellini

Skidmore College



HOWARD CHIEN

BSMechanical Engineering 2018
Parsippany Hills High School
Parsippany, New Jersey
Faculty Maurizio Porfiri
Other Mentor Violet Mwaffo

NYU School of Engineering

EXPERIMENTAL SETUP TO STUDY THE EFFECTS OF HYDRODYNAMIC ADVANTAGES AND ENERGY EXPENDITURE OF FISH SCHOOLING

Whilesocial interactions in animal speciesare wellstudied, the general mechanisms underlying collective behavior are not fully understood. In an effort to better understand the complex dynamical processes underlying collective behavior of fish schooling, we have developed a miniature water tunnel to study the role of hydrodynamic interactions on zebrafish schooling. This experimental platform is intended to recreate laminar water flow structure to study the hydrodynamics of fish swimm schooling. Such a platform is expected to greatly aid our understanding of zebrafish social behavior and offer a solid basis for performing a wide range of experimental tests involving perception and locomotion. To assess the effectiveness of our experimental apparatus, we have tested it with a fish swimming in the wake generated by a fixed bluff body, creating a Karman street matching the principal component of the vorticity shedding from the animal. We have gathered videos and oxygen consumption data of zebrafish swimming that will be used as control condition for future works intended to unde zebrafish body motion and energy expenditure during swimming based on robotic stimuli.



BROOKE COLON

BS Mechanical Engineering/MS Biomedical Engineering 2017
Pompano Beach High School
Pompano Beach, Florida

Faculty

Alesha Castillo

NYU School of Engineering

*Thompson-Bartlett Fellow

ASSESSMENT OF BIOMECHANICAL PHENOTYPES OF GENETICALLY ALTERED BONE

The human skeleton experiences various situations (e.g., walking, running, osteogenic disorders, fractures) resulting in changes in bone mass. Mechanical loading regulates bone mass, yet the regulatory mechanisms are unknown. Under investigation is the SDF-1/CXCR4 signaling pathway. Stromal cell-derived factor-1 (SDF-1) is a soluble chemokine ligand which binds to CXCR4—a membrane-bound G-protein coupled receptor found in the osteoblast lineage responsible for laying down new bone. SDF-1 is expressed and released by bone cells in response to mechanical loading, allowing for progenitor cells possessing CXCR4 to travel up the SDF-1 gradient towards the loading site and differentiate into osteoblasts.

To study this event, the CXCR4 gene was deleted in osteoblasts of aged (16-20 week old) r (CXCR4floxed: Osterix-Cre-GFP) in expectation that these Conditional Knock Out (cKO) mice will exhibit reduced periosteal and endosteal bone formation under mechanical loading. cKO mice and control mice (CT) then underwent in vivo cyclic compressional loading (8N, 2Hz, 60 cycles, 3 d/wk, 2 wks) of the right tibia, leaving the left tibia unloaded, which served as a control. In addition, fluorochrome bone labels were injecte and 18 days post the first day of loading with calcein, alizarin red, and calcein, respectively) to highlight new bone formation in the periosteum and endosteum. Following euthanasia, tibiae were analyzed by histology and microCT, static variables (label perimeters, area and bone perimeter) were determined using ImageJ to calculate dynamic variables attributing to new bone formation: mineralizing surface (MS/BS, %), mineral apposition rate (MAR, µm/day), and bone formation rate (BFR/BS, µm^3/µm^2/ year). Biomechanical properties (e.g., geometry, second moment of area, stiffness, toughness, etc.) will be determined and compared with MS/BS, MAR, and BFR/BS. These data will help determine the effects of CXCR4 gene deletion and loading on bone's a respond to physical forces. Testing our hypotheses using these experimental groups and parameters will contribute to a better understanding of the role of the SDF-1/CXCR4 si pathway on load-induced bone formation.



LAURA DONNELLY

BS RomanceLanguages2018

Fairfield Ludlowe High School
Fairfield, Connecticut

Faculty

Other Mentor

MaurizioPorfiri
NYU College of Arts & Sciences

TizianaBartolini

CAFFEINE EXPOSURE IN A GROUP OF FISH

Zebrafish is a commonly used species in biological and behavioral studies, sharing similarities with humans in terms of brain function and structure to humans. Adult zebrafish also exhibit complex individual and social behaviors, making them ideal for analyzing the effects of drugs and alcohol, and for studying social behavior and anxiety. This study examines the effects of caffeine on zebrafish behavior. Caffeine is recognized as a psychoactive compound, yet there is little information on what effects it may have on the brain and bodily functions of humans. This study seeks to monitor the effect that sociality has on individual zebrafish reaction to caffeine by observing a treated individual swim with untreated subjects. The response of untreated members to the caffeine-treated individual is also analyzed. The preliminary results indicate that zebrafish exposed to elevated doses of caffeine, and tested in isolation, exhibit reduced locomotion. We predict that the treated subject in a group of conspecifics displays a change in locomotion when compared to the treated subject tested in isolation. Furthermore, we hypothesize that individual locomotion will be mod ulated by caf fein e concentration and sociality.
The methodology applied in this study may have the potential to determine the treated individual's response in terms of caffeine exposure and sociality.



HYUN-JUN CHOI

BS MechanicalEngineering2017

The Barstow School Kansas City,
Missouri Faculty Sang-Hoon
(Nathan) Lee NYU School of
Engineering

CON EDISON UNDERGROUND WIRE SPLICING

ConEdison is a multibillion-dollar energy corporation that has been producing electricity since 1823. Because of high density of demand in urban areas, underground distribution network are the primary supply mode. Unlike overhead open wire feeders, where large clearances are available to complete safe live-line work, all underground cable feeders must be de-energized work. Multi-path characteristics of the system allow for de-energized work on components to not cause consumer outages. Rather, the remaining components in service are stressed and provide lower supply voltage to costumers. Live end caps are a type of splice that allow for repairs to be done on smaller sections in less time, reducing the stress placed on the overall system.

Con Edison seeks to develop a manned remotely controlled device above ground to splice medium voltage underground cable feeders in New York City. This will shorten outage period as well as provide a safer environment for electric workers. Throughout the duration of the project, different designs are tested and implemented in order to complete the task. In addition to this, emphasis was placed on budgetary constraints and efficiency. A combination of 3D computer modeling, 3D printing, and assembling special ordered parts were used to create a fully functioning prototype.



JAMES CARRINGTON GARDNER

BS Civil Engineering 2017

Saint Kentigern College

Auckland,New Zealand
Faculty
Maurizio Porfiri

Other Mentor

PietroDe Lellis
Collaborator

Nicholas Yang
NYU Abu Dhabi

DATA-DRIVEN CONTROL OF A ROBOTIC PREDATOR FISH VIA MACHINE LEARNING

RoboticFish haveserved a plethora of purposes and the further development of their internal systems, shape and swimming locomotion have led to them becoming more efficient in the control and manipulation of both individual and collective fish behaviour. However, these models tend to be user controlled or pre-programmed rather than data-driven and autonomous which limits behavioural control outside of a laboratory environment. The Dynamical Systems Laboratory has developed a robotic fish platform with onboard sensing capacities to perform experiments on animal behaviour. The aim of our study is to implement a data-driven machine-learning approach in a predatorial Nandus nandus replica which observes, maps and targets individual fish that are deemed to be non-schooling. This study will represent a step forward towards autonomous decision making in dynamic environments.

We use a generative model which probabilistically relates the measurements from the onboard camera to features of interests; these include degree of isolation and position. At every time instant, using the mapping from the frame space to the feature space, the predator checks whether an isolated fish is present. When an isolated fish is located, the robotic replica makes a simulated attack towards the located node thus reproducing predatorial behaviour. In the experimental setup, the Nandus nandus replica is separated from a shoal of zebrafish by a glass partition. Three experimental conditions are compared: the natural schooling of fish where the replica is still, random attack by the replica in a random direction, and the replica attacking according to the data-driven control strategy. The three conditions are compared through measuring the change in cohesion after the condition is applied. Biological research suggests an increase in the overall group cohesion will follow an attack from a predator – therefore, we expect to see significantly higher rates of cohesion in the data-driven simulated attack condition than other conditions.



KRISTEN MARVENTANO

BSMathematics|BSMechanical
Engineering 2018
Pocono Mountain West High School
Pocono Summit, Pennsylvania

Faculty Sang-Hoon
(Nathan) Lee

NYU 3+2

*Thompson-Bartlett Fellow



▲ Hyun-Jun Choi and Kristen Marventano partner with Con Edison to develop tools that shorten outage periods and improve safety for the organization's employees.



LANQI GONG

BS BiomolecularScience2018

Shijiazhuang No.1 High School

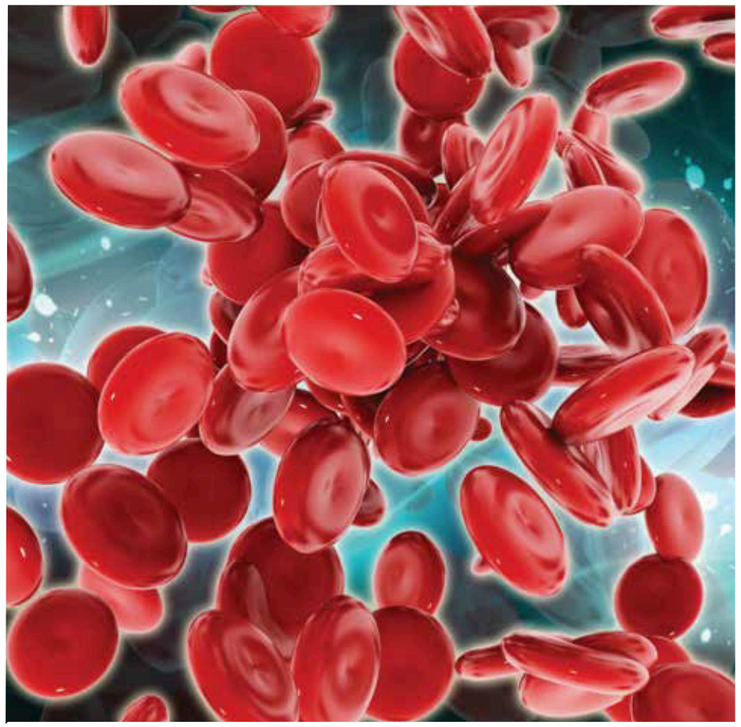
Shijiazhuang, Hebei, China

Faculty Weiqiang Chen

NYU School of Engineering

LOCALIZED SURFACE PLASMON RESONANCE BIOSENSING SYSTEM FOR LOW-CONCENTRATION CYTOKINE MEASUREMENT

To accurately monitorthe status of health with precision requires dense analysis of cytokines from regularly sampled human blood. However, currently the absence of a multi-channel, minute volume assays makes aforementioned monitoring for critical-conditioned patients practically implausible. Localized Surface Plasmon Resonance (LSPR) is a Bio-Sensing system used for measuring the relationship between cytokines' concentration and its intensity change under dark field imaging. The aim of this project is to gather enough data to plot accurate validation curves of different cytokines (Currently using TNF-α and IFN-γ). Therefore, by using these validation curves, we can understand the relationship between their concentration and intensity change, which will in turn allow us to measure an unknown sample's concentration based on its intensity change in the LSPR system. Currently, our project allows for high-sensitivity quantitative cytokine measurement at concentration from 10 pg/mL to 2000 pg/mL by only using 1 µL cytokine simple. The whole procedure of the measurement which contains loading cytokine sample, incubation, washing samples with different chemicals and data analysis can be finished within 30-40 minutes. Hence, by using the localized surface plasmon resonance biosensor, we can have a fast, multiplex and low volume diagnosis which is considered as a crucial change in the field of medicine and biomedical engineering.



▲ Lanqi Gong and Nasir Iqbal test developmental theories for comprehensive blood analysis tools.



NASIR IQBAL

BSMSMechanical Engineering 2017

William C. Bryant High School

Long Island City, New York

Faculty

Weiqiang Chen NYU School of Engineering



ALLISON JOHNSON

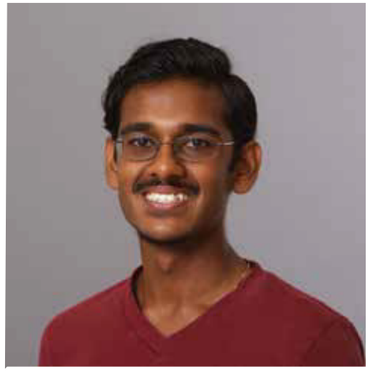
BS BiomedicalEngineering2018

Fiorello LaGuardia High School of Music and Art New York, New York Faculty Alesha Castillo

Georgia Institute of Technology

EFFECTS OF AGING ON THE PROLIFERATIVE CAPACITY OF SKELETAL PERIOSTEAL CELLS IN RESPONSE TO IN VIVO MECHANICAL LOADING

Aperson undergoes low magnitude axial loading of the bones through everyday activities such as walking. Bone senses these loads and responds through resorption and formation of existing bone, a process known as mechanotransduction. As the body ages, it becomes less responsive to these loads. However, the underlying cellular mechanisms for this observed decrease in load-induced bone formation are incompletely understood. The goal of this study is to better understand how aging affects bone formation in response to mechanical loading. In this study, young (16-wk-old) and aged (52-wk-old) mouse tibia underwent in vivo compressive axial loading. At 24 hours and 48 hours postloading, a time when periosteal cellular proliferation is maximal, mice were euthanized and the tibia was embedded in paraffin and sectioned for histological analysis. A Proliferating Cell Nuclear Antigen (PCNA) antibody was used to identify proliferating cells in the periosteum. Brightfield images were captured at 40x magnification and the number of proliferating cells in young and old bone was quantified. These data will address whether aging affects the proliferative capacity of periosteal cells in response to mechanical loading. Further studies will use in vitro approaches to quantify cellular forces required to induce cellular pro a function of age.



NICHOLAS KUMIA

BS MechatronicsEngineering2016

Valley Stream Central High School

ValleyStream,New York Faculty

Maurizio Porfiri

Other Mentor

Filippo Cellini

Vaughn College of Aeronautics and Technology

DEVELOPMENT OF 3D PRINTING TECHNOLOGY FOR 3D PRINTING OF ELASTOMERS

Additive manufacturing and3Dprinting technologieshave had a considerable impact in academic research and education, whereby 3D printing represents a simple and cost-effective instrument for rapid prototyping. Despite the advancements in print resolution and time for commercial printers, the choice of commercially available materials for 3D printing applications is still limited. This project aims to develop a technological platform for 3D printing of low modulus elastomers, such as thermoplastic polyurethane (TPU). Highly flexible and stretchable TPU filament is fabricated using a dedicated filament extruder. A commercial 3D printer is used to print the elastomeric material by adapting the extrusion system to the specific material needs. The development of this technique will impact current robotics research conducted at the Dynamical Systems Laboratory enabling 3D printing of flexible elements.



SHELLY LO

BS Mechanical Engineering2016

Brooklyn Technical High School

Brooklyn, New York Faculty

Vittoria Flamini

NYU School of Engineering

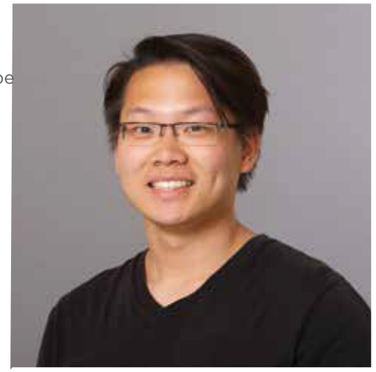
*Thompson-Bartlett Fellow

EBSTEIN'S ANOMALY: RIGHT VENTRICLE MAPPING AND VOLUME

Ebstein's Anomaly is a congenital heart disease characterized by a misplacement of the tricuspid leak, which in turns changes the shape and structure of the right ventricle (RV). It can be diagnosed early in the pregnancy, but severity of this malformation is unpredictable: some patients can grow and lead a normal life, while others have to undergo major surgeries.

Adult patients with this congenital disease are monitored using ultrasounds at six months intervals. It has been reported that RV volume is a key factor in grading disease severity and predicting life expectancy and disease outcomes. However, due to its complex shape, RV volume cannot be easily calculated from 2D ultrasound images. In this work we propose to define novel approaches to extrapolate more accurate RV volumes compared to state-of-the-art methods.

For this purpose we mapped 2D ultrasound views of Ebstein's anomaly adult hearts on RV volumes segmented from MRI images of the same patient. Since ultrasound are 2D images whose orientation is strongly operator dependant, we had to define an external, global coordinate system. By mapping patient-specific 2D images onto the corresponding 3D volume, we expect to be able to optimize the inverse transformation (i.e. obtaining an estimate of a 3D volume from a 2D planar image). We envision that improved grading of heart anomaly from ultrasound images will improve adult patients' treatment, and, more importantly, lead to the prediction of disease severity following a fetal diagnosis.



JIMMY LU

BS Mechanical Engineering2018

Staten Island Technical High School

StatenIsland,New York

Faculty Iraj Kalkhoran

Other Mentor

HamidehPourhashem

NYU School of Engineering

MIXING CHARACTERISTICS OF GASES IN TRANSVERSE FLOWS

Inthecontextof combustion application,thefluid dynamics of gas mixing in transverse flow is particular interest. In the energy industry, there is growing precedence for anti-pollution and performance-tuning innovation in gas turbines. Understanding variable characteristics such as the rate and quality of the reaction mixture with precision is necessary in coordinating various combustion reactions. Mainly, an accelerated homogeneous mixing of the injectant and mainstream is preferable. In order to investigate possibilities in improving gas jet mixtures, there is a need for an analysis that predicts the flow characteristics with reliable accuracy and reasonable computational cost.

In this research, a computational model is developed to analyze dynamics of a transverse turbulent jet introduced perpendicular to a cross flow. A nitrogen-air combustion reaction is specified using a global one step reaction mechanism which assumes complete conversion of the fuel to NO2. The reaction rate is determined utilizing the eddy-dissipation model as the turbulence-chemistry interaction model. The cross flow is composed of air, while the injectant jet is powered by a nitrogen gas through an orthogonal orifice. The analytical model characterizes both onset interactions at the injection site and residual mixing interactions subsequently after th injection site between nitrogenous fuel and oxidizer. Additional parameters such as material properties, and operational conditions are investigated in the analytical model as well.



ZED LUCIENNE

BS Mechanical Engineering/MS Biomedical Engineering 2017

Kingston High School

Kingston, New York

Faculty Vittoria Flamini

NYU School of Engineering

AORTIC DISSECTION

Aortic dissection occurs when the inner lining of the aorta is torn and blood is forced between the layers creating a distended, fragile secondary channel that puts the aorta at risk of rupture and the patient at risk of death. The object of this project was to computationally simulate the effect of drugs commonly used to treat chronic aortic dissection in order to assess their efficacy in reducing rupture risk for aortic dissection patients.

To achieve this, 3D patient-specific models were segmented from clinical CT imaging studies from two aortic dissection patients and one healthy patient. These models were converted to tetrahedral volume meshes for finite element simulations. An iterative algorithm was used to find the geometry and initial stresses of the aorta without the load from the respective patient's mean arterial blood pressure, essentially deflating the models. Peak pressure values were calculated based on physiological peak blood pressure and the drugs' effects on peak blood pressure as reported in medical literature. Then, the peak blood pressure produced by each medication was applied to each aorta model in a finite element simulation to reinflate the aorta and determine the resulting wall stress distribution. Areas of maximum wall stress were used to assess the rupture risk by comparing computed values of stress with aortic tissue ultimate stress.

In future efforts, the material property effects of arterial wall fiber orientation will be introduced into the simulations to improve the accuracy of the results, and fluid-structure interaction simulations will be performed to identify the effects of altered blood flow patterns on wall shear stress.



ADITYA SONI

BSMechanical Engineering 2018

Singapore International School

Mumbai, Maharashtra, India

Faculty Iraj Kalkhoran

Other Mentor

HamidehPourhashem

NYU School of Engineering



▲ Jimmy Lu and Aditya Soni determine ways of improving gas jet mixtures using a computational model that analyzes the reaction rate of nitrogen-air combustion.



AIMEE NOGOY

BSMS ElectricalEngineering2018

Immaculate Heart Academy

WashingtonTownship,NewJersey

Faculty

JooKim

Other Mentor

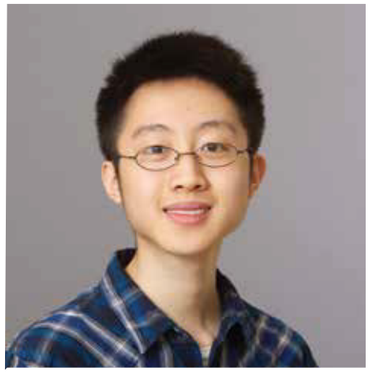
HenryClever

NYU School of Engineering

MULTI-DEGREE-OF-FREEDOM ENERGETICS OF ROBOTIC GAIT AND MANIPULATION

Whether to cut costs on automatedassembly lines or to extend the battery life of mobile robots, minimizing energy consumption is a major concern in the design of modern robots. In addition to advances in hardware, current research has focused on the potential of developing advanced motion planning algorithms for improving energy efficiency. While powerful simulation tools do exist for studying the dynamics of robots, there exist no reliable computational methods for evaluating the energetic costs of robotic motion. Instead, accurate data on energy consumption must be obtained experimentally with non-invasive measurement equipment.

In this project, an energy monitoring instrumentation system is implemented to study the energetics of the Dynamic Anthropomorphic Robot with Intelligence—Open Platform (DARwIn-OP) humanoid robot during gaits of varying cadence and stride length. The current and voltage were sampled at each of DARwIn-OP's actuated degrees-of-freedom to obtain the energy consumption according to Ohm's Law. The voltage was directly monitored with an analog to digital module and the current was monitored by measuring the voltage drop across a current sensing resistor. The sensor instrumentation system was integrated with the LabVIEW and Arduino platforms to provide logging and filtering capabilities during data acquisition. The real-time energy consumption data for each degree-of-freedom was synchronized with the motion trajectories of the corresponding actuator to identify patterns in energy consumption related to motion.



WILLIAM PENG

BSMS MechanicalEngineering2016

Hunter College High School
New York, New York

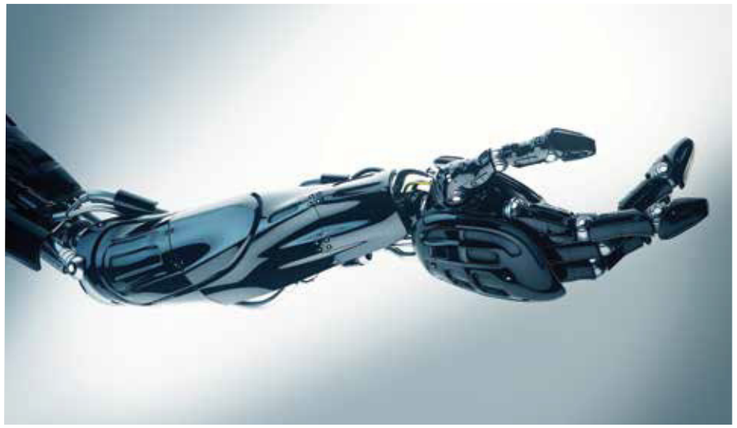
Faculty

Joo Kim

Other Mentor

HenryClever

NYU School of Engineering



▲ Aimee Nogoy and William Peng examine cost effective ways to measure energy consumption in robots.



STEVEN J. OSMA

BS MechanicalEngineering2016

Aviation High School Long
Island City, New York
Faculty Maurizio Porfiri
Other Mentor Filippo
Cellini

NYU School of Engineering

DEVELOPMENT OF A FLEXIBLE FISH REPLICA FOR ANIMAL BEHAVIORAL STUDIES

Experimental techniques that use replicas are assuming increasing importance in the study of social behavior of live animals. Ongoing research at the Dynamical Systems Laboratory involves the design of new fish replicas with flexible bodies, which can imitate the natural motion of real animals. This project focuses on the selection of the materials for the new replicas. Materials explored in this study are Polylactic Acid (PLA)/Thermoplastic polyurethane (TPU) blends, pure TPU elastomer, and poly (ethene-co-tetrafluoroethene) (ETFE). Slabs of each material are prepared through a dye molding process. To this aim, a dedicated mold has been designed and in-house fabricated and assembled. Identification of mechanical properties is conducted through rigorous material testing using standard characterization techniques, such as ASTM 3-point bending and 4-point bending tests. To interpret the results of the tests, experimental data are compared with theoretical models for bending of simply supported beams. The major goal of the project is the selection on the material for the replicas. The selection process is based on the analysis of the molding process and the resulting characteristics of the material. The repository of experimental data will be used to plan the transition from the molding pro a new 3D printing process for the replicas.



SUKHGEWANPREET SINGH

BSMS Mechanical Engineering 2017

Brandywine High School

Wilmington, Delaware
Faculty
Maurizio Porfiri

Other Mentor
Paul
Phamduy

NYU School of Engineering

DEVELOPMENT OF A NOVEL ROBOTIC PLATFORM FOR 3D ACTUATION OF A FISH REPLICA

Fish behavioral studies have often sought to understand the mechanics of fish interactions within their schools. This information can be potentially applied in order to aid fish schools to avoid dangerous situations, such as natural or man-made disasters b persuading them to swim differently than they naturally would. Research studies in contro environments on fish behavior involving visual cues are starting to adopt robotic platforms for its controllability and repeatability features. However, these types of robotic fish platforms have often been limited to motions in 2D. To further imitate fish free-swimming patterns, this project presents the design and development of a novel four degree-of-freedom platform to actuate a fish replica in 3D space. Specifically, the platform utilizes replicas modeled after the zebrafish, Danio rerio. The development and characterization of the platform are presented with preliminary spatial preference tests with live fish. Further improvements to the aesthetics of the fish replica will be presented. Future work includes the implementation of a dynamical real-time trajectory planning to fish behavior.



KATARZYNA SOMSZOR

BS ChemicalandBiomolecular Engineering 2017
Prince Poniatowski High School
Warsaw, Poland

Faculty Emilie Dressaire

NYU School of Engineering
*Thompson-Bartlett Fellow

AUTOMATED MICROFLUIDIC DETECTION OF CONTAMINANTS IN COLLOIDAL SUSPENSIONS

Porousmembranes are used to detect and remove contaminants suspended in a fluid phase, e.g. to filter water. Once a clog is formed in a pore incoming particles aggregate upstream. This aggregate grows over time, which leads to a dramatic increase of the hydraulic resistance. In this study, we focus on the growth of these aggregates (filter cakes) in single-pore geometry to better understand their influence on filtration process. The time-evolution of the volume of the aggregate for different pressure drops across the pore, particle concentrations and channel sizes is characterized. These findings are rationalized by an analytical model that predicts the growth of the colloidal aggregate in the microchannel. Based on these results, we propose a new experimental method to automatically detect the formation of clogs in a porous system. This approach which does not require the use of a microscope could allow to measure the concentration of contaminants in suspension and to monitor the aging of the filter.



CHRISTOPHER SOSNOFSKY

BS Chemistry 2015

Bay City Western High School
Auburn, Michigan

Faculty Alesha Castillo

Bowling Green State University

LOW MAGNITUDE MECHANICAL LOADING REGULATES BONE FORMATION IN CORTICAL BONE DEFECT HEALING

The humanbody is subjected to many different forms of mechanical loading in a given day. These forms of loading can range from compression, tension, shear, and torsion forces. However, it is not quite understood how our bodies respond to mechanical forces and specifically how loading affects bone repair. The goal of this study is to better understand how the process of bone regeneration responds to different types of mechanical loads. To this end, a one-millimeter surgical defect was created in a mouse. This method of injury was chosen due to its ease of reproducibility, simplicity, and the allowance of ambulation immediately after surgery. The mice then underwent compressive loading on post surgical day 2, 5, and 10 (psd2, 5, 10). In addition to this experiment, a finite element (FE) model was created, which estimates strain magnitude created by the application of axial compressive cyclic loading of 4N, 2Hz for 60 cycles which was chosen to simulate what humans undergoes in a daily basis. After 5, 10 and 14 days, mice were euthanized and the bone defect was embedded in paraffin and sectioned for histological analysis. 1% Aniline Blue, which stains collagen, was used to identify formation of new bone growth. To quantify new bone growth images were taken at 5x on a microscope. Next, images were analyzed using Photoshop to obtain a specific region of interest (ROI). New bone was then selected and a pixel count was recorded and compared to other samples gathered. From this study and preliminary data obtained, we hope to better our understanding of how mechanical loading affects new bone formation in injuries.



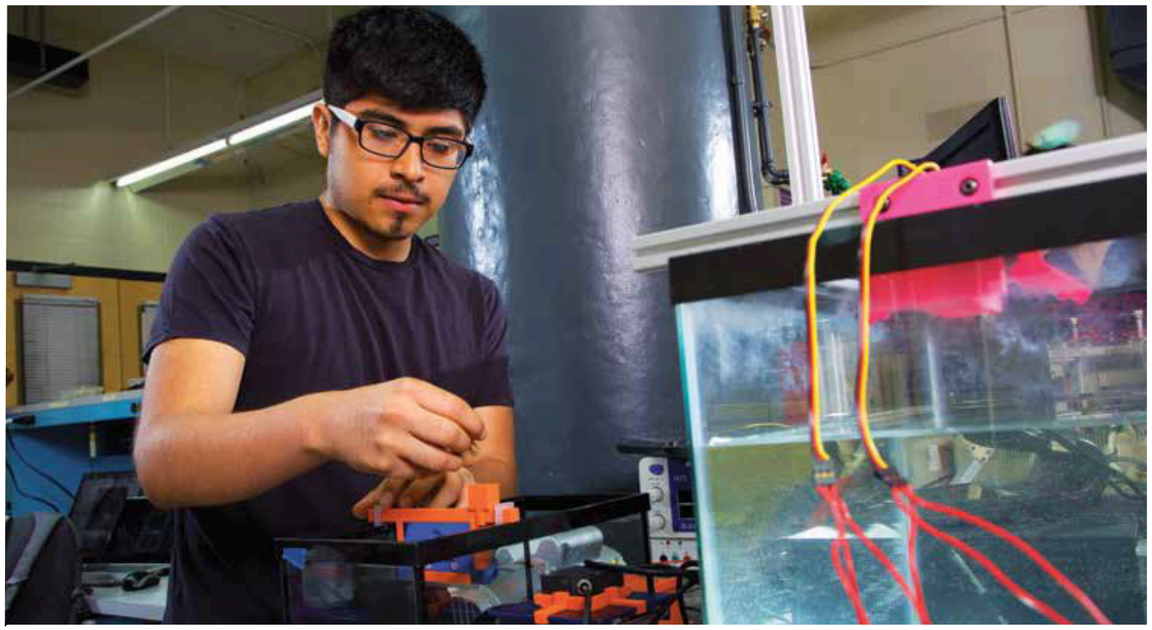
MIGUEL VAZQUEZ

BS MechanicalEngineering2017
Manhattan Hunter Science High School
NewYork,NewYork Faculty Maurizio Porfiri Other Mentor PaulPhamduy
NYU School of Engineering

MINIATURE FREE-SWIMMING ROBOTIC FISH FOR ANIMAL-BEHAVIOR INTERACTION STUDIES

Inthe field of animal behavioral studies,robotic animals are becoming increasingly valuable as research tools, as they provide controllable and repeatable stimuli to their live counterparts. Specifically, bio-inspired robotic fish used in behavioral studies have been shown to be effective in eliciting attraction and fear responses in live fish. However, cu robotic fish designs used in such studies are typically either tethered to an external power source or larger in size compared to the live fish due to an onboard power source.

In this study, the characterization of a free-swimming miniature robotic fish is presented alongside the development of the design. Specifically, tail beat frequencies and d cycles were varied and tested to determine their contribution to the speed and radius of curvature of the miniature robotic fish. The body and tail of the miniature robotic fish were printed utilizing a multi-material 3D printer, which encased a microcontroller executing an ad-hoc Arduino program. Further, in-house experimental setups to characterize the tail beat amplitude and the free-swimming velocities were developed. We will utilize the results of this study for future behavioral studies to mimic fish swimming patterns.



▲ Miguel Vazquez studies how the tail movement frequencies of fish correlate to their behavioral patterns.



THAIS DE MENESES VITAL

BS MechatronicsEngineering2016

Colégio Atenas Patrocínio, Minas Gerais, Brazil Faculty Maurizio Porfiri

Other Mentor Jeffrey Laut

Universidade Federal de Uberlândia (UFU) Brazilian Scientific Mobility Program

IMPLEMENTATION OF AUTONOMOUS OPERATION ON AN AQUATIC VEHICLE

Brooklyn-Atlantis is a mechatronics-based citizen-science project developed by the Dynamical Systems Laboratory aimed at aquatic environmental monitoring. The robotic vehicle used in the project contains cameras and water quality sensors, responsible for collecting environmental data. Citizen scientists contribute directly to the project through a web-based interface by analyzing images and water quality measurements captured by the vehicle. Their contribution is important for the assessing aquatic environments with high levels of pollution, such as the Gowanus Canal in Brooklyn, NY.

This research project is aimed at implementing an autonomous operational mode for the robotic vehicle, such that it can monitor the environment without the need of a human operator. In order to achieve this, motion and position sensors are attached to the vehicle and used to capture its current position and orientation to use as feedback for autonomous operation. The sensors' readings are processed by a microcontroller that is responsible for controlling the thruster commands while operating autonomously. These measurements are also wirelessly transmitted to a computer and plotted on graphs, allowing a human operator to monitor and coordinate the vehicle's locomotion. The vehicle's autonomous mode can be adjusted in order to satisfy the different project's tasks, meaning that it can also be configured to run linearly, or take more complex paths. The manual control by a human operator is still available, allowing the operator to switch between autonomous and manual control at any time while the vehicle is operational.



STEVEN ZELTMANN

BSMS MechanicalEngineering2016

St. John the Baptist Diocesan High School West Islip, New York

Faculty Nikhil Gupta

NYU School of Engineering

LIGHTWEIGHT MAGNESIUM MATRIX COMPOSITES FOR AUTOMOTIVE APPLICATIONS

The everincreasing push for higher fuel efficiency and reduced carbon emissions for automobiles and aircraft, as well as the desire for higher performance, requires the use of lightweight materials in the structures and load bearing components of vehicles. Magnesium, the lightest structural metal, is being proposed as a candidate for many lightweight structures and commercial alloys such as AZ91 (primarily a mixture of magnesium, aluminum, and zinc) have found applications such as gearbox housings on helicopters and body parts of high-end cars. In the present work, magnesium alloy composites reinforced with particles of silicon carbide are being investigated. In this work, a novel process is used to produce micro- and millimeter-size hollow particles of SiC in addition to a fabric of SiC fibers. These particles are hollow, so that a small quantity of air is entrapped in the material to create a reinforced foam known as "syntactic foam." The manufactured composites are tested for quasi-static and high strain rate compressive properties and strength improvements of up to 68% with respect to the base alloy are observed in the composite containing 40% by volume of 1 mm diameter SiC hollow spheres.



SAM ZHAO

BSMS Mechanical Engineering2017

Francis Lewis High School Fresh Meadows, New York

Faculty

Other Mentor

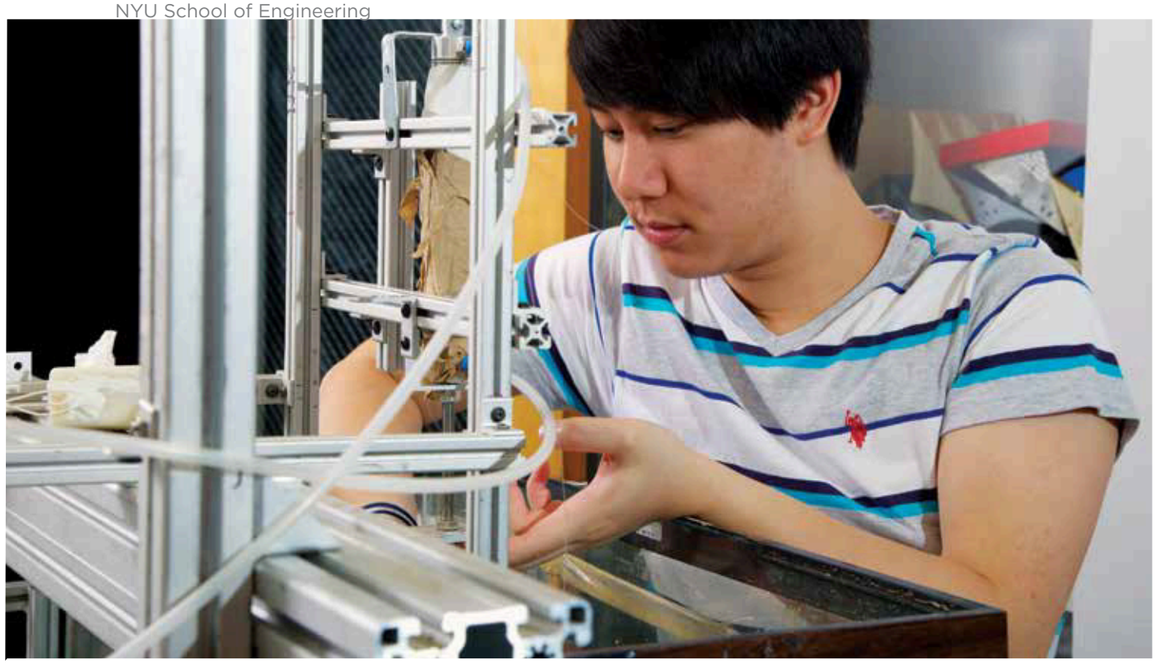
Maurizio Porfiri

Adel Shams

NYU School of Engineering

EXPERIMENTS ON THE WATER ENTRY AND EXIT OF RIGID AND FLEXIBLE WEDGES: HIGH SPEED IMAGING AND PARTICLE IMAGE VELOCIMETRY

Navalstructures, such as ship hulls and planning vessels, are subject to transient and large pressure loads as they sail and repetitively slam into the water surface. Understanding fluid-structure interactions is of great importance for the design of robust, yet cost efficient, planning vessels. The goal of this project is to experimentally characterize the water entry and exit, the so-called repeated water entry, of flexible and rigid wedges into a quiescent fluid through particle image velocimetry
(PIV). Experiments are performed on two identical flexible and rigid wedges with deadrise angle of 25°. The level of maximum immersion of the wedge into water surface is parametrically varied to investigate the effect of the penetration depth on the pile-up evolution, flow physics, and hydrodynamic loading during repeated water entry. Specifically, a pneumatic control system is utilized to simulate repeated water entry controlled by various parameters such as stroke, type of motion, and entry velocity of the wedge. High speed imaging is used to measure the penetration depth and wetted length of the wedge. In addition, PIV is leveraged to analyze the flow physics and the hydrodynamic loading during the water entry and exit of the wedges.



▲ Through his studies of water patterns, summer research participant Sam Zhao is developing practical approaches to shipbuilding to make it more cost effective.

TECHNOLOGY, CULTURE, AND SOCIETY



HIND ALTANTAWI

BS MechanicalEngineering2017

The Ahliyyah School for Girls
Amman, Jordan

Faculty

JonathanBain

NYU Abu Dhabi



SHEARYAR KHAN

BS Physics andMathematics/MS Computer Science 2017
Stuyvesant High School
New York, New York

Faculty

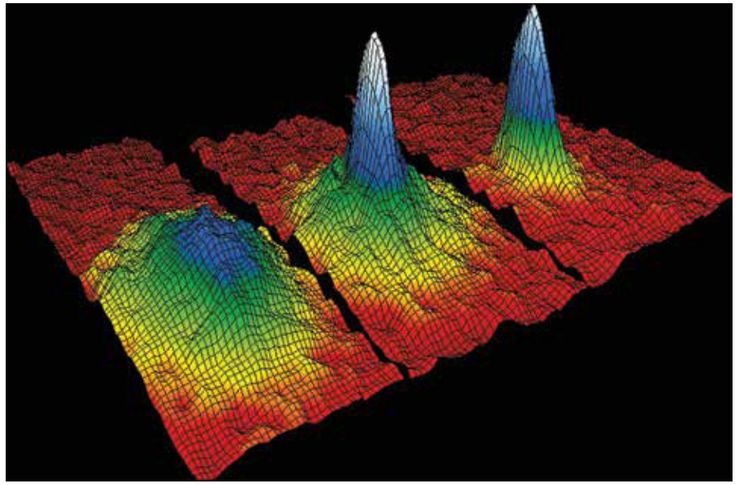
Jonathan Bain
NYU School of Engineering

WHAT EXPLAINS THE SPIN-STATISTICS CONNECTION?

Fermionsobey Fermi-Dirac statistics and bosons obey Bose-Einstein statistics. This entailsthatan exchange of two fermions in a group of fermions results in a change of the many-particle state, whereas an exchange of two bosons does not affect the many-particle state of a group of bosons (this implies that while bosons can be in the
same single-particle state, fermions cannot). Quantum mechanical particles can also possess either integer spin or half-integer spin. In relativistic quantum field theory, there is a fundamental connection between spin and statistics that is derived from the theory's axioms: fermions must possess half-integer spin and bosons must possess integer spin. However, there is no similar explanation in non-relativistic quantum mechanics. In simpler terms there is no simple explanation for why two half-integer spin particles (such as electrons) cannot exist in the same state, whereas integer spin particles can. This raises the question: What explains the spin-statistics connection in nonrelativistic quantum mechanics?

In this project, we conduct a literature review of attempts to answer this question. We sort each attempt in terms of the type of philosophical explanation it provides: causal-mechanical, structural, or unifying. We also assess its strengths and weaknesses.

It is important to take this philosophical approach because each explanation purports to describe reality in a different way. For example, a causal-mechanical explanation always requires a cause while a structural one says the phenomenon is a consequence of imposing mathematical constraints.



▲ Hind Altantawi and Shearyar Khan engage in quantum mechanics projects that explore the spin-statistics theorem.



LUCIANA JAALOUK

BS MechanicalEngineering2018

The French School of Kuwait
Salmiya, Kuwait

Faculty Christopher

NYU School of Engineering

Leslie



ANDREÍNA VIVAS THOMAS

BSElectricalandComputer Engineering 2017
Washington Academy
Caracas, Venezuela

Faculty Christopher

NYU School of Engineering

Leslie

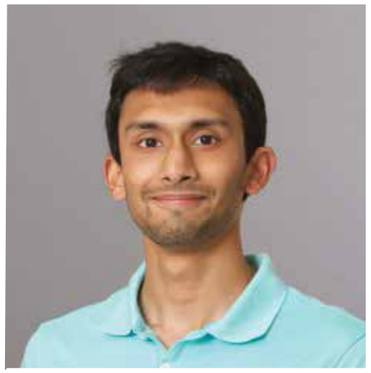
THE EVALUATION OF DIGITAL RESEARCH TOOLS FOR THE HUMANITIES

Thisstudy takes place to quantify the use of JSTOR, a humanities search engine created in 1 research tool. This comes down to the examination of how digital resources might be chang method and substance of humanistic inquiry based on how well online databases support th ideals of the humanities.

An initial online survey was given to a number of subjects in order to provide feedback on their use of search engines, their previous experiences and search methodologies, and their knowledge about them. Anonymously, they then searched for a specific arbitrary topic and rated the found articles based on relevancy and content. Finally, they were asked to give their impressions on these results and suggested possible improvements by sharing their thoughts on how interdisciplinary their research was. All records and times spent were registered and then analyzed on a broader scale to retrieve common trends that would help identify flaws, qualities, or possible developments on JSTOR.

About 75% of the remarks made during the engine testing fall into the category of design; JSTOR's engine design does not facilitate easy, relevant, and interdisciplinary findings in regards to the initial topic. Another more subtle realization comes with the construction of the search algorithm used by JSTOR; having changed many times over the years, this algorithm does not provide the users with enough valuable sources within the initial searches, even more so when these searches are advanced. By carefully designing the test environment, the findings accurately provide relia data due to the preset constraints: 30 minutes long, an interdisciplinary topic is given to users with beginner and/or intermediate research experience.

Hence, the solution indeed lies in the algorithm; improvements are needed in relevance of c filtering sources, and their interdisciplinary arrangement. Once all those changes are spotted and made, a new and better search engine for the humanities could be created which would satisfy most humanities researchers' needs.



MAHAMITRA JAGADHESHKUMAR

BS Electrical Engineering 2017

The Bronx High School of Science

Bronx, New York

Faculty Dana Karwas

NYU School of Engineering

EISENHOWER: A LIVE TRAFFIC PARTICLE SYSTEM

Theadvancement of live traffic data has allowed drivers to have on-demand traffic updates. Applications such as Google Maps, Here Maps, and Waze provide commuters with current traffic statistics allowing for personal optimization of desired routes, ultimately reducing the total time spent in traffic. Live traffic data feeds used for these applications come from commercial sources that require agreements with data vendors. Due to the limitations of these agreements, an open-source live traffic data feed for NYC is currently not available for public use.

Our research brings together computer vision and open source data with a visual particle system to create a new way of experiencing traffic. This new traffic experience, called Eisenhower (in honor of the Interstate Highway System), is a live traffic map featuring a glowing particle system that mirrors the twenty four hour flows and patterns of New York City traffic.

The human relationship with traffic is psychological and impacts the way we connect with visual signals. Traffic lights bring positive reactions when green, and negative reactions when red. Green gives the driver a sense of freedom because it suggests to them that there are no restraints, while red indicates the person must be restricted by stopping, even if she is late for work. This universal visual traffic language can be seen in the Google Traffic layer; green representing less traffic, while red represents congestion.

Our research approach consisted of a twofold process that incorporated visualization techniques and programming experiments. In order to get a better understanding of how light representing traffic functions across time and space, multiple scales of light were analysed. We collected images of night lights as seen from space and zoomed in until we were observing images of underground lights in our city's infrastructure. We also looked at traffic patterns and began testing individual particles and light points. Light quality and movement tests on traffic maps were conducted in Photoshop and animations were tested in Adobe After Effects.

The proof of concept for Eisenhower was created for downtown NYC using p5.js and Ruby. In order to create a scalable map of NYC that allowed us to attach moving objects to it, a vector map of NYC was used. A premade SVG file containing downtown Manhattan was obtained and converted into a p5.js rendering through Ruby. Using p5.js, a particle system was attached to each street on the vector map and computer vision was used to pull live traffic data from Google Maps. The particles are programmed to move at specific speeds depending on the color of the traffic data in Google Maps (Red, Yellow, Green,). For example: red is heavy traffic, yellow is moderate traffic, and green is light traffic. Speeds were also adjusted based off of speed limit data obtained from the NYC DOT. The Eisenhower proof of concept will be viewable as an online map accessible through any browser.

By reimagining the experience of mapping traffic we hope that Eisenhower can help us gain a greater understanding of the systems and networks that make up NYC.



STANFORD MENDENHALL

BS Integrated Digital Media 2016

St. Mary's High School
Manhasset, New York

Faculty Dana Karwas

NYU School of Engineering



LUIS RAMIREZ

BS Science and TechnologyStudies 2017

School of the Future
New York, New York

Faculty Jonathan Bain

NYU School of Engineering

EMERGENCE IN THE FRACTIONAL QUANTUM HALL EFFECT

The experimental discovery of the fractional quantum hall effect (FQHE) in 1980 was followed by attempts to explain it in terms of the emergence of a novel type of quantum liquid. This project seeks to articulate a notion of emergence that is compatible with the observed phenomena associated with the FQHE. Doing so is important for at least two reasons. First, notions of emergence have been used by physicists for quite some time to describe other types of condensed matter systems such as superconductors, superfluids, and Bose-Einstein condensates; however
only fairly recently have philosophers begun to take notice: traditionally,
notions of emergence in philosophy have been restricted to the philosophy of mind and general metaphysics. Second, for some authors, a notion of emergence must include an account of a mechanism by means of which emergent behavior is realized; but this is problematic in the case of the FQHE due to there being at least four alternative explanations that appeal to ontologically distinct mechanisms, none of which is more privileged than the others.

The goals of this project are to distinguish the fundamental features of the FQHE that make it distinct from other condensed matter systems that exhibit emergent behavior, to juxtapose accounts of emergence in the philosophy of mind with accounts of
emergence in physics, and finally to provide an alternative, non-mechanism-centric,
account of emergence that is applicable to the FQHE.



GRIFFIN TEED

BS Chemical andBiomolecular Engineering 2017

Bethel High School
Bethel, Connecticut

Faculty Christopher Leslie

NYU School of Engineering

CITATION ANALYSIS OF PERSONALIZED MEDICINE

Citation analysis has been a field of interest to those indexers, librarians, and information scientists who want to find the most influential papers in a field. Digital resources have been
developed to give easier access to large numbers of academic papers, yet not always a means of analyzing them. This study used the citation analysis software CiteSpace in order to create representations of the data from the databases PudMed and Web of Science. PubMed is a database composed of biomedical citations while Web of Science is a platform that has a massive catalog of papers, books, journals, etc. from all of the different scientific fields. The combination of these three tools allowed the study to examine the burgeoning personalized medicine field. Since the initiation of the Human Genome Project, the phrase "personalized medicine" has become buzzworthy, a manner of talking about healthcare in a revolutionary, groundbreaking way. With the number
of published papers rapidly growing, it is constructive to pause a moment to evaluate the nature of personalized medicine and how it is talked about within academia. With an STS approach in mind, the study attempted to delineate what Bruno Latour calls the "mythology" of personalized medicine, which is characterized by the main narratives that are discussed within the academic community. CiteSpace was used to uncover the frequently alluded to genetic variants that impact treatments. The data was gathered through a network analysis of the bibliographies of articles available through PubMed and Web of Science. By finding commonalities among papers published in journals dedicated to personalized medicine or relevant fields, an assessment of practitioners' assumptions
about the field emerged.

TECHNOLOGY MANAGEMENT AND INNOVATION

HUMAN-COMPUTER INTERACTION AND SOCIAL INTERACTIONONLINE



HONG-GYU LEE

BS ComputerEngineering2017

Glenbrook North High School
Northbrook, Illinois

Collaborator

Faculty

Jonathan Kwok
NYU School of Engineering

Oded Nov

Directto consumer genetic reporting has become significantly more obtainable to an average person in recent years; what had previously cost millions to sequence, can now cost as little as a smartphone. These reports provide tremendous amounts of important and very personal information, which may influence an individual's decisions, emotional state, and well-being. This subject of genetic reporting is a compelling study for Human-Computer Interaction (HCI), as the use of web-based interactive technologies to deliver such valuable information raises questions about how users comprehend, engages with, and relies on their personal genomic data. Questions about how people interpret their personal genomic information and how comfortable they feel about sharing it in order to advance scientific and bio-medical research are of paramount importance for society, policy makers, and HCI researchers alike.

Funded by the National Science Foundation and in collaboration with the Harvard Personal Genome Project and Wellesley College's HCI Lab, research was conducted to effectively design interaction techniques for non-experts with personal genomic information, and whether user interface design interventions have an impact on users' willingness to share their personal genomic data. In order to parse genomic data and generate visualizations, HTML, JavaScript, and Python scripts were used for backend development. The visualizations would assist users in comprehending and engaging with their genomic data to make important connections regarding their personal health. "VarExplore," a website designed for users to easily navigate through and annotate different gene variants of their genomic report, was created using the Django Web Framework and APIs.



▲ Hong-Gyu Lee collaborates with national organizations and institutions to develop user-friendly solutions that interpret genetic data.



NYU | POLYTECHNIC SCHOOL OF ENGINEERING

All correspondence should be sent to:
Office of UndergraduateAcademics
Polytechnic School of Engineering
New York University
6 MetroTech Center
Brooklyn, NY 11201
uga.engineering@nyu.edu
engineering.nyu.edu