2010
Undergraduate Abstracts



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Undergraduate Abstracts

FOURTH POLYTECHNIC INSTITUTE OF NYU
SYMPOSIUM ON UNDERGRADUATE RESEARCH

Introduction

NYU-Poly's Summer Undergraduate Research Program provides a unique opportunity for NYU-Poly and NYU College of Arts and Science students to become involved in research during the summer. This program offers students far more than the traditional classroom experience by allowing them to work alongside faculty mentors on cutting-edge research projects. Close interaction with faculty and research staff provides students with an educational experience that promotes the i^2e 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 students' knowledge base by applying classroom learning to solve practical and contemporary problems and to better prepare them for life-long learning.

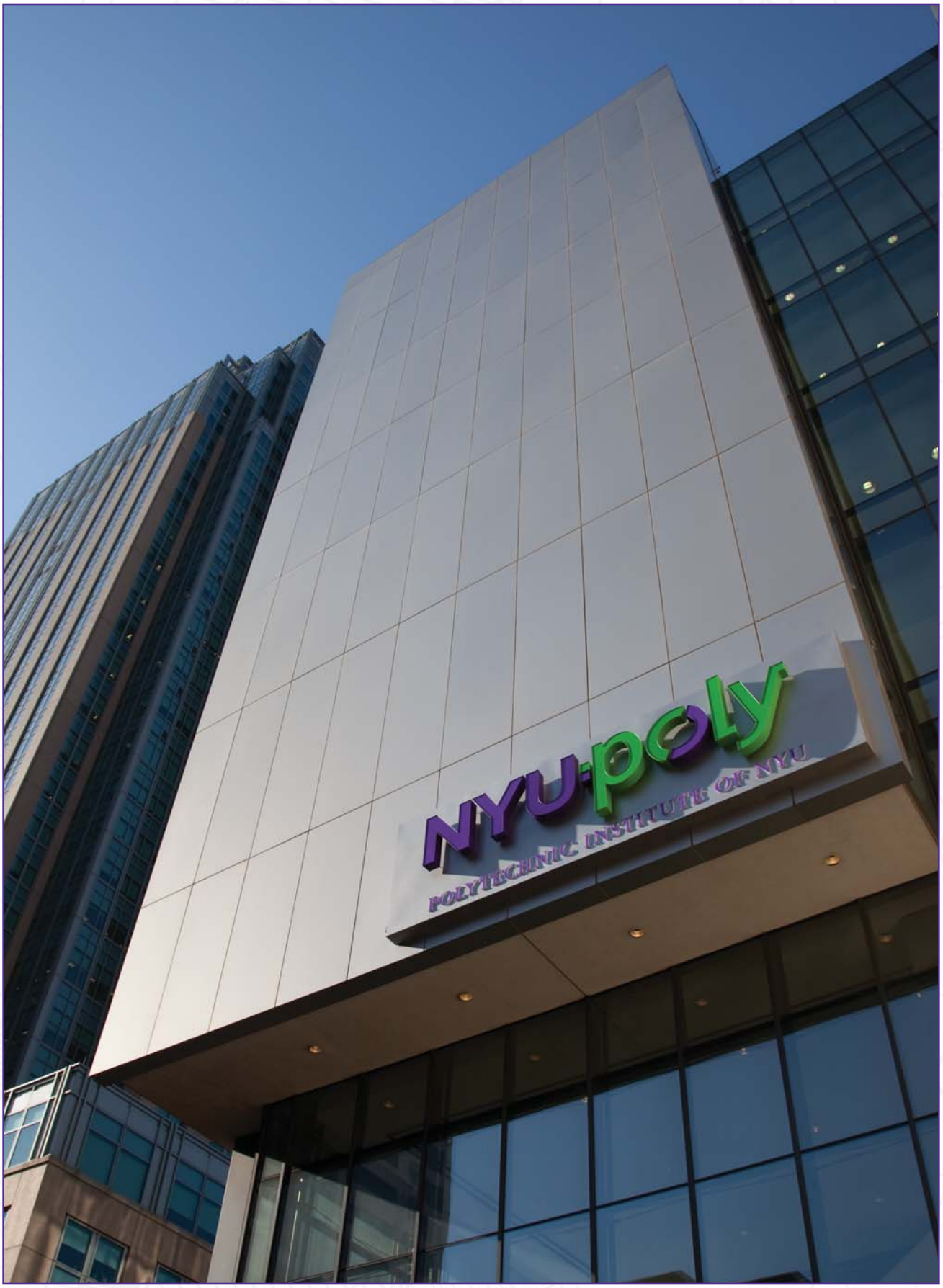
Summer 2010 is the fourth year of the Summer Undergraduate Research Program with 29 faculty members and 45 undergraduates participating. In addition to their work in the labs, students attended several seminars in which faculty members presented and discussed their own research. Additionally, the students also presented their work-in-progress to other students in the research cohort at a special lunch dedicated to practicing presentation skills and fostering inter-group collaboration on current and future projects.

NYU-Poly's faculty participation in this program was essential, as was the financial support from many faculty mentors and the Polytechnic Institute of NYU's Board of Trustees. The program was an initiative of Institute Professor Erich Kunhardt and Associate Provost Kurt Becker, who have played a vital role in making the program possible since its inception.

The abstracts published in this volume are representative of the poster presentations given at the symposium celebrating the accomplishments of the undergraduate researchers during the New Student Convocation on August 30, 2010.

I congratulate all of the student researchers who participated in the 2010 Su
Undergraduate Research Program and look forward to future summers of inte
and scholarly activities.

Iraj Kalkhoran
Associate Provost and Dean of Undergraduate Academics


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Rastislav Levicky
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Computer Science and Engineering

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Physics

Stephen Arnold
Kurt Becker
Erich Kunhardt
Vladimir Tsifrinovich

Technology Management

Bharat Rao

Chemical and Biological Sciences



Anika Ahmed

Biomolecular Science/2013

Brooklyn, NY
Midwood H.S.

Faculty Advisors:
Richard Gross and
Mark H. Schofield

NYU-Poly

Synthesis and Anti-microbial Properties of Novel Sophorolipid Derivatives

Sophorolipids (SLs) are glycolipid surfactants produced from glucose and oleic acid by a variety of yeast species including candida bombicola. These glycolipids are known for their biodegradability, low ecotoxicity and anti-microbial activity. Crude sophorolipid, obtained by fermentation, was purified by recrystallization from a mixture of ethyl acetate and hexane to yield a largely lactonic fraction. This compound was converted in high yield to the ethyl ester by alkaline hydrolysis in ethanol. The ethyl ester was hydrogenated in ethanol in the presence of 0.1 wt % Pd/C (10 wt % Pd) and 1 atm hydrogen pressure to produce hydrogenated ester 1. Although 1 is insoluble in most solvents, it was identified by its mass spectrum. Previous work in this laboratory demonstrated that ester derivatives containing ethyl, butyl and hexyl chains vary in their bioactivity, yet the corresponding amide derivatives have not been described. The acidic sophorolipid ethyl ester was treated with excess primary amines of the type RNH_2 (R = ethyl, butyl, hexyl, and octyl) to produce the corresponding amides 2a, 2b, 2c and 2d which were characterized by LC-MS and ^{1}H and ^{13}C NMR spectroscopy. After synthesizing these different derivatives their antimicrobial activity will be evaluated.

In addition, crude sophorolipids were separated into acidic and lactonic fractions using flash chromatography.



Aarti Bedi

Biomolecular Science/2012

New Delhi, India
H.C. School

Faculty Advisor:
Richard Gross

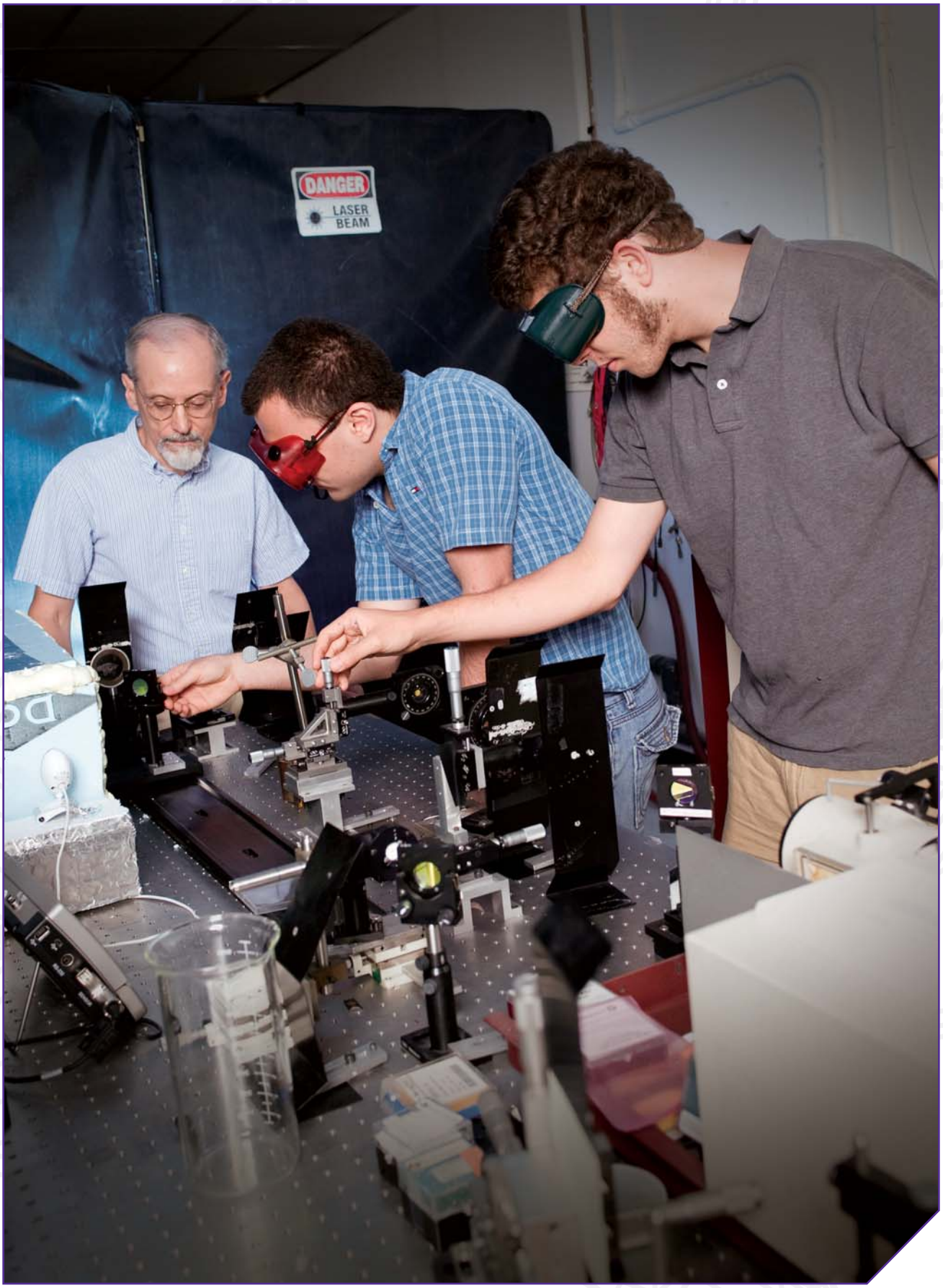
NYU-Poly

Porcine Pancreatic Lipase: Ion-pairing, Purification and Extraction

Porcine pancreatic lipase (PPL) is a glycoprotein that catalyzes the hydrolysis of ester bonds in water insoluble, lipid substrates. This enzyme, found in pigs, is 96 percent similar to human pancreatic lipase (HPL). Since PPL is generally found in the aqueous phase, our primary objective is to transfer it into the organic phase by a process known as ion pairing. To achieve this, we have chosen to optimize three important variables—pH of buffer (sodium acetate), concentration of salt ($CaCl_2$) and concentration of the organic solvent, isopropyl alcohol (IPA).

All enzymes have an isoelectric point or a pI value that is the pH at which any given surface carries no net electrical charge. At a pH below their pI, enzymes carry a net positive charge; above their pI they carry a net negative charge. As we lower the pH, PPL gets positively charged and through electrostatic force of attraction binds to the negatively charged surfactant—sodium bis (2-ethylhexyl) sulfosuccinate (AOT), which is present in the organic phase. It is through this method that the enzyme is brought into the organic phase.

Aside from PPL ion pairing, this study also conducts PPL activity assays (PNPB analysis) to determine the efficiency of the enzyme. Gel electrophoresis is also carried out to establish the purity of PPL after ion pairing. This is followed by the purification of the PPL sample to extract only the pure enzyme as the protein contains several other lipases. The end goal for this research is to optimize the extraction efficiency of PPL, which would be embedded in PCL films, and to study its degradation profile.



Professor Bruce Garetz, left, with Radu Iliescu and Quinn Gibson working with lasers.



Fabrice Bernard

Chemical and Biomolecular Engineering/2011

Elmont, NY
Holy Trinity H.S.

Faculty Advisor:
Richard Gross

NYU-Poly

Synthesis and Characterization of Amino Acid Conjugates of Sophorolipids

The glycolipids known as sophorolipids have many physical and biological properties. Some physical properties include the ability to emulsify as well as the ability to self-assemble and form helical ribbon structures in solution. Sophorolipids are known to have anti-viral as well as anti-fungal properties that make them a much safer natural alternative to dangerous industrial chemicals. Sophorolipids themselves are quite versatile molecules and can be altered through the use of simple organic chemistry in order to produce conjugates. The key to unlocking the full power of sophorolipids lies in the creation and rigorous testing of these conjugates.

The purpose of this research will be to produce amino acid conjugates from crude acidic sophorolipid. Through the use of dicyclohexylcarbodiimide coupling, an amide bond will be formed between the acidic sophorolipid and the amino acid group. The amino acids used in this research are penylalanine, tryptophan, tyrosine, leucine and alanine. Once the crude mixture is purified by flash chromatography, the structure will be characterized by nuclear magnetic resonance and mass spectrometry. The physical properties of the molecules in solution will be observed through microscopy. The anti-microbial aspects of the conjugates as well as their bioactivity in mice will also be explored.



Abhishek Channa

Electrical Engineering and Computer Science/2011

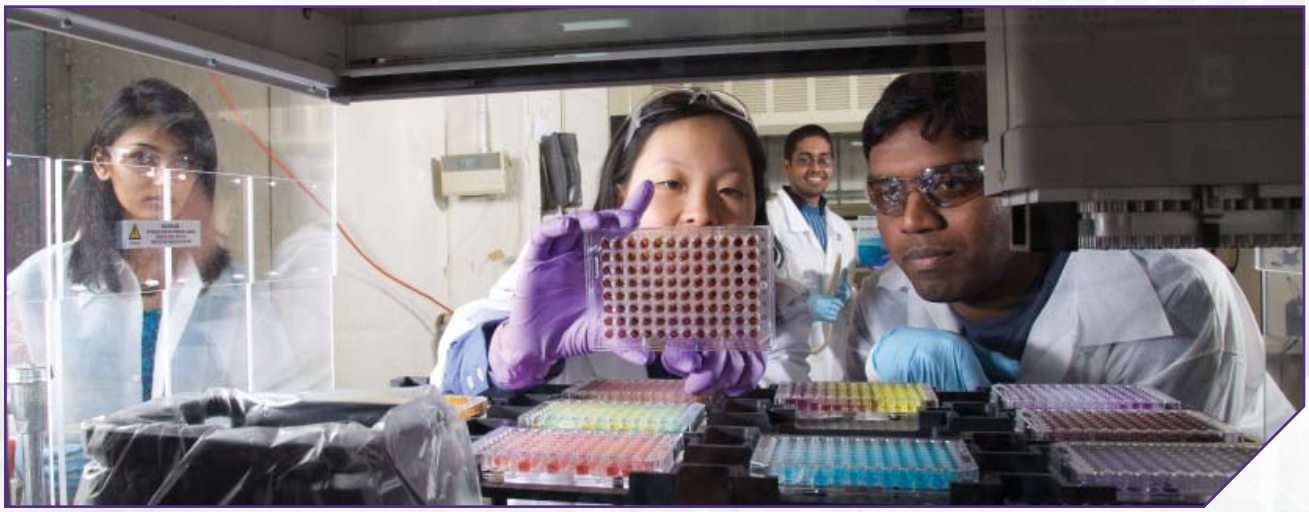
Queens, NY
John Bowne H.S.

Faculty Advisor:
Charles Martucci

NYU-Poly

The Effect of Carbon Dioxide on Viscosity of Mucus Solutions

Studies have shown that increased carbon dioxide (CO_2) retention in the lungs, through breathing techniques, can play an important role in reducing the symptoms and the need for medication in asthma patients. However, there has not been much investigation into the mechanism(s) by which CO_2 functions in this process. As asthma patients tend to build up significant amounts of mucus, a glycoprotein solution of mucin, in their respiratory system, the hypothesis presented here is that CO_2 affects the viscosity of mucus, which consequently eases the trachea/bronchi airway. To test this theory, a solution of 6 percent pig mucin was used. Viscosity measurements were made before and after the addition of CO_2, using three different types of viscometers: 1) a falling ball viscometer, 2) a rotary viscometer and 3) a cone and plate viscometer. These measurements showed that an increase in CO_2 content reduces significantly the viscosity of a mucin solution. The reduction in viscosity was especially pronounced when tested using the cone and plate viscometer. This data suggests that the benefit of breathing exercises to increase the content of CO_2 in asthma patients is due to the reduction in mucus viscosity.



Assistant Professor Jin Montclare, center, analyzes synthesized proteins.



Quinn Gibson

Chemistry and Physics/2011

Berkeley, CA
Berkeley H.S.

Faculty Advisors:
Bruce Garetz and Janice Aber
NYU, College of Arts and Science

Non-photochemical Laser-induced Nucleation of Super-cooled Water

In 1996 Garetz et al, discovered that upon treatment with a high-power infrared laser, supersaturated solutions of glycine and urea would nucleate. This was named non-photochemical laser-induced nucleation (NPLIN) as the process did not involve absorption of the laser light. Since then, multiple studies of the effect of NPLIN on super saturated solutions have been performed. Testing the effect of the high power laser on super-cooled liquids is the next step to understanding the mechanism of NPLIN. Water, being an extremely important and heavily researched liquid, was chosen for this experiment. First, a novel apparatus designed for the maintenance of 1ml water samples at temperatures well below zero degrees Celsius during laser treatment was built. Parameter testing was then performed, including testing of the effect of cooling rate and the dependence of water nucleation rate on temperature. Finally, initial laser experiments at below -10C were performed, using green light. Initial results suggest that laser treatment can induce nucleation in super-cooled water. Different crystal morphology was also observed when comparing samples nucleated with laser treatment to those nucleated without. Further research includes the continued testing of the effect of laser treatment on the nucleation rate and crystal morphology of water.



Radu Iliescu

Biomolecular Science/2012

Targu Jiu, Romania
TudorVladimirescu
National College, Romania

Faculty Advisors:
Bruce Garetz and Janice Aber
NYU-Poly



Professor Richard Gross, left, works with synthetic plastics in his laboratory.



Jinhui Zhao

Biomolecular Science and Chemistry/2012

State College, PA
State College Area H.S.

Faculty Advisor:
Jin Montclare
NYU-Poly

Synthesis of Protein Scaffolds for Cartilage Tissue Engineering

Cartilage tissue synthesis requires scaffolds that can specifically bind to and interact with the extracellular matrix (ECM) proteins on the surface of chondrocytes. One possible way of creating such a scaffold is the incorporation of argine-glycine-aspartic acid (RGD) repeats that are commonly found on ECM proteins. The purpose of this series of experiments is to create RGD mutations on the linker regions of di- and tri- block copolymers consisting of repeats of COMPcc-ZR and COMPcc-ZE-COMPcc. COMPcc is the self-assembling coiled-coil domain of cartilage oligomeric matrix protein, while ZR and ZE are a leucine zipper pair that aides in the formation of heterodimers. Once the proteins with RGD sequences are expressed and purified, their structure and stability are evaluated through small molecule binding to vitamin D, all-trans retinol and curcumin. In addition, circular dichroism (CD) is used to identify the secondary structure, while matrix-assisted laser desorption/ionization (MALDI) is used to confirm the mass of the synthesized proteins. Once those proteins are successfully synthesized and characterized, they will be subjected to template chondrocyte cell growth.

Chemical and Biomolecular Engineering



Ruth Choi

Chemical and Biomolecular Engineering/2011

Quito, Ecuador
Santa Mariana de Jesus

Faculty Advisor:
Rastislav Levicky

NYU-Poly

Morpholino Purification by SDS-PAGE

Morpholino oligomers are high-affinity, non-ionic molecules that resemble DNA. They consist of a backbone made from morpholine rings to which naturally occurring nitrogenous bases (adenine, guanine, thymine or uracil and cytosine) are attached. Unlike the classic probes DNA and RNA, this synthetic nucleic acid analog possesses an uncharged backbone that increases its binding strength to its complementary nucleic acid strand. Additionally, morpholinos appear to be completely stable in biological systems and they show excellent solubility in aqueous solutions. These properties make morpholinos widely used tools in gene knockdown as well as in therapeutic applications.

When using morpholinos, it is extremely important to have a pure sample. To be more specific, the morpholino sample should contain only same sized molecules. A few methods have been used to purify these oligomers, including high-performance liquid chromatography (HPLC). However, self-base pairing and aggregation take place very often, thus preventing the effective purification. To solve the problem, this study seeks to develop a novel purification method for morpholinos on the platform of SDS-PAGE (Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis), a technique commonly used to separate proteins according to their mass to charge ratio. This method requires the binding of the amphiphilic surfactant molecule SDS to proteins that provide the molecule with an overall negative charge.

In a study conducted by Wanqiong Qiao in 2009-2010, the melting properties of morpholinos were observed to change in the presence of SDS. Therefore, an interaction with SDS such as the one seen with proteins is expected with morpholinos. Consequently, this study attempts to determine the relationship between the molecule size and the rate at which it migrates through the polyacrylamide gel.



Nataliya Furman

Chemical and Biomolecular Engineering/2011

Brooklyn, NY
LaGuardia High School of Art

Faculty Advisor:
Jovan Mijovic

NYU-Poly

Dynamics of Candida Antarctica Lipase B in Water Solutions

The yeast, candida antarctica, contains the enzyme Lipase B (CaLB). This lipase is like others in that it hydrolyzes triglycerides; however, CaLB is unique in that it is non-specific and resistant to temperature-induced denaturation. CaLB also has two crystal forms: orthorhombic and monoclinic. By using differential scanning calorimetry (DSC), the crystallization temperature is found to be -15C. This was discovered after the reference cell was changed from air to water, thus removing the masking effects of water. There is also "noise" within the DSC melting curve, best seen in a 5mg/ml solution. A dynamic mechanical spectrometer (DMS) was used to obtain a more detailed picture of the rheological dynamics of CaLB. The DMS uses two parallel plates and sheers the substance in between at a given frequency and a certain strain. The results from 5mg/ml CaLB are in the process of being analyzed. However, they do correspond to the DSC data.



Assistant Professor Jin Ryoun Kim, top left, observes the experiments performed by Tina Xiong and Sofia Golbert.



Sofia Golbert

Chemical and Biomolecular Engineering/2010

Kramiel, Israel
Kramin H.S.

Faculty Advisor:
Jin Ryoun Kim

NYU-Poly

Aggregation of Alpha Synuclein

Parkinson's disease is a neurodegenerative disease that is associated with the existence of toxic intermediates in the aggregation of a protein called alpha synuclein (AS). It is a 140 amino acid protein which can be characterized by three different regions: an amphipathic N terminus (residues 1-60), a hydrophobic self-aggregating domain known as the NAC region (non-Aß-component, residues 61-95) and an acidic C terminus (residues 96-140). The NAC region is believed to be critical for the high aggregation propensity of AS that results in ß-sheet structured amyloid fibrils. The aggregated protein includes two linker regions encompassing residues 65-68 and 83-86 that connect ß-strand structures of the aggregate in fibrils.

In this project, a mutant AS protein is generated. The mutation involves a split tetra-cysteine tagging in carefully selected positions. Their location has to be at enough proximity to the linker regions to ensure optimal geometry and distances for the binding of FlAsH (a biarsenical dye that binds a specifically conformed tetra-cysteine motif). The mutations were constructed to detect intermediate species in ß-sheet conformation. Therefore, upon mixing the mutant construct with the wild type one, it is also intended not disturb the general fibrillation propensity of AS wild type. Thus, the aggregation process of AS is monitored using various characterization techniques such as circular dichroism (CD), fast protein liquid chromatography (FPLC) and rapid ß-sheet conformation detection using the above described recombinant DNA. This detection mechanism is useful in the recognition of intermediate toxic species that undergo conformational change and may be responsible for the pathology of Parkinson's disease.



Jaroslaw Jaracz

Bio-Chemistry/ Mathematics/2013

Jaslo, Poland
Brooklyn Technical H.S.

Faculty Advisor:
Stavroula Sofou

NYU, College of Arts and Science

Cooling Rate and pH Dependence of Domain Formation in Giant Unilamellar Vesicles

The pH and cooling rate dependence of domain shape and formation in giant unilamellar vesicles (GUVs) was studied via fluorescence microscopy, with domain size and shape measured at pH 7.0 and 5.0. The GUVs studied were composed of two lipids, one with a neutral and the other with a negatively charged head group, in a ratio to one another and to cholesterol. In a pH >7.0, it is expected for the electrostatic repulsion of the negatively charged head groups to dominate, preventing domain formation. However at lower pH, the negative head groups become protonated, resulting in hydrogen bonding and domain formation. This was indeed observed, though the extent of domain formation at pH 7 is based on the Ka of the specific lipid used, since a Ka close to 7.0 means that a sufficient number of head groups is protonated to exhibit significant hydrogen bonding. Domains forming at pH 7.0 were usually found to be circular in shape. In contrast, domains at pH 5.0 exhibit a distinctive florent shape, which minimizes the vesicle surface tension while maximizing the extent of hydrogen bonding (thus minimizing energy), allowing the vesicle to maintain structural integrity. Cooling rate affects the number and size of domains. A slower rate of cooling should result in the formation of fewer nucleation points, and a small number of relatively large domains. This was indeed observed. Interestingly, it was found that the domain area in observed GUVs never exceeded 35 percent of the total vesicle surface area. It is believed the vesicles lose structural integrity beyond this point. pH dependent domain formation is a promising line of research for chemotherapeutic drug delivery as extensive domain formation would be expected to cause the leakage of vesicle contents (such as a chemotherapeutic), taking advantage of the acidic interstitial environment found in tumors.



Robert O'Connor

Chemical and Biomolecular Engineering/2011

Staten Island, NY
St. Joseph by the Sea H.S.

Faculty Advisor:
Rastislav Levicky
NYU-Poly

DNA Detection through Label-free Electrochemical Transduction

Completion of the human genome project in 2003, which took 13 years and $2.7 billion dollars to complete and produced a draft of a consensus human genome, has pushed us into a "genomics era." Since that time, scientists have established linkages between sets of genes and an individual's propensity to suffer from a particular disease, such as heart disease, diabetes and certain cancers. Thus, possessing technologies that can reliably identify a given set of genes is relevant to human health.

Surface hybridization, which consists of surface-immobilized probe nucleic acid molecules binding solution-borne DNA targets, is a technique that is commonly used to read a large number of genes in a platform of probe arrays often termed "DNA chips." The state-of-the-art DNA chips rely on fluorescence as their readout mechanism. The process is laborious and requires expensive reagents. Undoubtedly, there is room for improvement. Towards this end, a label-free capacitance-based surface hybridization method has been developed.

This project tackled two aspects of this technology, one fundamental and the other practical. Fundamentally, the molecular mechanisms of surface DNA-DNA hybridization and its concomitant capacitance signal were identified and interpreted by comparison to numerical Poisson-Boltzmann simulations. The significance of this lies in understanding DNA-DNA hybridization at this molecular level will help in better designing DNA chip technologies. The practical part of this project is aimed at determining the source of noise in the label-free method by changing components of the electrochemical cell in which hybridization takes place. The result is half of the noise is reduced. The sensitivity of the label-free technique is limited by noise. The greater the level of the noise, the harder it is to resolve the reporting signal. This project has helped advance the technology of surface hybridization were the label-free method is now closer to seriously competing with other state-of-the-art methods.



Tina Xiong

Chemical and Biomolecular Engineering/2012

Brooklyn, NY
Brooklyn Technical H.S.

Faculty Advisor:
Jin Ryoun Kim
NYU-Poly

Stabilization Effects of Domain Insertions in Mesophilic and Thermophilic Scaffolds

As the application of proteins to pharmaceutical and biotechnological advancements greatly impacts our well-being, the status quo underscores the necessity to develop proteins with enhanced stability. This research compares the effects of fusing a target protein to two other host proteins of varying stability. These host proteins are chosen based on their substantially homologous structures, but grave differences in stability. The centerfold target protein, TEM-1 ß-Lactamase, which begins unfolding at about 50˚C, is the control in these studies. ß-Lactamase is implanted through the use of recombinant DNA technology into a library of sites (31, 120, 133, 173, 206, and 303) found in *Escherichia coli* maltodextrin-binding protein (EcMBP). A corresponding library is also created where ß-Lactamase (BLA) is inserted into analogous sites of *Pyrococcus Furiosus* maltodextrin-binding protein (PfMBP), which is an extremophilic version of its mesophilic counterpart EcMBP.

Kinetic and thermodynamic studies of these variants were carried out to probe the degree of stabilization. Urea denaturation, fluorescence, circular dichroism, along with differential scanning calorimetry were used to evaluate the thermodynamic behavior of both sets of hybrid proteins. Results of these studies revealed that the EcMBP hybrids were destabilized compared to the wild type BLA, whereas PfMBP hybrids showed no perturbation in stability compared to that of the wild type. Irreversible denaturation over a period of time was used to characterize the kinetic stability of the hybrids, revealing an overall increased kinetic stability for PfMBP hybrids. Analysis of expression levels of western blots also indicated in many cases greater expression levels of PfMBP hybrids than those of EcMBP hybrids, but no discernible advantage over wild type BLA.



Moshe Caplan

Computer Science/2012

Brooklyn, NY
Mesivta Chaim Shlomo H.S.

Faculty Advisor:
Nasir Memon
NYU-Poly

Recovering Deleted Microsoft Word (.docx) Files

The ability to recover deleted computer files is a necessity in today's high-tech world. Much of the digital data in the world today is not backed up and hence, if for some reason that data is deleted or becomes partially corrupt, it is essential that tools exist to recover it. Recovery is possible because in most cases file contents are not overwritten when a file is deleted, but rather a slight change is made to indicate that the memory location is unallocated and can be overwritten. Such tools are particularly useful for their forensics value such as recovering deleted data from a criminal's computer can provide evidence of their guilt.

Microsoft Word is one of the most widely used programs in existence today. Thousands of documents are written, edited and distributed daily using this program. Therefore, it is imperative that the ability to recover such documents exist. While current tools will recover some documents, most of these tools rely on the data being stored continuously on disk (non-fragmented data). Fragmented data that is broken up into different clusters and stored on blocks throughout the disk is much more difficult to recover. This project has begun to develop a tool that will accomplish this task by relying on the actual contents of the file itself, a process known as file carving. In file carving, a file is rebuilt using the specific characteristics of each file and file format, instead of using the file's metadata, which may be unavailable when dealing with deleted or partially corrupt files. The tool focuses on the ZIP format of a docx file, since a docx file is stored as a collection of compressed files. Additionally, it utilizes the XML structure of a docx document to aid in pairing consecutive data blocks. The final tool will be able to reconstruct all the docx files from a hard drive, for all data that has not been overwritten.



Professor Nasir Memon, left, is an expert in cybersecurity.



Jeffrey Dileo

Computer Science/2012

Merrick, NY

Sanford H. Calhoun

Faculty Advisor:
Nasir Memon

NYU-Poly

Packaging of a Virtual Laboratory for Information Assurance Education and Research

Based on work originally done from 2001 to 2003, a virtual laboratory was created at NYU-Poly to act as an information assurance lab (IA lab) for information security courses and research. The main benefit of this virtual laboratory is that it meets the stringent requirements of an IA lab, which are otherwise prohibitively expensive and difficult to build. The setup needs to be dedicated and isolated and cannot be part of a general purpose campus laboratory. A virtual laboratory is one that can be accessed via the Internet through a browser interface. This research is focused on packaging this virtual laboratory, the Virtual InformaTion Assurance Laboratory (VITAL), for easy deployment. The original extended purpose of VITAL was to be a central laboratory hosted at one institution that could be remotely accessible to smaller educational institutions that lack the resources to create and/or maintain an IA lab of their own. Therefore, the purpose of this research is to eliminate many of the difficulties involved in setting up VITALs at other institutions or organizations requiring an IA lab of their own. To fulfill the role of an IA laboratory, the VITAL was designed to be reconfigurable, heterogeneous, scalable, cost effective, robust, maintainable, realistic and insulated. Of these characteristics, those beneficial to the packaging research are the reconfigurability, scalability, robustness, maintainability and insulated nature of the VITAL because they allow for scaling down the VITAL to a more easily manageable configuration. From that point, packaging the VITAL setup is done by creating installation instructions and scripts for the configuring of each of the three physical machines that make up the VITAL—a XEN server, a gateway machine and a Network File System (NFS) server.





Martin Lau
Computer Science/2010
Brooklyn, NY
Brooklyn Technical H.S.
Faculty Advisor:
Joel M. Wein
NYU-Poly



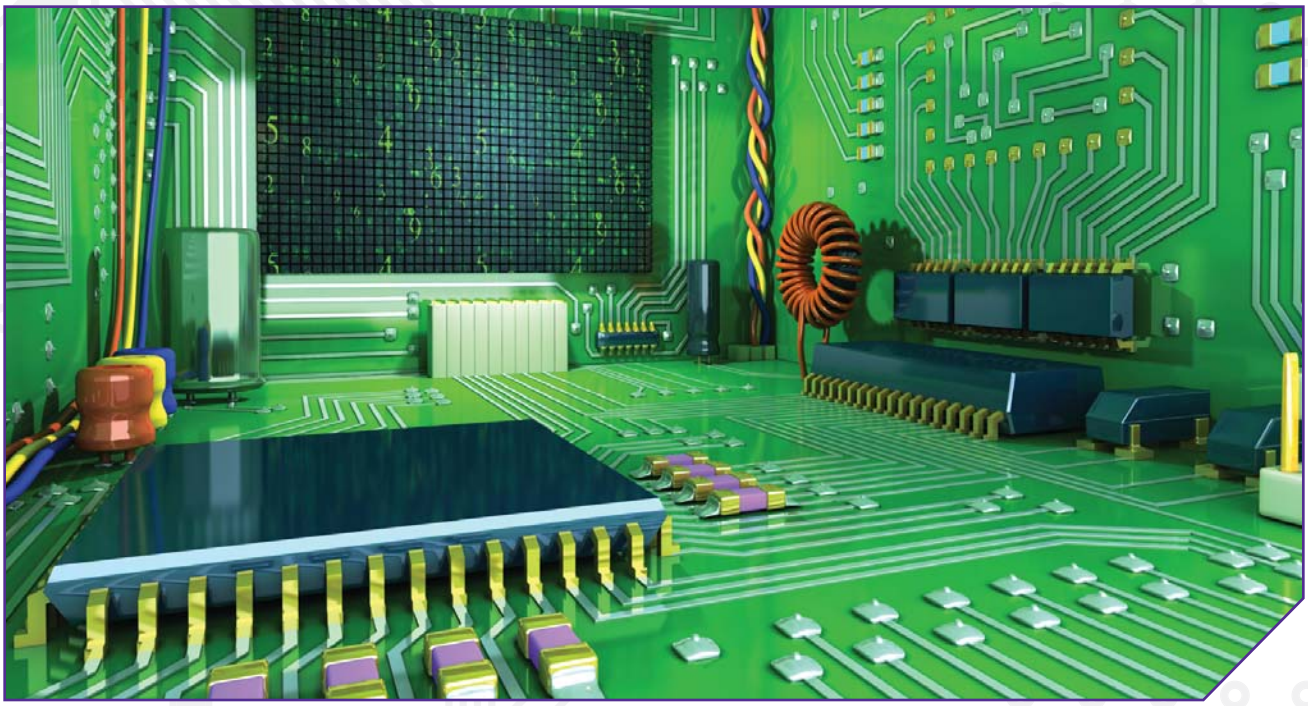
Lawrence Ng
Computer Engineering/2012
Brooklyn, NY
Brooklyn Technical H.S.
Faculty Advisor:
Joel M. Wein
NYU-Poly

Teaching Complex Distributed and Parallel Systems through a Virtualized Gaming System

There is a concern that the current material available for teaching distributed and parallel systems is not sufficient for equipping students with the tools they need to analyze one of these systems. Professors are challenged to teach the concepts of distributed and parallel systems not only through words and theory, but through practical applications. This project is a realization of two goals: teaching students how to work with a complex distributed and parallel system using a game we created, and observing if teaching concepts through a game will help students learn better. The game has been developed by Professor Wein's research teams and is currently code named DWORLD.

This is an ongoing project spanning several years. This year's goal is to rebuild the foundation of the game. Art assets were created to supplement the new front end, which takes place in an isometric view of a virtualized office setting built using Microsoft's XNA/C# game development platform. Information needed by the front end is retrieved from the MySQL database, which is fed by the back end written in PHP and C++. Scenarios are designed to balance a difficulty curve such that the game is not overwhelming in the beginning, but is challenging enough to teach students the necessary concepts.

When students start the game, they will find themselves immersed in a colorful and vibrant world with music and friendly non-player characters (NPCs). The story of a startup company will engage students as they complete the scenarios to increase their revenue. They will be tasked with utilizing what they are taught in class to improve their virtualized distributed system. Class assignments for the students are integrated into the storyline of the game, further immersing the students in a virtual environment where they are encouraged to learn. Ongoing research is being conducted to observe whether learning in this kind of setting is beneficial to students.





Moran Sidi
Computer Engineering/2012
Ramat Gan, Israel
Ohel Shem
Faculty Advisor:
Phyllis Frankl
NYU-Poly

Database Testing and Model Checking

Database application programs play a central role in our information-based society. Every day, millions of people use database application programs to shop, pay bills, travel and more. Enterprises, for example, use database applications to manage employee and customer records. Given the critical nature of these systems, testing their behavior is of a great importance.

A relational database consists of a collection of data tables. A database management system (DBMS) translates these high-level descriptions of data into low-level data storage and executes queries that may retrieve or modify data from the database. Application programmers write queries to access the data stored in tables. These queries are typically written in a mixture of high-level language, such as Java or C (called the host language), and a declarative language, such as SQL.

Two major concepts are being followed in this research: model checking, in which all execution paths of a program are being explored, and errors are reported as traces, and symbolic execution, which refers to the analysis of programs by tracking symbols rather than actual values. One of the latest open source applications which follows both concepts is the Java Pathfinder (JPF), released by NASA in 2005. JPF is an explicit-state model checker for Java programs that is built on top of a custom-made Java Virtual Machine. In this research, existing tools such as the JPF that will be used for SQL database based programs testing are integrated. The goals of this project are to enable the SQL string-based queries checking and to increase the time efficiency of the system by creating a state priority search based on JPF. This will be done by investigating whether existing complex symbolic execution frameworks can be adapted for our purpose.

Albert Yau
photo not available
Computer Science /2012
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Syosset High School
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NYU-Poly

Implementation of Image Tampering Detection through Demosaicing Artifacts

Many techniques to detect post-processing operations performed on an image have been developed in image forensics, but many are limited to either detecting whether an operation has been performed on the entire image (universal tampering) or finding local regions that have been tampered. However, through color filter array (CFA) demosaic techniques, which are based on the way that most digital cameras process their images, both universal and local tampering can be detected with high accuracy.

The objective of this project is to use CFA pattern number estimation and noised analysis to create a user-friendly implementation for image tampering detection. The program is written in C++ with the use of the OpenCV library. PHP is used to integrate the program with a website. Major challenges are to balance processing time with resolution of local regions for good usability and to output information and images that best display results of tampering detection.



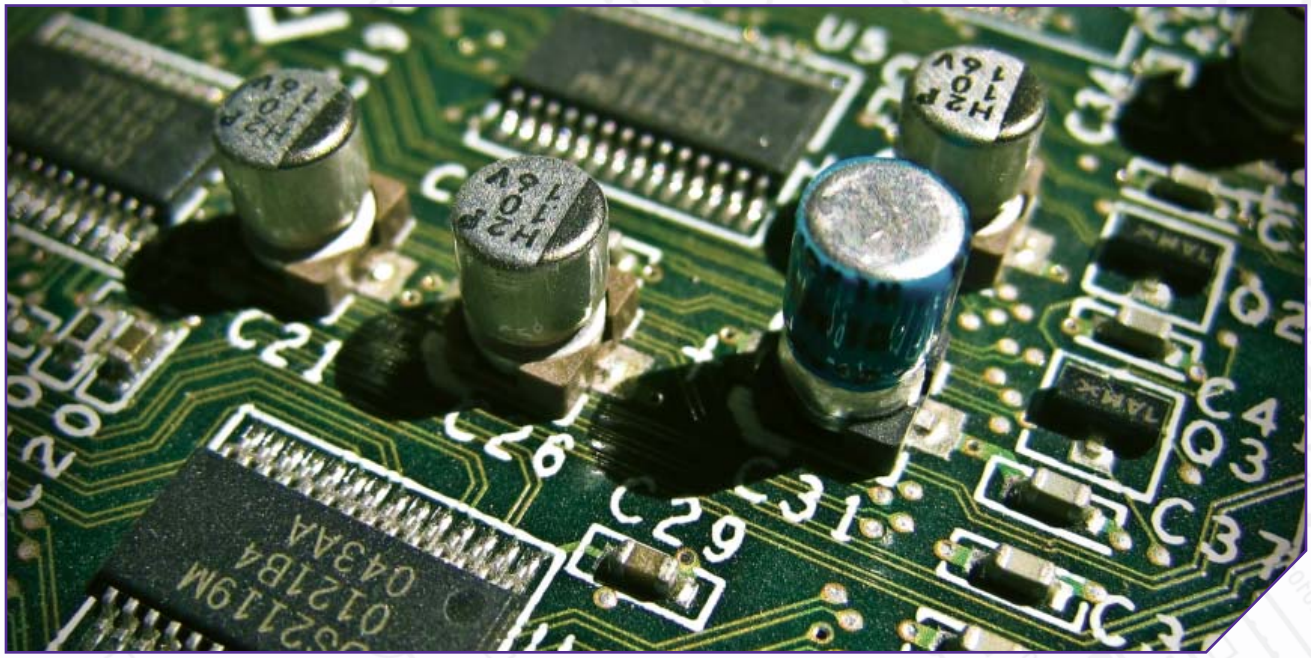
Po-Chen Chen
Electrical Engineering/2010
CK High School
Faculty Advisor:
Zhong-Ping Jiang
NYU-Poly

Impact of Distributed Generations in Sutton Network

Distributed generations (DG), generate electricity from small energy sources, using small-scale power generation technologies located close to the load being served.

DGs help to save energy as they can improve the efficiency of providing electric power. In the modern world, countries generate most of their electricity in large centralized facilities. Most power plants are often far away from cities due to the waste and heat they produce. With the installation of DGs, the electricity is generated very near to where it is used, sometimes even in the same building, so the amount of energy lost in transmitting electricity and the size and number of power lines that must be constructed can be reduced. Additionally, DG technologies may provide the benefit of more reliable power for industries that require uninterrupted service.

This project is in conjunction with Con Edison utility company on DGs over Sutton Network in Manhattan, NY. For the utility company, it is critical that the impact on the utility network is assessed accurately, so that these DG units can be applied in a manner that avoids causing degradation of service. As the control team, we are working together with the power team and Con Edison engineers to analyze the potential impact of DGs over the network. The goal is to predict a set of possible scenarios for the size and location of future installation of DG units within the network. We hope to understand how these statistical analyses will provide guidance for system design that optimize the network's performance.





Chaorong Chenn
Electrical Engineering/2012
China
No. 2 Secondary H.S.
Faculty Advisor:
Francisco De Leon
NYU-Poly



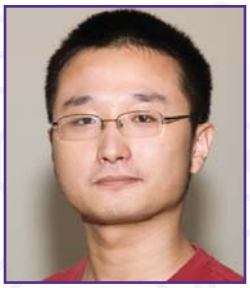
Aditya Chintapalli
Electrical Engineering/2010
Brooklyn, NY
John Browne H.S.
Faculty Advisor:
Francisco De Leon
NYU-Poly

Universal Controller for Interconnection of Distributed Generators

During this research program, two important tasks were given. The first one is related to distributed generators or DGs, which are small generating units mounted at various points of an electric power system. DGs can be used in many ways such as providing primary power and can also be more economic than running a power line. They are very important in improving the security of energy supplies by decreasing the need for fossil fuels and reducing the emission of greenhouse gases. The objective is to find the connection between customer-owned small DGs to the utility lines by using a "universal controller," also known a magic box. Many issues are associated with this task, such as the increased fault duty on circuit breakers, ground fault over-voltages, power system stability and harmonic distortion contributions.

The second task was in the field of analyzing power systems. The definition of power has long been a complicated and confusing field when analyzing a nonlinear AC circuit. Numerous attempts to establish a power theory that fits independent nonlinear and unbalanced circuits have produced a wide range of theories that only apply to specific cases. This research is the first step to build a universal definition of power that would apply to any nonlinear AC circuit no matter how complicated the inner configuration is. In the research, an instantaneous power theory, derived directly from Maxwell's equation, was proposed as an attempt to solve the problem. Accordingly, only the energy transformed and the energy stored or restored is taken into consideration. To test the viability of the theory, a matrix was deduced to accurately identify power components in all kinds of nonlinear and unbalanced circuits based only on the voltage and current values in the terminal. The success of the theory will be a basis for the future of smart grid technology.





Wenbo He

Electrical Engineering/2011

Nanjing,China
Jing Ling H.S.

Faculty Advisor:
Michael Knox
NYU-Poly

Software-defined Radio for Cooperative Communications

In radio, multiple-input and multiple-output, or MIMO system, is the use of multiple antennas at both the transmitter and receiver to improve communication performance. The basic idea has existed since 1970 with the work of A.R. Kaye and D.A. George. Today, MIMO is an important part of modern wireless communication standards such as IEEE 802.11n (WiFi), 3GPP Long-Term Evolution, WiMAX and HSPA+.

In this project, the objective is to approach real application based on the theory of the MIMO system. Universal Software Radio Peripheral II (USRP2) is used as the hardware platform to provide real-time wireless communication. Transmitter and receiver are both designed in software (Simulink in MATLAB) and using a gigabytes ethernet to transmit a signal to USRP2. The MIMO model built here is a simpler vision. Two signals on different power level are generated inside PC, and then transmitted out simultaneously, sharing the same frequency spectrum. In this way, the signals interfere with each other. At the receiver side, one antenna receives the mixed signal and passes it through several software-programmed processing blocks which are expected to extract and recover both signals. During the transmission process, this signal was distorted due to phase shift, frequency offset and timing difference. Specific blocks are designed to solve each of the problems and also make the data readable to FPGA chips inside USRP2. All blocks should be synchronized in proper data rate and data type in order to maintain low probability of error rate.



Songze Li

Electrical Engineering/2011

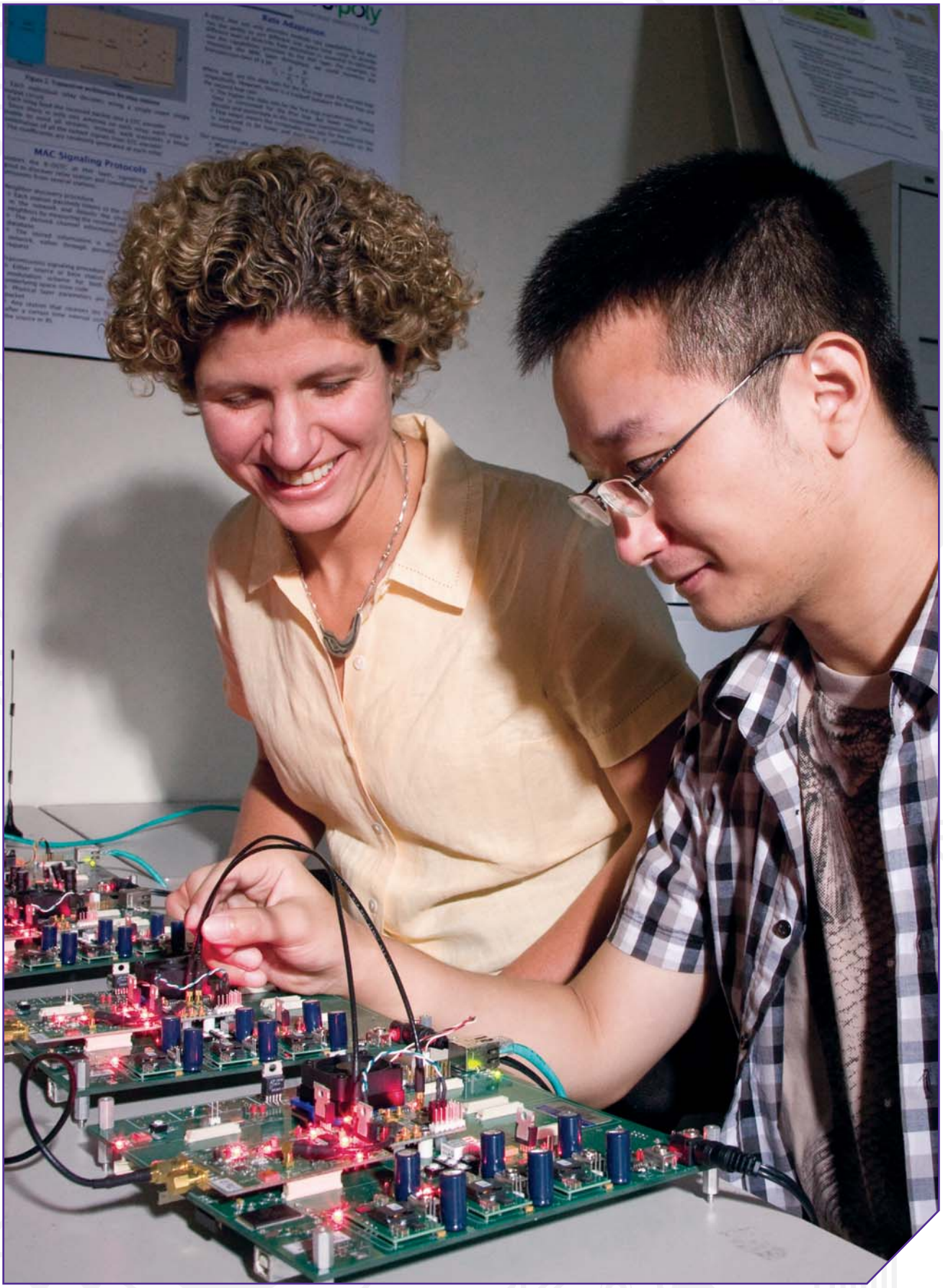
Nanjing,China
Jing Ling H.S.

Faculty Advisor:
Elza Erkip
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Cooperative Wireless Communications: Fundamental Principles

Wireless networks such as the cellular and 3G networks are widely deployed in our living and working areas. Within these networks, the transmission diversity is usually achieved by introducing multiple antennas at the transmitter or receiver or both. Recent studies find that a better alternative in terms of network throughput and battery life is to exploit cooperative communications. In this cooperative scheme, other terminals in the same network with the transmitter can be chosen as partners, and the partner would forward the signal overheard from the transmitter to the destination. Therefore, two or more copies of transmitted signals are observed at the receiver and the spatial diversity is obtained. With this operative diversity scheme, a virtual transmit antenna array is formed. There are several approaches to implement the user cooperative diversity, and the one this research focuses on is the coded cooperation.

This research looks into the situations when the relay is cooperating as well as interfering. For the cases when the relay is helping, the strategy of whether or not to apply the coded cooperation strongly depends on the inter-user channel condition between the source and the relay. The overall systems with multiple inter-user channel qualities are simulated and the channel performances in terms of BER and SNR/bit are observed. Meanwhile, when the relay is transmitting its own information bits, it can be an interferer. This research explores the way to mitigate the interference at the receiver and to increase the chance to decode the source bits correctly. Simulations are conducted with different scenarios where the interferer transmits at different power levels and different decoding strategies are applied. The results are observed and analyzed.



Associate Professor Elza Erkip and Wenbo He, who is studying the MIMO system.

Humanities and Social Sciences



Skye Book

Digital Media/2010

Bellmore, NY
Kellenberg Memorial H.S.

Faculty Advisor:
Carl Skelton

NYU-Poly

Betaville

Betaville is a massive, multiplayer online game intended to be used for something other than obliterating digital opponents half way around the globe. As a world-editor, Betaville enables communities to actively participate in the process of urban design; a radical departure from the usual town hall meetings praised by politicians, but ultimately deemed ineffective by citizens.

The platform is built in Java and relies on jMonkeyEngine to provide the graphical capabilities needed to understand the complexities involved in city planning. By allowing users to navigate not only over a landscape, but through it as well, Betaville can provide invaluable information about how it feels to be somewhere before that place may even exist. Details such as sightlines, pedestrian and traffic routes, movement of the sun and the overall usability of space can all be analyzed within. In the near term, this allows for the smart redesign of costly mistakes while in the future it can aid in eliminating them from context.

Based on the same open-source model popularized by community-based software development, proposals can be created "in world" as a "Request for Comment." Other users then have the ability to voice their thoughts on the proposal as well as contribute to one or to work on their own.

In accepting not only three-dimensional models of buildings, but audio, two-dimensional images and video, we are ensuring that those with the desire to design have the outlet to do so. With such a media-rich space, an empty slate quickly begins to feel like a living and breathing city.

Merritt Dailey

photo not available

Physics/Philosophy

Philadelphia, PA

Faculty Advisor:
Myles W. Jackson

NYU, School of Arts and Science

Psychoacoustics

Studies suggest that scent is the strongest sense tied to memory. However, hearing a melody can often trigger memories that are just as specific and evocative. Why do human beings have such a pronounced internal response to music? Why are they compelled to express themselves through it? Since the dawn of civilized peoples and even human interaction, music has been just one step behind language development. This project sets out to analyze why and how humans have historically shared this compulsion to create sound, to harmonize and pass these traditions through generations. Modern science has compounded history and given us a new lens through which to view music, allowing us to not only understand the mechanics of music itself, but also our physiologic reaction to it. Compiling various research from different contexts and disciplines, the paper produced by this research project presents current evidence on the fabric of music and its interactions with humans to address some analogous undercurrents within this collective understanding and possible applications of such discoveries that has come to be known as the budding field of psychoacoustics.



Assistant Professor Carl Skelton and Skye Book design cities using Betaville.



Andrew Karas

Chemical and Biological Engineering/2013

Pittsburgh, PA
Fox Chapel Area H.S.

Faculty Advisor:
Myles W. Jackson
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Gene Patents in Today's Society

In April 2010, the courts ruled in favor of the American Civil Liberties Union in their lawsuit against Myriad Genetics over the constitutionality of Myriad's patents on the BRCA1 and BRCA2 genes. When mutated, BRCA1 and BRCA2 genes increase the likelihood of breast and/or ovarian cancer. Now is the time to reexamine both the legality and benefits of granting patents over human genetic sequences. This project resulted in a paper that examines from a primarily scientific stance some of the issues surrounding gene patents. This paper features an examination of the legality of gene patents by discussing the science of DNA and how it relates to other similar court cases that serve as precedents.

By examining how Myriad exercised their patent rights over the BRCA genes, this paper describes the troubles that can arise when a company has control over information found in nature. There is also a discussion of how gene patents have affected the scientific community and how the scientific and medical communities could be affected in the future as technology and our understanding of genes improve. Based on these findings, it would appear as if the net societal benefits of gene patents have not been achieved in the same manner as for other types of patents.

Mathematics

Brian Law
photo not available
Mathematics/2012
New York City
Stuyvesant
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Franziska Berger
NYU, School of Arts and Science

Shaul Shaulov
photo not available
Mathematics/2011
Brooklyn, NY
James Madison
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NYU-Poly

Combinatorial Games on Graphs

While the subject of graph theory had its beginnings in recreational math problems such as the ones addressed in this research, it has grown into a significant area of mathematical research with applications in chemistry, operations research, social sciences and computer science.

For this project, combinatorial games played on graphs were used as a tool to investigate extremal and structural properties of graphs. In the Cartesian Hunt Game, two players alternate in moving a checker along the edges of a directed graph D with the objective to be the first player who reaches a designated goal vertex. During the course of this project, a polynomial time algorithm to determine a winning strategy for one of the players was developed. That player is then in the position to counter any move of his/her opponent and always wins the game.

A second positional game is called Gold-Digging in Graphs. It is played on a labeled tree, i.e., on a connected graph G = (V,E) with no cycles whose vertices are assigned fixed integer labels. The labels could model resources located at the vertices that can be harvested. The players alternately pick a vertex of degree one (a leaf of the tree), harvest the resources and then delete the vertex. The goal for each player is to develop a removal strategy that allows him or her to always collect more resources than the other player. If the tree consists of a path, then it is easy to see that the first player has a winning strategy. More general trees for the existence of winning strategies that can be computed in polynomial time were investigated.

Mechanical and Aerospace Engineering



Ed Bear
Electrical Engineering/2010
Raleigh, NC
Faculty Advisor:
Maurizio Porfiri
NYU-Poly

Aquatic Energy Harvesting with Ionic Polymer Metal Composites

Energy harvesting from small-scale, distributed, and/or local sources available in the environment is the subject of sustained research efforts. Advantages in applications such as low-consumption, electronic devices powering are represented by extended lifetime, limited maintenance and reduced on board weight.

Ionic polymer metal composites (IPMC) are a novel class of smart materials that can serve as the foundation for unique and innovative energy-harvesting devices operating in both air and wet environments. IPMCs consist of an ion-permeable polymer, electrolessly plated with noble metal electrodes and neutralized with mobile counterions and an uncharged solvent. Several microscopic phenomena in the IPMC result in macroscopic coupled electromechanical behavior. While IPMCs promising electrical source characteristics include low-source resistance, broad frequency response, high-charge storage and excellent underwater stability, their immediate implementation in contemporary electronic power systems is prevented by low-output voltages.



Professor Franziska Berger discusses the objectives of combinatorial games with students.



Assistant Professor Maurizio Porfiri, right, and Christopher Pagano construct a water channel.

This work entails the study of experimental methodologies to boost IPMC output voltages through vibro-impacts and pre-bent configurations. In every experiment, an electric shaker drives a conductive clamp holding a 2 cm^2 IPMC strip in a water tank with a stroke of approximately 1 mm. Experiments on vibro-impacting dynamics of the IPMC against an approaching and receding metal stop showed enhanced charge transport, consistently associated with impact events. Current spikes on the order of 5 mA and voltages on the order of 100 mV were observed during excitation. Experiments on pre-bent configurations, performed at low frequency with radii of curvature on the order of millimeters, showed that capacitors can be charged through a single Schottky rectifier up to 400 mV.

These results will enable the design of effective IPMC-based, energy-harvesting devices employing traditional electronic components for operation under environmental conditions unfavorable for established harvesting practice, such as thermoelectric, piezoelectric and electrochemical technologies.

Structural Health Monitoring of Composite Materials Using Embedded Sensors

Kevin Chen

Mechanical and Aerospace Engineering/2013

Brooklyn, NY
Manhattan Center for Science and Mathematics

Faculty Advisor:
Nikhil Gupta

NYU-Poly

Use of a novel fiber-optic loop-sensor design for sheer stress measurement and vibration analysis is shown in this work. Development of fiber optic sensors is rapidly growing for structural health monitoring (SHM) in composite and fiber-reinforced materials due to their small size and high sensitivity to external forces. In the present case, loop-sensors are bonded, using epoxy, with the fiber-reinforced composites and the intensity losses or gains are calibrated with the forces applied to composite specimens. Flexural tests are conducted to show the intensity modulation over a displacement range of 10 mm. The power modulation trend is associated with the displacement and can be used for structural health monitoring of composite materials.



Assistant Professor Maurizio Porfiri, right, and Chris Xu explore propulsion mechanisims in robotic fish.

Reduced Kinematic Modeling of Human Torso

Frank Hsu

photo not available

Computer Engineering/2010

Oakland Gardens, NY
Bronx High School of Science

Faculty Advisor:
Joo H. Kim

NYU-Poly

From a mechanical perspective, the human body can be considered to be a complex mechanism with countless degrees of freedom and hundreds of joints. In order to better understand and simulate the human motion, an efficient computational model is needed. The objective of this project is to create an accurate, yet simplified kinematic model of the human torso using Denavit-Hartenberg (DH) method, which is widely used in the robotics discipline. This project assumes the curvature of the spine is a feasible representation of

the human torso configuration and suggests reducing the complexity of the human spine (thoracic and lumbar) to three active revolute joints and a minimum number of passive joints. The purpose of the passive joints is to represent the curvature of the spine, since DH parameters only allow for rigid links between joints. Based on flexibility data of each spinal component, one can formulate an expression for the curvature of the spine. By combining the DH joints with a number of passive joints, one can achieve a reduced model that will allow for better simulations and will require less computational effort for further research in a variety of applications such as design and control of humanoid robots, development of prosthetics and analysis and simulation of human multi-body dynamics.



Jenny Lin

Mechanical and Aerospace Engineering/2012

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Midwood H.S.

Faculty Advisor:
Maurizio Porfiri

NYU-Poly

Underwater Swimming Captured by a Schlieren System

A schlieren system is used to image fluid flow that cannot be seen with the naked eye in transparent media with different refractive indices. This project was aimed at constructing a schlieren system to observe and compare the fluid flow around a flapping ionic polymer metal composite (IPMC) and a live fish's tail. IPMCs are used as the artificial tail and propulsor of the robotic fish created in the Dynamical Systems Laboratory.

A schlieren system was constructed in the lab with two parabolic mirrors, a point light source, a razor blade and a ground glass screen. In the test area of the schlieren system, a tank with fresh water and a clamp to actuate the IPMC was used. The fluid flow around the IPMC was observed by injecting salt water into the tank along the IPMC. A similar method was used to observe the live fish. We observed similar characteristics between the IPMC tail and the live-animal swimming. This flow visualization technique can be used to further improve the robotic fish using bio-inspired design.



Christopher Pagano

Mechanical and Aerospace Engineering/2013

Glendale, Queens
Townsend Harris

Faculty Advisor:
Maurizio Porfiri

NYU-Poly

Assessing the Suitability of Fluorescent Particles in Tracing Hill-Slope Hydrologic Process

The suitability of fluorescent particles as tracers for investigating hill-slope hydrologic processes is tested in this project. The results of this work will help in determining flow patterns in environmental applications and forecasting natural disasters such as flooding.

A water channel with a varying slope and rough walls was designed using the aid of the 3D modeling program SolidWorks and then constructed for an experiment with the dynamic behavior of the particles. The design parameters included volume, weight, mobility and cost. The channel's structure was similar to a larger water channel already within the Dynamical Systems Laboratory that was not portable and did not have the ability to change slope. Using the design dimensions, a pump power was calculated to give the water flowing within the channel a specific maximum velocity and maximum height. After several different designs were developed and critiqued, a final offset piping design was chosen to leave enough room beneath the channel for instrumentation.

Concurrent with the construction of the water channel, the particles visibility was tested through experiments in a static turbid environment. The experimental setup included a box, a UV lamp, a Petri dish and a circuit containing a photo resistor connected to a computer running a LabVIEW program. The visibility of the fluorescent particles in water with increasing concentrations of clay was inferred by seeing the amount of output voltage that was read by the LabVIEW program after a voltage was sent through the circuit. As more light passes through the Petri dish and solution and hits the photo resistor, the resistance of the photo resistor decreased yielding a higher output vol
changes in output voltages were analyzed to determine the potential u



Aadhar Rohila

Mechanical and Aerospace Engineering/2012

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APJ School

Faculty Advisor:
Joo H. Kim

NYU-Poly

Conditions of Falling of Simple Mechanisms with Single Foot Support

Falling of mechanical systems is a very common, yet somewhat less extensively studied motion; it is not even well-defined in the literature. Although several criteria for balance such as zero-moment point (ZMP) have been proposed by the robotics research community, a comprehensive condition of falling has not yet been introduced. The objective of this project is to define the falling of mechanical systems and to identify its criteria from analytical perspective.

This research is focused on falling caused by loss of balance for a mechanism with a single foot support. Starting by introducing rigorous definitions of falling states of a system, the dynamic model of falling of a mechanism is then studied. For any given position and momentum of a system, the dynamics of foot-ankle models with and without actuation are analyzed to derive the phase space boundary of dynamic balance. Computational simulations using MATLAB show the validity of the proposed criteria. The result will provide a necessary and sufficient mathematical condition for dynamic balance, which can be applied to more complicated multi-body systems, such as humanoid robot control and human motion prediction.



Hussein Saab

Mechanical and Aerospace Engineering/2011

Lebanon

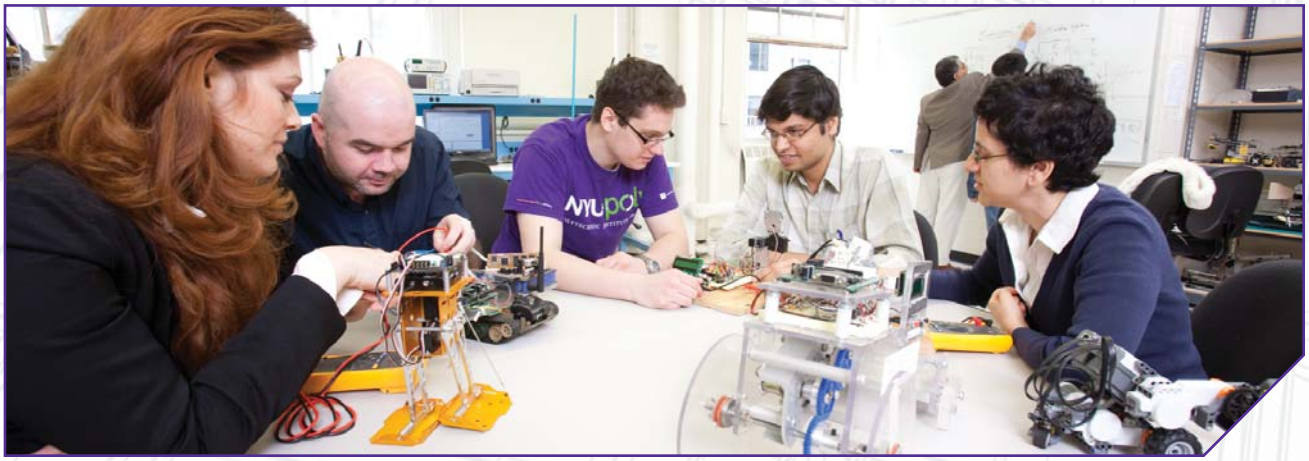
Faculty Advisor:
Remi Dingreville

NYU-Poly

Modeling of the Heart

The understanding of biomechanics is a concern for biomedical engineering, since the biomechanical properties of biomaterials (such as cells, limbs, soft tissues and bones) are important for many purposes such as understanding and studying some diseases, or improving clinical and surgical methods.

The scope of this research focuses on the biomechanical properties of arteries, in particular the aorta, the largest artery in the human body. The study is a contribution in a research to build a model of the aorta that describes its mechanical properties and responses (such as stresses and stretches) due to forces and pressures (such as blood pressure). The desired model will be built using computer software and is based on the characteristics of the arterial wall such as heterogeneity, incompressibility, real geometry, residual stresses, nonlinear hyperelastic behavior and isotropic and anisotropic behaviors. The software calculates mechanical properties such as stresses, stretches, displacement, von-misses stresses, in addition to the generation of the deformed shape due to forces and pressures, which can be compared with experimental results. The nonlinear hyperelastic models considered include Neo-Hookean, Mooney-Rivlin and Yeoh models. In the process of this research experimental information and parameters (for the mechanical properties of the aorta or other arteries) from published articles are used to generate the experiment using computer software and reproduce the results, which are then compared to experimental results.



Graduate fellows testing robots.



Ankur Vishwakarma

Mechanical and Aerospace Engineering/2011

Queens, NY
Brooklyn Technical H.S.

Faculty Advisor:
Remi Dingreville

NYU-Poly

Modeling the Shift in a Nanobeam's Natural Frequencies and Critical Buckling Load

Due to a high surface to volume ratio, nanostructures, such as nanowires and nanobeams for example, have a variety of novel applications for the technological world. Atomic force microscopy (AFM) and ultra-sensitive biosensors are two examples of such applications. While steady technological progress in all fields of nanoscale technology and probe technology have enabled the synthesis, assembly, development, characterization and improvement of such devices, the lack of understanding of their microscopic behavior is a major roadblock for inserting these materials into engineering applications. When the characteristic sizes of these devices shrink to the nanometer length scale, surface effects play an important role in their mechanical behavior. Therefore, there has been a resurgence of interest in theoretical and experimental work directed towards the investigation of surface effects in nanostructures.

This research is concerned with the surface effects on the buckling and natural frequency of nanobeams. An innovative approach that combines continuum mechanics and finite element methods is proposed to model the shift in a nanobeam's natural frequencies and critical buckling load. A previous model developed by Dingreville et al. (2005) is used in a classical mechanical framework to account for the size effect. The results are compared with existing results from literature and those obtained from finite element analysis accounting for the full anisotropy of the elastic properties and size effects.



Chris Xu

Mechanical and Aerospace Engineering/2012

Ridgewood, NY
Archbishop Malloy H.S.

Faculty Advisor:
Maurizio Porfiri

NYU-Poly

Experimental Characterization of a Flapping Fin's Thrust Production

Characterizing the thrust produced by a flapping fin is an essential step in creating an efficient bio-mimetic underwater vehicle such as a robotic fish. In this project, the thrust production of an in-house designed robotic fish is directly measured and characterized, and an experimental setup for the measurements is devised and realized. The robotic fish used in this study is propelled by a propulsion mechanism comprised of a flapping artificial tail actuated by a servomotor. The propulsion mechanism is retrofitted to fit onto a custom design measurement apparatus, consisting of a load cell force sensor, a high-speed camera and measurement and control software. The load cell used in this project is not capable of discerning the direction of an applied force. Therefore, a very low-friction linear guide is used to restrict forces of the propulsion mechanism to one dimension (direction of the thrust force) for the measurements. The motion of the flapping fin is captured with a high-speed camera and the thrust produced is directly measured with the load cell in the form of an electrical voltage signal. Factors such as tail shape, tail-beating amplitude, frequency and motion waveform are varied in the experiments. This characterization is intended to provide parameters for use in a mathematical model of the robot for closed-loop control, and hence, autonomous operation.



Christina DeAngelis

Physics/2011

Staten Island, NY
Staten Island Technical

Faculty Advisor:
Vladimir Tsifrinovich

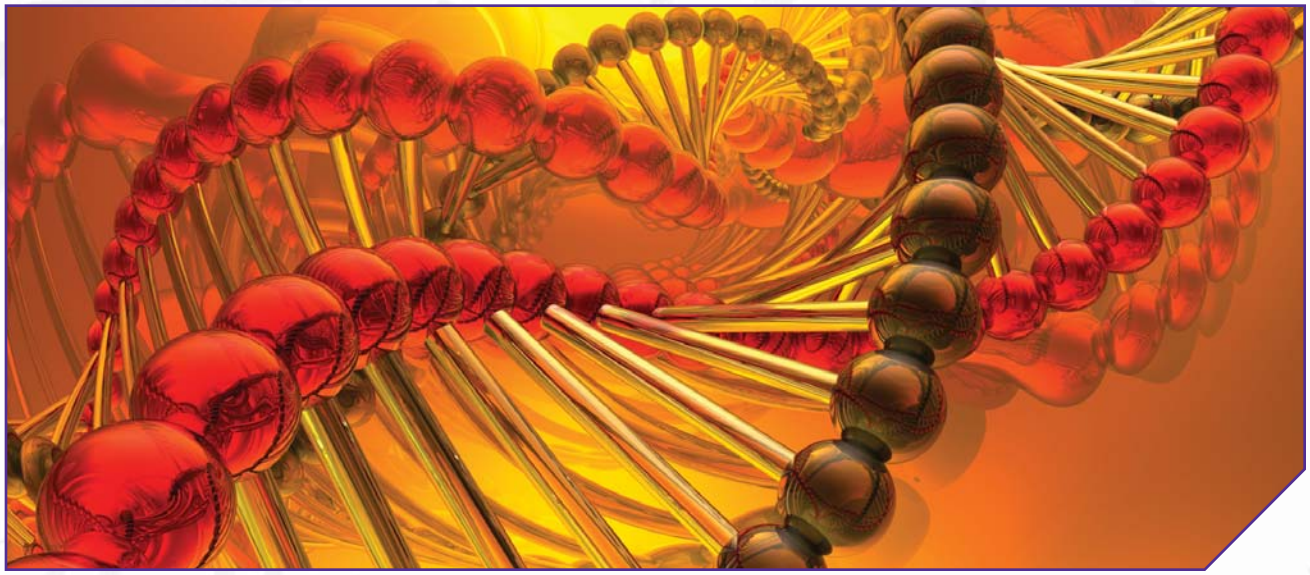
NYU-Poly

Generating Neutrino Beams Using Electron Capture Decay

Methods for creating neutrino beams are current topics of interest. These beams can be used for experimental purposes such as the observation of neutrino flavor oscillations over long distances.

One approach to beam production has been devised in this project. This method, which uses electron capture decay in radioisotopes, has the advantage of not requiring the use of a particle accelerator like other current techniques. The nuclei in the radioactive sample must have their spins aligned in order to achieve a net flow of neutrinos in one direction. In the ideal case, which would involve the presence of a very large magnetic field and temperatures approaching zero Kelvin, the nuclei will be completely spin polarized and all emitted neutrinos will move in one direction only. A magnetic field that is attainable in a lab will produce only some polarization and a net neutrino direction results. The z-component of total spin must be conserved after decay and, as a result, the neutrinos move along the z axis creating a directed neutrino beam.

Since the radioactive sample must be spin polarized using magnetic fields, an isotope with a large nuclear magnetic moment is desirable. Ferromagnetic samples allow for the existence of a strong hyperfine field at the nucleus that can be used for spin alignment instead of an externally produced magnetic field. Important factors in isotope selection are the half-life, neutrino energy and the existence of EC as the sole decay mode. This research works to find an isotope that will most efficiently produce the greatest net flow of neutrinos and, thus, the strongest beam. Among considered isotopes are ^{57}Co and ^{119}Sb. Once an isotope is chosen, calculations can be done to determine the net neutrino direction.



Plasma-assisted Surface Modification of Dental Materials

Non-thermal atmospheric plasmas have long been used in dentistry for the purpose of sterilization. Research into the medical applications of plasmas has become increasingly prevelant as its effects on living tissue have become better understood. Working in conjunction with the NYU School of Dentistry, the purpose of this research is to determine the effects of direct plasma application on dentine. The hope is that such application will make the surface of the dentine more favorable to bonding with various dental substances. Various setups will be constructed to test the effectiveness of various gas and gas mixtures. Special attention will paid to electrical parameters (current, voltage, power).



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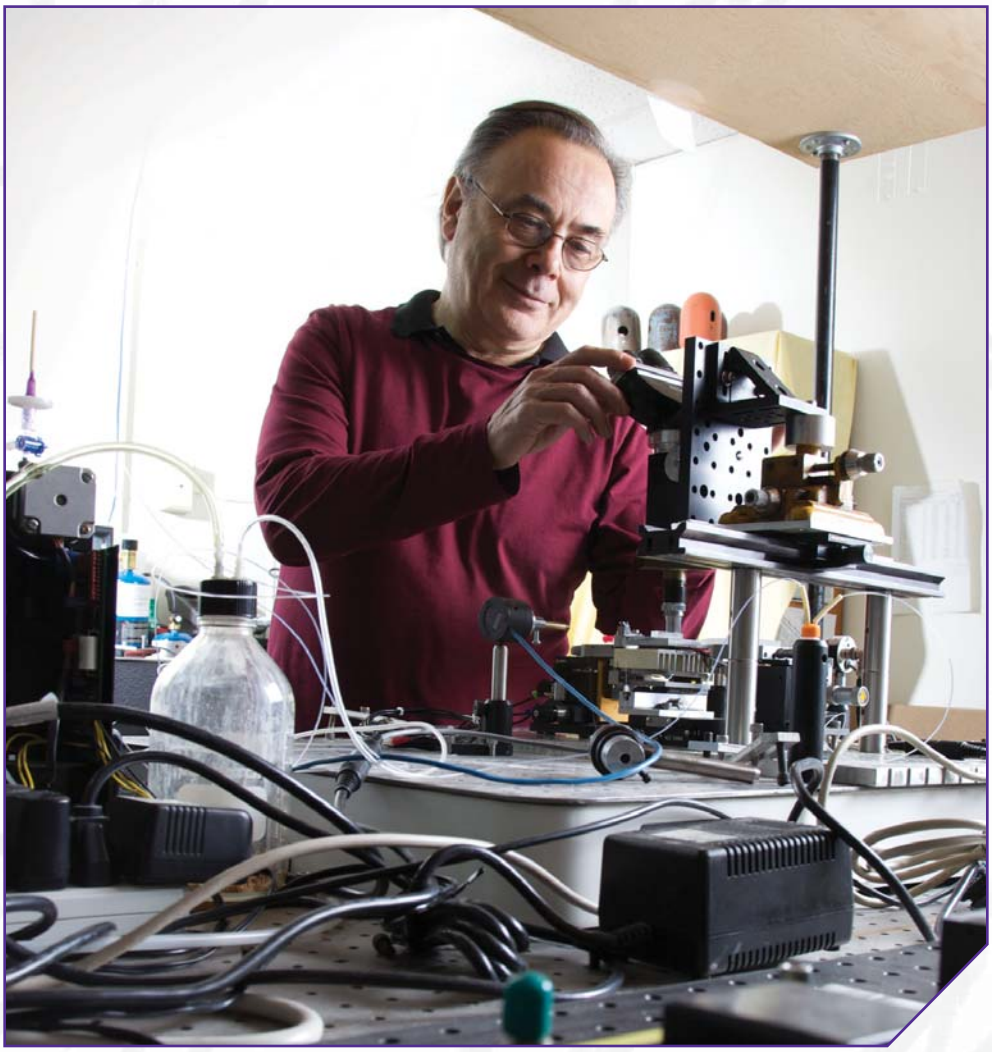
Ilaan Shtaygrud

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Stephen Arnold, Thomas Potts Professor of Physics and Institute Professor, in his physics laboratory where he teaches students the use of the distributed feedback telecom lasers for Whispering Gallery Mode resonance spectroscopy.



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Sub-dermal Biosensing

The use of distributed feedback telecom lasers (DFB) for Whispering Gallery Mode resonance spectroscopy substantially reduces cost in comparison with external cavity lasers (ECL). Since water absorption is reduced by orders of magnitude in the visible, most researchers and technologists have gravitated toward much more expensive, slower and far less portable ECLs for which wavelengths are commercially available down to 633nm. A significant reduction in the limit of label-free detection of individual viral-sized nanoparticles in aqueous solution can be achieved through the use of a frequency-doubled telecom laser constructed from a DFB-PPLN (periodically poled lithium-niobate) union. By driving a Whispering Gallery Mode Biosensor near a wavelength of 650 nm with this device, real-time adsorption steps for particles 36 nm in radius with a signal to noise ratio of 8 has been detected. The noise equivalent detection limit is ~ 20 attograms (17 nm radius). This new lower limit is attributed to the ultra-low resonance wavelength noise [$(Dl_{rrms}/l_r < 10^{-9}$] associated with the use of the DFB-PPLN device.



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Radiation from a Collection of Particles

The understanding of the radiation from a collection of charged particles accelerated by femtosecond laser pulses is the goal of this research. This radiation is in the Tera-hertz regime (10^{14} Hz). At present, there are no sources for THz radiation and by understanding how the radiation is emitted, we will take a step closer to a Tera-Hertz laser.

Since the trajectory of a charged particle in the electromagnetic field of a femtosecond laser, including the radiation, cannot be obtained analytically, simulation by computer is necessary. The objective then is to model the dynamics of the collection of particles, about 10 billion particles, in the electromagnetic field of a femtosecond laser pulse. The model consists of the equations of motions for each particle in the collection, which was formulated specifically for implementing in the computer using Python.

For this research, an understanding of computing error in calculating derivatives and the way a computer stores numbers had to be reached. A computer can only store decimal number with a certain error; however, by making a program which converts the integer part and the decimal part as string and then puts them back together at the end of the calculation, the error was eliminated. Then, different algorithms were used to approach a derivative. To test each algorithm, the trajectory of an electron was simulated in a magnetic field and compared to the known analytic solution. The string algorithm combined with different algorithms, such as Runge-Kutta and Leap-Frog was implemented to check the error in the solution; energy conservation of the system was also used as a test for the accuracy of the solution. Having found the particularities of many other algorithms, the need to understand which one will be most appropriate to model the radiation problem remains.



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Radiation by Accelerated Charges

The stability of an atom was one of the great puzzles left unsolved by classical electrodynamics. The early models of the atom suggested that the negatively charged electron orbits a positively charged nucleus, thus undergoing constant acceleration.

The project began by trying to understand the mechanism of radiation by accelerated charges. The main question asked and answered was, "Why does an accelerated charge radiate energy?" This study culminated in the Larmor formula, which relates the power radiated by an accelerated, non-relativistic charged particle to its charge and acceleration.

The next step of the study was to understand the motion of such an accelerated charge. For a radiating charged particle, an additional radiation reaction term must be introduced into the dynamical equations to account for the effect of the radiation. Abraham-Lorentz provided the most widely accepted form of this radiation reaction term. However, the resulting equation accepts solutions that violate physical logic. Subsequently, Landau-Lifshitz introduced an approximation to Abraham-Lorentz that gave better results. This, however, raised the question of how an approximation can be more accurate than what it is approximating. Although the nature of this equation is still a topic of debate, the objective is to arrive at a working model that includes relativistic effects.noise ratio of 8 has been detected. The noise equivalent detection limit is ~ 20 attograms (17 nm radius). This new lower limit is attributed to the ultra-low resonance wavelength noise [$(Dl_{rrms}/l_r < 10^{-9}$] associated with the use of the DFB-PPLN device.

Future work in this area will involve investigating the implications of such an equation in the study of electron-ion recombination (free-bound atomic transitions), electronic transitions (bound-bound transitions) and the generation of Terahertz radiation by a collection of charged particles accelerated by a femtosecond laser pulse.

Technology Management



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ICT Impact in Education in Developing Countries

This project, based on previous information and communication technology (ICT) research, explores ICT implementation and application in rural areas in terms of education. Over the last decade, governments in both developing and developed countries have regarded ICT implementation as part of their national strategy. Currently, ICT has been widely applied within developing countries in medicine, business and education.

Using the analysis provided by The Second Information Technology in Education Study (SITES), this project reviews the situation in South Africa to further analyze what ICT impact has on developing countries. Getting ICT involved in education systems attempts to bridge the gap between developing and developed countries. ICT, known for its distance-free and space-free implementation may provide a path for rural areas to reach the advanced education in urban countries. Additionally, whether applying ICT is an effective way to improve education quality in developing countries has been studied in the project.

The 2010 Undergraduate Summer Research Program Seminar Series

Michael D. Ward

Silver Professor and Chair, Department of Chemistry
NYU College of Arts and Science
Director, Molecular Design Institute
Director, NYU Materials Research Science and Engineering Center
Editor, Chemistry of Materials
"Pathological Crystallization:
Tailored Growth Inhibition of L-Cystine Crystallization for Prevention of Kidney Stones"

Erich E. Kunhardt

Professor of Physics
Polytechnic Institute of NYU
"Gamma Rays"

Kurt Becker

Associate Provost for Research and Technology Initiatives and Professor of Physics
Polytechnic Institute of NYU
Editor-in-Chief, European Physical Journal D
"The World of Microplasmas"

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