SUMMER RESEARCH PROGRAM UNDERGRADUATE ABSTRACTS 2012



NYU poly

POLYTECHNIC INSTITUTE OF NEW YORK UNIVERSITY



SUMMER RESEARCH PROGRAM UNDERGRADUATE ABSTRACTS

SIXTH ANNUAL NYU-POLY UNDERGRADUATE SUMMER RESEARCH PROGRAM

INTRODUCTION



NYU-Poly's Undergraduate Summer Research Program provides a unique opportunity for NYU-Poly, NYU College of Arts and Science and NYU Abu Dhabi students to engage 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 education 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 lifelong learning.

Summer 2012 was the sixth year of the Undergraduate Summer Research Program; since its inception, 231 students and 139 faculty have participated in the program. In addition to their work in the labs, students attended seminars on presentation skills, resume and cover letter writing, graduate school admissions and gene patenting. Additionally, the students presented their work-in-progress to the other members of the research cohort at a special lunch dedicated to practicing presentation skills and fostering inter-group collaboration on current and future projects.

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. NYU-Poly's faculty participation in this program was essential, as was the financial support from many faculty mentors as well as the Polytechnic Institute of NYU's Board of Trustees. 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 first year of the George Juul Thompson Undergraduate ECE Research Stipend. Three of this summer's researchers were graciously supported by this fellowship made possible by Ms. Dede Thompson 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.

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 27, 2012.

I congratulate all of the student researchers who participated in the 2012 Summer Undergraduate Research Program and look forward to future summers of intellectual and scholarly activities.



Iraj Kalkhoran

Associate Provost and Dean of Undergraduate Academics

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MEASUREMENT OF HYPERFINE SPLITTING AND OBSERVATION OF COHERENT POPULATION TRAPPING IN ^{85}RB AND ^{87}RB ATOMIC VAPORS

Hyperfine splitting for ^{85}Rb and ^{87}Rb isotopes in the ground state ($5S_{1/2}$) and the first excited state ($5P_{1/2}$) was measured using saturated absorption spectroscopy. Saturated absorption spectroscopy uses counter-propagating pump and probe laser beams traveling through a Rubidium vapor cell. Doppler broadening, or widening of the peaks in the absorption spectrum of the probe beam, occurs due to the velocity distribution of the atoms in the cell. As the frequency of the laser is scanned across the Rubidium D2 resonance, atoms moving toward or away from the laser beam come into resonance with either the probe or pump beam depending on their velocities. Some atoms move transverse to both beams, causing them to come into resonance with both the probe and pump beam simultaneously. Since the atoms are only able to absorb light from one of the sources, the probe beam then excites fewer Rubidium atoms. Thus there are dips in the absorption spectrum revealing the hyperfine sublevels, which allows one to calculate the energy and frequency differences for the hyperfine splitting in both the ground and excited states. The frequency differences in ^{87}Rb are 6.89±0.08 GHz and 6.88±0.06 GHz for the ground state sublevel, 0.078±0.007 GHz for excited state sublevel 0 to 1, 0.160±0.012 GHz for excited sublevel 1 to 2, and 0.267±0.019 GHz for excited state sublevel 2 to 3. The frequency differences in ^{85}Rb are 3.06±0.05 GHz for the ground state sublevel, 0.068±0.007 GHz for excited state sublevel 2 to 3, and 0.128±0.008 GHz for excited state sublevel 3 to 4.

Coherent Population Trapping (CPT) was also observed for the Rb D2 resonance for both ^{85}Rb and ^{87}Rb isotopes. CPT occurs when light from two coherent laser sources is simultaneously incident to an atomic vapor with lambda type atoms (two closely spaced ground state and one excited state). It is a two-photon resonance for which a “dark state” is created, and the vapor becomes transparent to the incoming light. We used a single diode laser with a frequency-modulated sideband for the two photon light source. An external magnetic field splits the magnetic sublevels of the ground state, resulting in lambda type atoms. The CPT observations were used to make preliminary measurements of the earth’s magnetic field in the laboratory.



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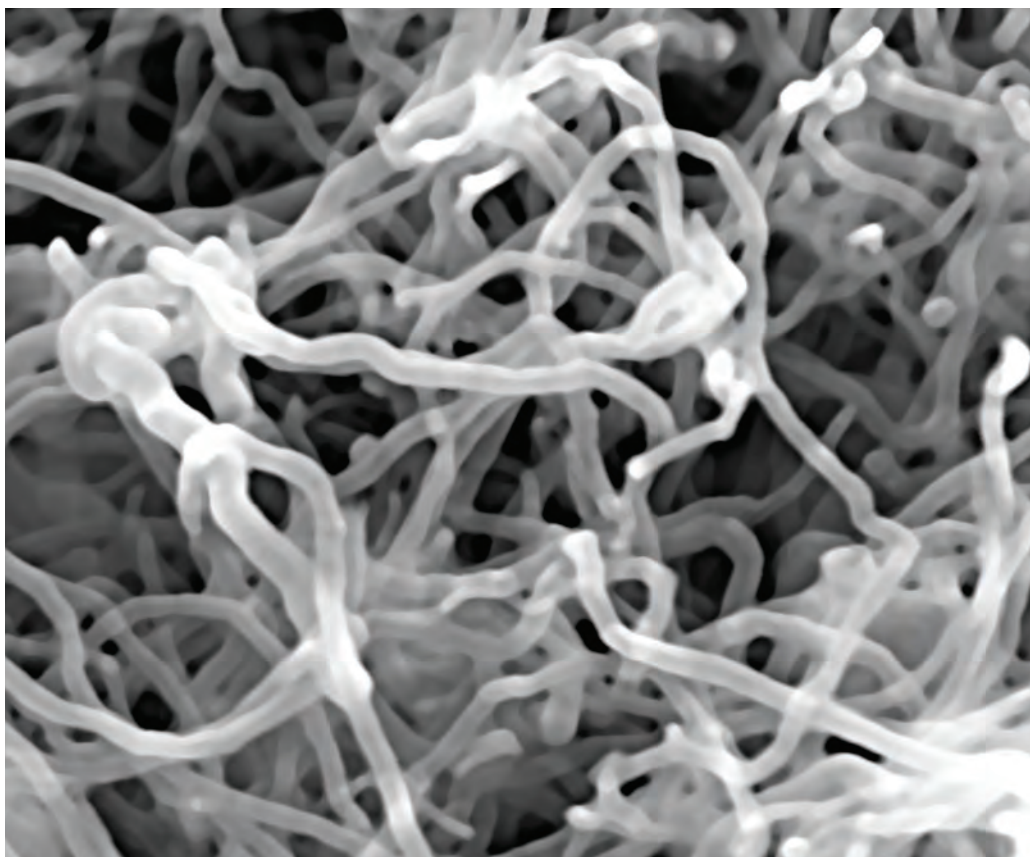
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INVESTIGATION OF ELECTRONIC FIELD EMITTERS OPERATING AT HIGH TEMPERATURE

Increasing the efficiency of the internal combustion engine has recently become a high priority due to the rising prices of fossil fuels. It has been proven that ionizing even small fractions of fuels in the combustion chambers of internal combustion engines will greatly increase the efficiency of the combustion. Nanotubes have been extensively studied since their discovery because of the unique mechanical characteristics and the field emission and conductive properties of the materials. Boron nitride nanotubes (BN) seem to be the best solution for a field emitter to ionize the incoming air-fuel mixture in a combustion chamber. Here, it is crucial to understand the chemical stability and resistance to oxidation of the nanotubes in the combustion chamber of internal combustion engine where the possible chemical reactions between the nanotubes and O^2 and other fuel molecules may destroy the integrity of the structure of the nanotubes.

By using Density Function Theory (DFT) and ab initio Molecular Dynamics which are coded in software, SIESTA, this research has theoretically investigated the stability and resistance to oxidation of BN nanotubes at the temperatures same as those in a combustion chamber. Future work includes more simulations with varying numbers of contaminants and temperatures to find what nanotube structure has the best characteristics. The next stage of development will be to make and test these field emitters for ionizing air in an actual internal combustion engine.



Boron nitride nanotubes under an electron microscope



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SELF-INTERACTION IN CLASSICAL FIELDS: THE CASE OF ELECTRODYNAMICS

Current models of charged particles and their self-fields leave much to be desired. Chiefly, persistent questions arise when attempting to understand the force that a charge's radiation field inevitably has back on the source. While classical models provide a logical framework to begin, mathematical paradoxes arise in attempting to treat the field singularities at the position of the charge and quantitative results may only be found in special cases. While quantum arguments are able to calculate these forces in an exact manner, they do not provide much in the way of conceptual clarification. This prompts concern that many ideas in electrodynamics, which carry over into most modern field theories, may only be of limited validity. Any theory that treats a force of one particle on another through the use of a classical particle-field complex suffers from these preclusions to a closed logic. It would appear that the only way to provide satisfactory answers is to fundamentally retool the notion of particle, field, and their coupling.

This project reviews a number of methods used recently to grapple with these protean concerns. Three main methodologies are discussed: moving to essentially eliminate the concept of the field by allowing it zero degrees of freedom, attempting to describe the charges as extended aspects of the field in order to unify the ideas, and trying to refine the description of the field exclusively. In doing so, this research can provide new insights into this cornerstone problem and extend them to a multitude of puzzling questions.

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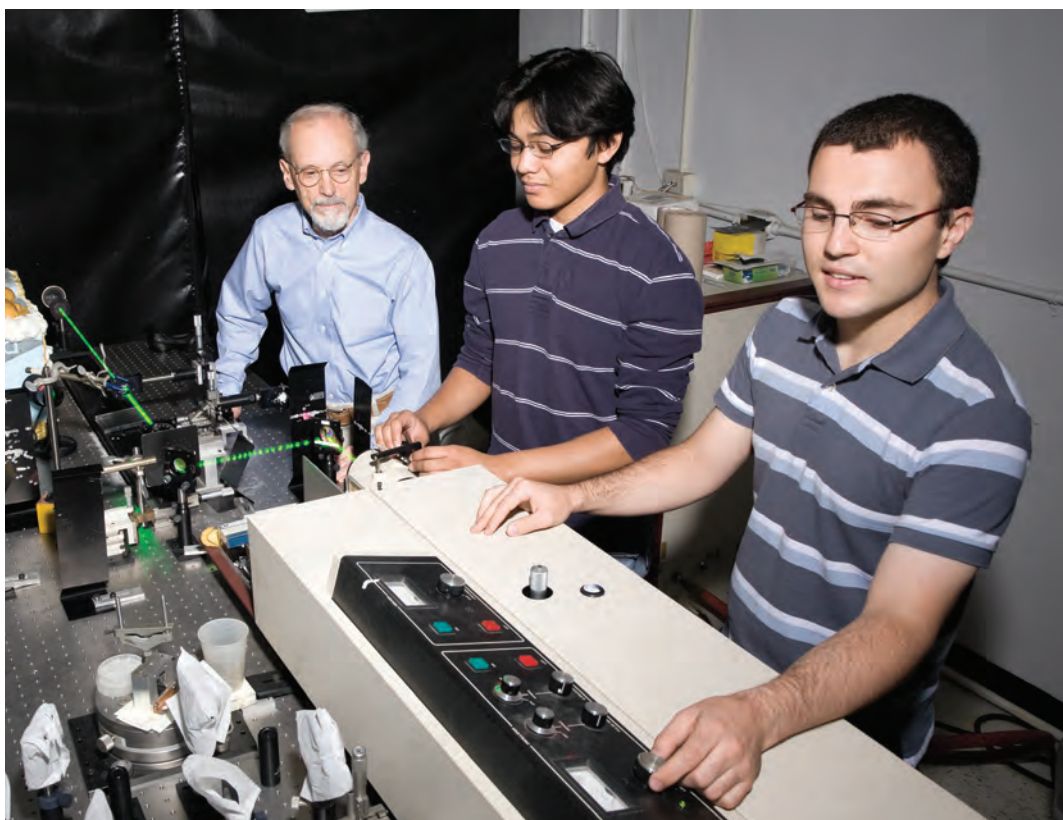
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NON-PHOTOCHEMICAL LASER-INDUCED NUCLEATION OF SUPER-COOLED GLACIAL ACETIC ACID

In 1996, Garetz *et al.* discovered that upon treatment with a high-powered infrared laser, super-saturated solutions of glycine and urea would nucleate; nucleation is the very first step of crystallization/freezing. This was named *non-photochemical* laser-induced nucleation (NPLIN), as the process did not involve absorption of the laser light. It was hypothesized that the optical Kerr effect—alignment of molecules along the direction of the electrical vector of the laser light—is the main mechanism of NPLIN. Since then, multiple studies of the effect of NPLIN on super-saturated solutions have been performed and NPLIN was proven possible even in super-cooled solutions of potassium acetate and glacial acetic acid. However, the NPLIN mechanism is still unclear.

Previous experiments have shown that certain molecular compounds, such as water and phenyl salicylate, could not be induced to nucleate with a high-powered laser beam. Since super-cooled glacial acetic acid (GAA) was successfully induced to nucleate, GAA was chosen as a suitable substance to study the NPLIN mechanism in more detail. The stability of 1 mL GAA samples was tested for various degrees of super-cooling. It was also found that super-cooled GAA can be nucleated using a 532 nm laser beam. This was followed by a study of the relationship between the degree of super-cooling and the laser intensity required to induce nucleation. Future research will focus on obtaining x-ray crystallography data in order to determine whether laser exposure and/or varying the polarization of the laser light can lead to novel GAA polymorphs.



Radu Iliescu and Arthur Dysart with Professor Garetz are studying the effects of non-photochemical laser-induced nucleation on super saturated solutions.



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EFFECTS OF ALPHA-SYNUCLEIN VARIANTS ON BETA LACTAMASE ENZYME ACTIVITY

Alpha-synuclein is a well-known heat-resistant protein that does not aggregate upon heat treatment. It is made up of three distinct regions totaling up to 140 residues: a N-terminus hydrophobic region (res. 1-60), an amyloidogenic NAC region (res. 61-95), and a highly negatively charged acidic C-terminus (res. 96-140) that is responsible for alpha-synuclein's chaperone effect. Mutations of alpha-synuclein were made at linker regions of the protein (res. 65-68) to possibly promote even further chaperone effects. The two linker variants used in these experiments were AS-PPGK and AS-YNGK. In order to test the chaperone effect of these varying proteins, the AS was co-incubated with the enzyme beta-lactamase (BLA) at different temperatures for varying durations. Using a UV-spectrophotometer and CENTA, a substrate typically employed to measure BLA's enzyme activity, data regarding the chaperone effects of AS were gathered. The desired effect of these experiments was to discover a certain mutation of the protein that could yield an even greater chaperone effect for BLA's enzyme activity that would typically diminish under harsh conditions. The results from the UV-spectrophotometer in addition to some data analysis led to a number of conclusions. The mutant of alpha-synuclein known as AS-YNGK produced results that actually caused BLA to denature more quickly under harsh conditions. As for AS and AS-PPGK, both yielded results which are expected from chaperone proteins, and while AS-PPGK appears to have a slightly higher effect than AS, the difference is not significant enough to conclude anything. Further data must be gathered by increasing the harsh conditions of incubation and analyzing the data further.



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USING AUTOMATED TIRF MICROSCOPY TO STUDY DNA HYBRIDIZATION

In recent scientific history, the study of DNA sequencing and DNA hybridization has allowed for the detection of genetic diseases, production of DNA-based treatments, as well as many other breakthroughs in molecular biology, agriculture and forensics. With these advances, it has become essential to develop efficient methods of studying DNA in limited supply.

The research being conducted here uses TIRF (Total Internal Reflection Fluorescence) microscopy to study the thermodynamics of DNA hybridization with limited samples of DNA. This method uses a surface immobilized target DNA sequence and a fluorescently labeled DNA probe in solution. The intensity level emitted by these specimens correlates to the level of hybridization. The fluorophores are excited by an evanescent electromagnetic field that results from the total internal reflection of a laser beam within a microscope slide containing the target DNA on its surface. The evanescent field decays exponentially as a function of distance away from the surface. This enables the selective fluorescence of hybridized DNA. By varying the temperature of the specimen, the measured intensity can be used to accumulate melting curve data.

To produce a melting curve, the temperature must be varied from 10°C to 70°C at a rate of between 0.1 to 0.3°C/min. This can result in a total experiment time of approximately 6 hours. In addition to this, the laser must be briefly activated (for~20 s) with every 1°C change in temperature during which time a photograph is taken of the sample. The laser is kept on only intermittently because exposure of the specimen to the laser for extended periods of time would result in an irreversible change in the fluorophores, rendering them non-fluorescent. This poses an inconvenience because it requires the constant attention of the experimenter and is an inefficient use of time.

To solve this issue, an automated system to control the experiment was designed and developed; thus, freeing the experimenter. The system uses LabVIEW as the programming language. It detects a specified change in temperature, at which point a signal is sent to a stepper motor that activates the laser. After waiting a short duration for the laser to stabilize, a photograph is taken. The laser is then deactivated and awaits the next temperature change. This automated system allows for a full experiment to be run with minimal supervision.

The next step for this research group is to implement the use of a nanovolume reaction cell. This consists of a device that can greatly reduce the volume of the solution allowing for increased concentration of DNA while using less sample. This can allow for a completely automated and efficient way to study limited amounts of DNA.



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ON THE USAGE OF PANI ELECTRODES FOR THE MONITORING OF THE DNA POLYMERASE REACTION WITH POTENTIAL APPLICATION TO SEQUENCING AND CLINICAL DIAGNOSTICS

The chain elongation reaction of DNA polymerase results in the release of a proton, and this release can be hypothetically measured to follow the progress and extent of reaction. It has been shown that using a polyaniline (PANI) electrode in a potentiometric measurement can be used for this purpose, but the resulting drop in pH causes enzyme action to cease. In order to overcome this problem, two preliminary immobilization schemes were designed. In one, the DNA polymerase is immobilized using the gluteraldehyde method, while in the other a primer with a C6-SH linker is immobilized using a electrochemical thiolation of the PANI. Thus, the system can simply be rinsed with the buffer without loss of enzyme or DNA. The former scheme can be used for DNA sequencing, while the latter can be incorporated into an assay to detect the presence of microbes by using species-specific primers. In order to test these functionalities, a suitable DNA fragment was needed, and this was selected to be a 14kb fragment from *Streptococcus mutans*. Thus, the *S. mutans* had to be cultured from a glycerol stock, and the DNA extracted, a time consuming process. With this complete, research on the potentiometric measurements themselves can commence.



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BETA AMYLOID FIBRIL IMMOBILIZATION AND ITS EFFECTS ON ENZYME KINETIC STABILITY

The beta amyloid in the Alzheimer's disease is well-known for its deteriorating effects on the brain when it loses its normal function due to aggregation. However, the fully aggregated form known as fibrils appear to have great potential as a nanomaterial due to its incredible thermal stability and strength comparable to that of spider silk, which is five times that of steel. The fibrils are stacks of anti-parallel beta sheets bonded together via extensive hydrogen bonding. One of its potentials lies within these bonds that may be able to immobilize enzymes that come in contact with it. Immobilization is popular within the biotech industry to improve enzyme stability thermally and kinetically, but with a chance of reducing activity initially.

In this project, beta amyloid fibrils were mixed with the enzyme TEM1-beta lactamase (BLA). In solution the fibrils interact with the BLA via unspecific non-covalent bonds. To obtain the fibrils needed for the experiment, beta amyloid was agitated for a week and checked by the use of fluorescence spectroscopy. The enzyme kinetics were studied by the use of enzyme assays to observe activity reduction under various temperatures and the Michaelis-Menten kinetics parameters were calculated.



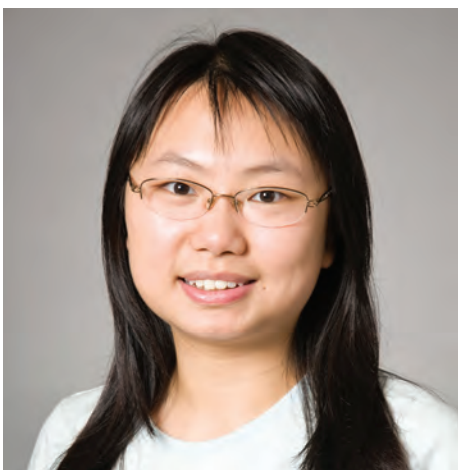
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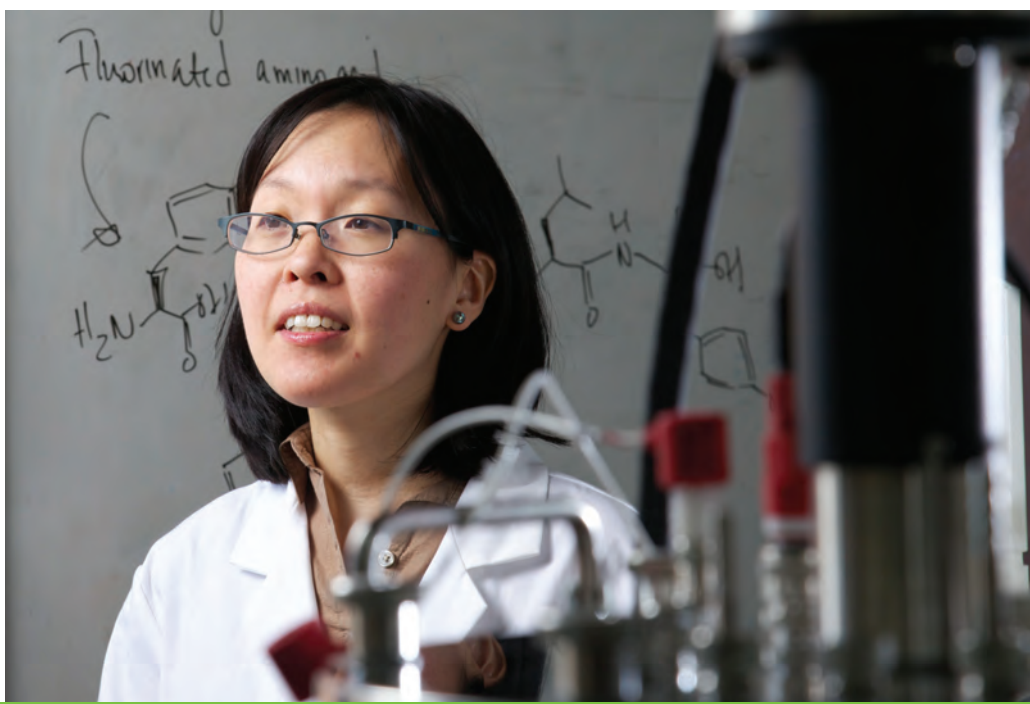
ENGINEERING ARTIFICIAL PROTEINS DERIVED FROM HISTONE ACETYLTRANSFERASE FOR CANCER TREATMENT

The histone code refers to patterns of post-translational modifications of histones that play a critical role in gene regulation. Histone acetyltransferases (HATs) catalyze the acetylation of histones on specific lysine residues. p300/CBP associated factor (PCAF) is a HAT that acetylates the histone substrate H3 as well as the tumor suppressor p53. Recently, this lab has found the incorporation of *para*-fluorophenylalanine (pFF) in PCAF (pFF-PCAF) leads to enhanced activity for p53, indicating the effectiveness of fluorinated residues in modulating substrate specificity of HATs for therapeutic applications. This research combines mutagenesis with unnatural amino acid (UAA) incorporation to synthesize a mutant of pFF-PCAF that can acetylate and activate the tumor suppressor p53 for therapeutic applications. Three variants of PCAF, V572A, C574L and Y612F, have been created based on homology alignment and biochemical data. The effects of residue-specific incorporation of pFF on the substrate specificity and structure of the mutants are assessed, with wild type PCAF being utilized as a control.

Fig. 1: Rendering of PCAF (blue) highlighted are the single mutations: V572A (Red), C574L (Yellow) and Y612F (Orange) and the phenylalanines (Green) (PDB. 1cm0).

SYNTHESIS OF PROTEIN SCAFFOLDS FOR CARTILAGE-TISSUE ENGINEERING

Cartilage tissue regeneration requires scaffolds that can specifically bind to and interact with the extracellular matrix (ECM) proteins on the surface of chondrocytes. Our goal is to generate scaffolds and to incorporate cell-binding motifs, argine-glycine-aspartic acid (RGD) repeats, for cell adhesion. We intend to design the scaffolds by using di- and tri- block co-polymers 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 aids in the formation of heterodimers. Upon mixing the block co-polymers highly cross-linked scaffolds may be generated by self-assembly. We have successfully incorporated RGD motifs in the block co-polymers, expressed in E. coli bacteria, purified the proteins, and performed secondary structure and stability analysis using circular dichroism (CD). Our future work will be to determine the secondary structure and stability using CD in the presence of small molecules such as vitamin D, all-trans retinol and curcumin. Once these proteins are successfully synthesized and characterized, they will be subjected to template chondrocyte cell growth and tissue regeneration.



Professor Jin K. Montclare



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PRODUCTION OF OLIGO (L-LYSINE) WITH NARROW DISPERSION BY PROTEASE CATALYZED OLIGOMERIZATION OF L-LYSINE METHYL ESTER DERIVATIVES IN AQUEOUS SOLUTION

Protease-catalyzed peptide synthesis can efficiently catalyze peptide bond forming reactions by proper manipulation of the physiological conditions of the reaction. This research project involved the protease-catalyzed synthesis of oligo(L-lys) from L-lys ethyl ester in an aqueous reaction medium at controlled pH using a pH-stat machine. Four proteases (papain, bromelain, α-chymotrypsin and trypsin) were studied to determine their activity for L-lys ethyl ester oligomerization at pH values ranging from 6 to 11. Bromelain was found to be preferred relative to the other protease catalysts since it gave the highest values of oligo(L-lys) yield and *DPavg*. To evaluate reaction progress and product structure, 1H-NMR and HPLC-UV-MS methods were developed. A series of model oligo(L-lys) compounds with chain lengths 2, 3 and 4 was obtained and analyzed in order to assign 1H-NMR signals. All components of the mixture were successfully resolved and analyzed by HPLC-UV-MS by ion-pairing reverse phase chromatography using heptafluorobutyric acid as the ion-pairing agent. Effects of medium pH, L-lys-Et concentration, bromelain concentration, reaction time and reaction temperature on oligo(L-lys) synthesis were evaluated. Oligomers with chain lengths more than 10 are formed within 5 min. By 30 min, the *DPavg* and longest oligomer chain lengths reached maximum values of ~3.6 and 12.0, respectively. Residual L-lys-Et was only 2% by 40 min. Products formed by 30 min remained relatively unchanged as the reaction was continued for 2.5 h.



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MODEL OF DRUG-RELEASE KINETICS USING LIPID-COATED ALGINATE BEADS

The oral route, despite being the most popular method of drug administration, is not sufficient for a number of drugs due to their susceptibility to digestive enzymes in the stomach and small intestine. Furthermore, the liver has been known to quickly metabolize these drugs before they can take effect, further contributing to the ineffectiveness of oral delivery. As a means of alleviating this dilemma, liposomes, known to improve the bio-availability of drugs drastically, have been developed over time to encapsulate a drug of interest and have it delivered to the targeted site unharmed from the hostile environment of the human body.

In this study, liposomes from granular lecithin are synthesized with the modification of an alginate gel core within for improved biocompatibility. Alginate is an anionic polysaccharide commonly used as a food additive due to its high stability and resistance to the gastrointestinal tract. Using the well-known ionotropic gelation method, 1 wt% sodium alginate is made and added to 5 wt% calcium chloride solution using a 1mL Sub-Q 26G 0.45mm x 16mm syringe, allowing the formation of a gel bead as a result of cross-linking with divalent calcium ions. FD&C Red No. 40, a commonly used water-soluble azo dye, is added to the alginate and allowed to diffuse out, thus providing a reasonable mock drug delivery system with the dye acting as the encapsulated drug of interest. Using a Shimazdu UV-3101PC Spectrophotometer, the dye release kinetics of both the plain alginate beads and the lipid-coated beads were measured. The results clearly show that liposomes entrapped with a polymer gel core can control drug release rate and can be a potential system for sustained drug delivery.



SUDEEP DEB

Chemical and Biological Engineering/2013

New York, United States
Sylhet Cadet College

Faculty
Richard Gross

NYU-Poly



SAMANTHA MURRAY

Biomolecular Science/2012

New Jersey, United States
Gloucester County Institute of Technology

Faculty
Kalle Levon

NYU-Poly

SYNTHESIS OF POLYESTER AMIDE FROM w-HYDROXYL FATTY ACID

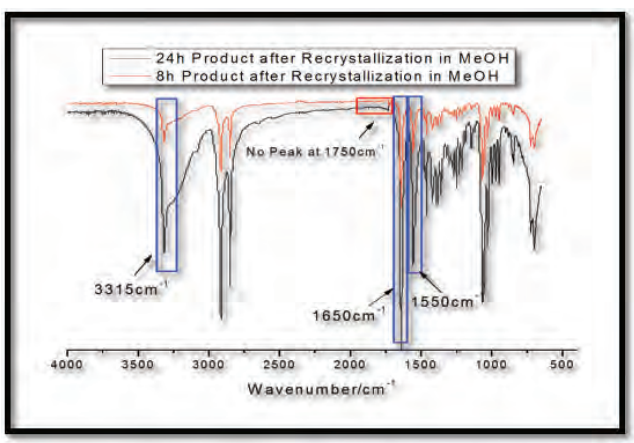
The synthesis of bio-based plastics is an important field of modern day academic research. Bio-based plastics are biodegradable and produced from natural resources such as biomass can decrease our dependency on petroleum and prevent environmental pollution. The bioplastic PEA (polyester amide) was produced reacting methyl w-hydroxyl fatty acid, a new monomer fermented from *Candida Tropicalis* strand DP428 with adipic acid in our laboratory. The first step was to produce monoamide diol from methyl w-hydroxyl fatty acid (MeC14) and ethanolamine and monitor the reaction result by IR. Once we had no pick at 1750 cm, we carried on the polymerization reaction of monoamide diol with adipic acid.

The polymerization reaction was taken place for duration of 6 hours with the presence of a catalyst named Titanium isopropoxide. The condition for the first 2 hours was 160°C in N_2 and the last 4 hours was 200°C in vacuum. PEA can be dissolved in both organic solvent $CHCl_3$ and THF. We used THF for GPC (Gel Permeable Chromatography) to figure out the molecular weight and PDI of the polymer. Then a technique called DSC (Differential Scanning Calorimetry) was used to analyze different thermal properties like melting point temp (T_m), crystallization temp (T_c) and glass transition temp (T_g) of the polymer. Now we are using different reaction conditions like varying temp, catalyst concentration to get the best product with better M_n , M_w and other thermal properties. The mechanical properties of the polymer will be measured in SUNY-Stony Brook University lab, which is collaborating with our research group.

CELL-BASED SENSING

Cell-based sensors contain living cells in order to determine cytotoxicity. These sensors can be used for rapid testing of drug toxicity and food/water contamination. Such biosensors could rapidly test toxicity in vivo or be used to test water purity in areas where testing facilities are not readily available. Current biosensors, however, lack the flexibility and biocompatibility to be implanted without yielding inflammatory responses.

The purpose of this research project is to create a highly sensitive, flexible and biocompatible sensor. Living cells carry a negative voltage across their cell membranes. In this project fibroblasts, a cell type found in connective tissue, was used. In culture, healthy, living cells secret collagen, which allows them to adhere to smooth surfaces. This phenomenon, however, reverses upon cell death, causing fibroblasts to detach. The fibroblasts' negative charge and ability to adhere to surfaces allows these cell-based sensors to detect cell viability. Based ON readings of past research, Polypyrrole (PPy) was selected as the polymer for this project. In order to allow the polymer to detect voltage, a dopant was added—in this case, Polystyrene Sulfonate (PSS). Potentiometry was used to measure the change in potential across the PPyPSS film. Potentiometry is a method that uses two electrodes—a reference electrode and a working electrode (in this case the PPyPSS film). This setup allows the detection of cells as they adhere to the surface of the working electrode and as they die and detach from the electrode. In the future, more sensitive conductive polymers will be studied as well as a way to miniaturize the setup.



Fun Group	WN/cm^{-1}
NH	3315
C=O (acid)	1750
C=O (amide)	1650
C-N	1550

IR result obtained after recrystallization of the monomer

Sudeep Deb's diagram on the synthesis of polyester amide from w-hydroxl fatty acid



NAVJOT SINGH

Biomolecular Science/2013

New York, United States
Benjamin N. Cardozo High School

Faculty
Jin K. Montclare

NYU-Poly

ENGINEERING SMART PROTEINS FOR DRUG DELIVERY

Inspired by nature, biomaterials comprised of two self-assembling domains (SADs) derived from Elastin (E) and the coiled-coil domain of the Cartilage Oligomeric Matrix Protein (C) were developed. With the objective of employing these biomaterials for drug delivery and tissue engineering, protein diblock polymer E_nC and CE_n libraries in which the E domain length is tuned from 4 to 1 repeat was generated. A a trend in the thermo-responsive behavior of the diblock polymer libraries was observed: as the E domain is shortened, the polymers exhibit an increase in inverse transition temperature (T_t). However the ranges of temperature change differ dramatically between the E_nC and CE_n library even though they are compositionally nearly identical. While all polymers assemble into nanoparticles, the bulk mechanical properties of the E_nC are very different than CE_n. The CE_n members are predominantly viscous at all temperatures while the E_nC members demonstrate more elastic character at room temperature and temperature above their T_t's. All library members demonstrate binding to the anticancer agent curcumin. The differential thermo-responsive behaviors of the E_nC and CE_n libraries make them suitable for potential use in biomedical applications.

Selecting the E_1C and CE_1 proteins, this research initiated experiments to template gold nanoparticles with the goal of producing an optical signal in response to temperature. The characterization and key properties of the protein materials are presented.



OLGA KRESTYANINOVA

Chemistry and Biomolecular Science/2015

New York, United States
North Rockland High School

Faculty
Richard Gross

NYU/NYU-Poly 3+2 Program

NEW ω-HYDROXYFATTY ACID BASED MATERIALS –(II), EFFECT OF MOLECULAR WEIGHT AND NANOCLAY ON PPDL

Poly (ω-pentadecalactone) (PPDL) with M_n=170000 was synthesized by enzyme catalyst at 85°C. Then PPDL was blended with an organically modified clay, Closite 30B with a weight ratio of 10% or lower wt/wt by melt/mix technique. The PPDL nanocomposites were characterized by Differential Scanning Calorimetry (DSC), Thermogravimetry Analysis (TGA), Dynamic Mechanical Thermal Analysis (DMTA), Wide Angle X-Ray Diffraction (WAXD), Scanning Electron Microscopy (SEM), and Tensile test respectively. DSC results indicate that organically modified clay can accelerate crystallization of PPDL during cooling and affect crystallization process, forming crystals with different patterns. XRD data show that some surfactants were eluted from the clay galleries during melting/mixing. During this process, intercalated structure of PPDL and clay was formed. TGA shows that organoclay can distinctly improve thermostability of PPDL, increasing onset decomposition temperature by 57.2°C. Results of DMA and tensile measurements verify that adding organoclay into PPDL matrix can improve the modulus of PPDL materials. Tensile experiments also indicate that adding appropriate amount of organoclay can improve the tenacity of PPDL. It was determined that 2% wt/wt content clay is the optimum choice for improving thermal stability and mechanical properties of PPDL polyester.



ANDRES FERNANDEZ

Electrical Engineering/2015

Spain
American School of Madrid

Faculty
Masoud Ghandehari

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JASON GLENN

Civil Engineering/2013

New York, United States
Holcomb High School- Holcomb, Kansas

Faculty
Masoud Ghandehari and Alexey Sidelev

NYU-Poly

CIVIL AND URBAN ENGINEERING

REMOTE SENSING

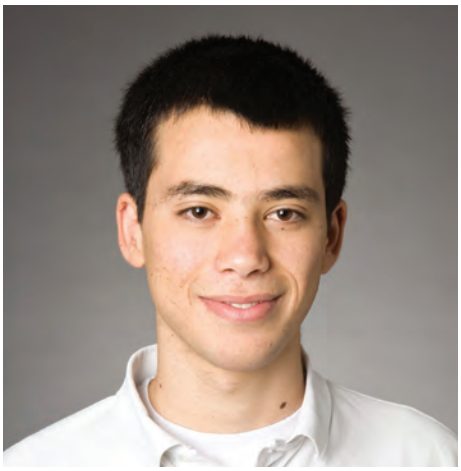
Desalination plants are utilized in areas where water is scarce, but have a large negative impact on the environment surrounding them. Desalination plants require large amounts of energy to desalinate the water and also return water with high amounts of salt back to the sea. When concentrated salt water is returned into the sea, the increased salinity significantly impacts the ecosystem, therefore compelling monitoring to recognize and prevent irreversible damage.

As the different levels of salt that a body of water has changes, the flow of the currents changes and thus affects land and water temperature. This change of temperature endangers some species. It is therefore important to have live monitoring systems to monitor the environmental conditions. Until very recently, salinity measurements were done manually with probes measuring conductivity which took long periods of time before being able to determine salinity in a large body of water. Recent technology has allowed for monitoring of sea surface salinity (SSS) in large areas via remote sensing. With the use of microwave radiometers and scatterometers, world salinity levels can be obtained within seven days. There are limitations to this technology however, since it can only detect surface salinity and measurements can be easily swayed by noise. Research has to be done in order to calibrate these remote sensing devices namely, that the results need to be compared to the results of other methods used to measure SSS with data provided by agencies like NASA, CONAE and ESA. With our own instruments, this research focuses on finding accurate monitoring methods in order to supervise the water near desalination plants in order to take care of our environment.

INFARED IMAGING OF SUBSURFACE CORROSION

The prevention and control of corrosion is one of the most important variables in the long-term integrity of steel structures. According to the Federal Highway Administration report, FHWA-RD-01-156, the total cost of corrosion to the U.S. economy is estimated to be 6% of GDP and 50% of structural failures are directly or indirectly associated with corrosion. While the bulk of studies on corrosion prevention focus on protective coatings, there is a need for greater quality control in the surface preparation and application of these coatings. Infrared imaging is a possible method of providing this quality control by allowing the detection of early onset corrosion beneath the surface of newly applied protective coatings.

This method of detection is made possible by the difference in thermal properties of steel, air and corrosion by-products. When imaging a surface that has been heated by either the sun or a heat lamp the differences in temperature recorded can be related to sub-surface corrosion or air pockets. In the case of a heat-lamp where the power input can be estimated, it is possible to determine the depth of the corrosion or air pocket by its corresponding difference in temperature relative to the surrounding area. Many factors such as the chemical composition of the corrosion and its density affect the accuracy of these determinations. Two important advantages of infrared imaging are the ability to image a surface without immediate contact and the possibility of comparing new images with retrieved images from previous observations. The focus of this research is to relate the behavior predicted by a theoretical model and the lab experiments while considering the more significant variables that contribute to the methods degree of accuracy.



SUHAIB MOHAIDAT

Civil Engineering/2015

Jordan
King's Academy

Faculty
Masoud Ghandehari

NYU Abu Dhabi



MICHELLE TSE

Civil Engineering/2013

New York, United States
Brooklyn Technical High School

Faculty
Masoud Ghandehari and Alexey Sidelev

NYU-Poly

SOLAR DICATHLON

Challenges in integrating solar energy into our daily lives unfortunately still exist. For the sake of promoting this valuable, unlimited, clean and reliable resource, the solar decathlon competition attracts many universities worldwide to compete in designing and building a zero-energy home, powered only by sunlight. The house is judged based on its architecture, engineering, affordability, home entertainment and energy balance. Each of these items has a designated score and the team that gets manages to keep track of these requirements wins.

The thermodynamics of the house is critical to the project because the aim is to obtain an optimum temperature in which a comfort zone is achieved inside the house as well as minimizing the energy consumption in processes of heating and cooling which are usually major consuming factors in buildings. Since concrete is going to be used in building the house, introducing Phase-Shift materials to the project was crucial since it regulates the heat flow across concrete. The mechanism behind this material is based on the fact that any material below its melting point tends to release energy, while when above its melting point, it absorbs energy. PCMs have a melting point close to the comfort zone (23°C) therefore when the temperature is considerably hot (above 23°C), energy is absorbed. As a result the house is cooled down and brings the temperature back to the comfort zone. While when the temperature is considerably cold, the PCM releases energy back into the system driving the temperature up back to the comfort zone. As a result, energy balance is achieved, as it is a vital element in the judging process of the house during the competition.

FIBER OPTIC MOISTURE SENSORS FOR CEMENT CURE MONITORING

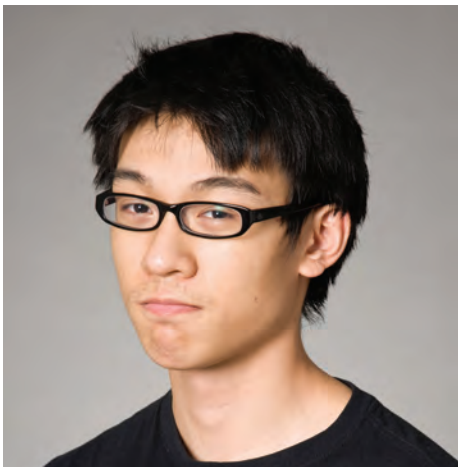
Proper cement hydration in concrete is integral to its strength and durability. Cement hydration is the chemical reaction between the silicate and aluminate minerals in cement with water to form concrete. The inappropriate amount of moisture content can prevent concrete from developing to its full strength and lead to deterioration in concrete structures. Additionally, excessive water leads to large porosity and voids that can result in shrinkage problems. However, insufficient amount of water can delay the hydration process. Traditional methods of using electrodes for moisture level monitoring present several disadvantages; for instance, they produce electromagnetic interference, are relatively costly and require long term maintenance. Thus, fiber optic sensors with a sol gel coating are being introduced as a more viable option. These sensors are inexpensive and more durable compared to traditional electrode monitoring. Fiber optic sensors are immune to electromagnetic interference, will not degrade during pouring or curing, and are chemically non-reactive with the cement making them suitable for the harsh environment present in the concrete.

Following fabrication and sol-gel coating, the sensors were calibrated in water to achieve the initial absorbance spectrum and response time. The sensor was then embedded in fresh concrete allowing for real-time monitoring of moisture levels during the curing process. After curing and the evaporation of moisture, the specimen was immersed in water to verify proper sensor response. The goal of this research is to verify the response and durability of the fiber optic sensors allowing for the monitoring of moisture levels during the curing process and throughout the life of the concrete structure.



Professor Gandahari with his students

COMPUTER SCIENCE AND ENGINEERING



DEREK CHEN

Computer Science and Engineering/2016

New York, United States
Hunter College High School

Faculty
Claudio Silva

NYU / NYU-Poly (3+2 Program)

CREATING VISUALIZATIONS WITH DEFOG

When working with sets of data, it can often be difficult to interpret collected information in a meaningful way just by inspecting the numbers. Using visualizations can be crucial to a better understanding of the data and may expose new pathways for exploration. They can also be invaluable for presenting results in a manner that is simple for viewers to follow, in addition to supplementing analysis. Having a tool to experiment with multiple visualizations and manipulate data effectively can be essential to smoothly and quickly navigating through information. Defog is a program that can facilitate this exploration of data, while supporting the means to present and explain findings as well. It provides an environment where different forms of data can be accessed and traversed, and multiple visualizations can coexist on a single canvas.

In implementing different visualizations, one must consider how best to make the user's experience as minimally time consuming as possible. This includes providing better defaults that will allow a user to easily create a presentable visualization, customize graphs or more intuitively handle data. Options like tag clouds or heat maps can uncover details lost by merely plotting points, which helps to illuminate new aspects of the data. Suggestive prompts to determine better choices for visualizations and interactive features can further aid with data exploration. Combining such tools can enhance data analysis in almost any field of study.



DAMIAN "π" LANNINGHAM

Computer Science/2015

Florida, United States
Forest Hill Community High School

Faculty
John Iacono

NYU-Poly

REPLICATION OF GENUS 0-SHAPES VIA WANG TILES

A popular model of self-assembly is the system known as Wang Tiles, wherein tiles "bond" and come together into larger superstructure via simple rules. The research herein primarily deals with a new method of arbitrary replication of genus-0 two dimensional shapes using wang tiles, which is unique in that it shows promise for extension into a similar, three dimensional replication system. A set of tiles with O(1) glue complexity and O(log(n)) tile complexity were developed which achieve replication by "walking" along the outside of the object in discrete, separable chunks. This system can then be extended to a system in which the faces of a three dimensional object are traversed in a similar fashion, and will be the subject of future research.



LEONARD LAW

Computer Science/2014

New York, United States
Thomas A. Edison Career and Technical High School

Faculty
Justin Cappos

NYU-Poly

CRITERION-BASED SELECTION OF VIRTUAL MACHINES

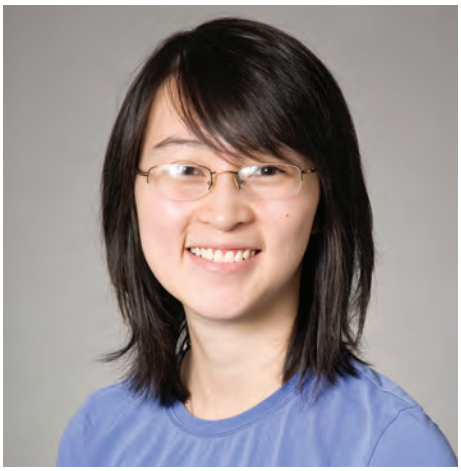
Seattle is a global network of virtual machines (vessels) that are easily accessible by anyone. It is used in networking and distributed systems research, as well as educating students in existing networking technologies. These vessels run on various platforms, consisting of end user computers, computers in research facilities, and portable devices. Currently, Seattle only allows users to acquire vessels from three categories: NAT, LAN and WAN. This project created and integrated the SeleXor project, an extension for Seattle that allows users to acquire vessels based on additional criteria that are more relevant to users.

There are two classifications of criterion (rules) that users may specify: vessel-level and group-level. Vessel-level rules only need information readily accessible on a vessel, such as a vessel's geographical location, its uptime, its IP subnet, or the number of times its IP address has changed. Group-level rules are dependent on the contents of the group, including the average latency, the distance between each vessel, and the number of different locations that the vessels are from. The contents of a group will be different every time these rules are run, which in turn cause the pool of good vessels to vary in a non-deterministic manner between iterations.

As it is possible for the selection process to continue indefinitely, the number of retries that each request can have is limited. Vessel-level rules are first applied to remove vessels that are guaranteed not applicable to the request. This lowers the number of combinations of vessels that can satisfy the request, increasing the probability that the request can be processed successfully within the allowed number of retries. Further work needs to be done in finding a search algorithm that can perform faster than the current algorithm, ideally with a higher rate of success.



Derek Chen, Feng Shu and Professor Claudio Silva create large-image acquisition and visualization.



KATHY OU

Computer Science/2014

New York, United States
The Bronx High School of Science

Faculty
Justin Cappos

NYU-Poly

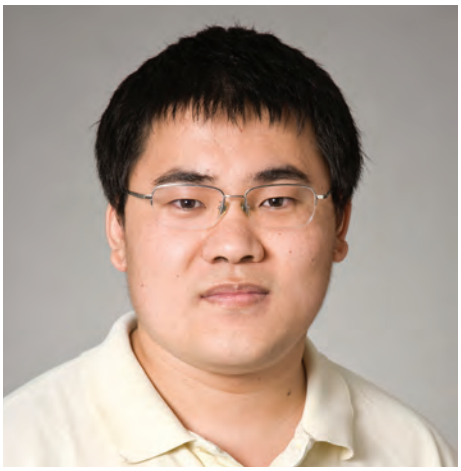
SEATTLE

Seattle is an open source platform that displays the power of Cloud Computing for research on networking and distributed systems. The project operates on worldwide donations of computer resources, such as CPU, memory, and network bandwidth, which can be shared or obtained by users for their own projects. Seattle is currently being used in classrooms and by researchers to test code or project prototypes in different environments, such as different operating systems, to study the characteristics of the internet or for other educational purposes. It has currently already been installed on approximately 1,000 machines worldwide and supports multiple platforms including Linux, UNIX, and Windows. To ensure the privacy and safety of these computer users, programs that are tested on a computer are sandboxed to limit the consumption of the available resources, to prevent users from attacking the computer, and to minimize the impact on the system security and performance of the compute

One of the goals of this project to improve on Seash, which is the experiment manager used in Seattle to control the programs running within the sandboxes, by handling bugs and adding new features for the users. Another goal is to create new installers for each of the supported operating systems, especially UNIX and Windows, to make the installation of Seattle more appealing to the users of those systems. However, along with providing users with a way to install the necessary files for Seattle, the installers must also determine the amount of resources that can be donated by the computers that are installing Seattle.



Professor Justin Cappos



FENG ZHU

Computer Science/2013

Pennsylvania, United States
Lower Merion High School

Faculty
Claudio Silva and Huy Vo

NYU-Poly

LARGE-IMAGE ACQUISITION AND VISUALIZATION

For large-image acquisition, GigaPan is used. It was developed by Carnegie Mellon University in collaboration with NASA Ames Intelligent Robotics Group, with support from Google. Using GigaPan EPIC Pro, it is easy to capture incredible high-resolution images. After hundreds or thousands of photos are taken, GigaPan Stitch software is used to combine these photos into one amazing gigapixel panorama. This gigapixel panorama may be uploaded to gigapan.com to have a full view or save as an image file on a local computer.

Some of the gigapixel panoramas will be gigabytes or even terabytes. It is impossible to fit the image data into the main memory of a computer. As a result, an out-of-core algorithm has to be developed to convert large images to the streaming format so that it can be shown on the display wall. This out-of-core algorithm has to be efficient because of the non-uniform memory structure of modern computers (e.g. L1/L2 cache, main memory, hard disks, etc). The access time to each memory cell is dependent on its memory location. Because of the non-uniform memory structure, 2D Z-order (Lebesque) space filling curve is used in this out-of-core algorithm. Lebesque space filling curve has a hierarchical fractal structure and its well-known spatial locality properties. In addition, the image is read in chunks because of the limited size of main memory. In this way, it is much more efficient to streaming the data out-of-core.

ELECTRICAL AND COMPUTER ENGINEERING



STANLEY CHEN

Electrical and Computer Engineering/2014

New York, United States
Stuyvesant High School

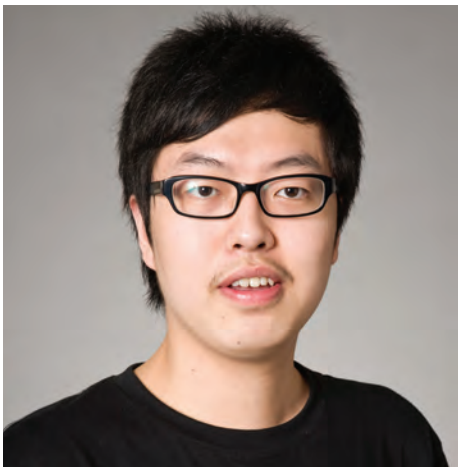
Faculty
Yang Xu

NYU-Poly

HIGH-SPEED PACKET PROCESSING IN SWITCHES/ROUTERS: STUDY OF COMPRESSION TOOLS

As more and more Internet enabled devices becomes available, internet usage has increased a great deal. Bandwidth has become a scarce resource and the trend of compressing the data before sending or receiving becomes a standard. As this provides a better speed on data transfers, it also increases the time it takes to scan a file for malicious software. Since the file is in a compressed state at transfer, it has to be decompressed first before processing. This shows a need to find a way to scan the file in the compressed state. But before doing that, an understanding of the different compression methods is needed.

The purpose of this research is to understand and compare different compression tools such as gzip and sdch. This research has considered the compression tool gzip, a compression method that is free and widely used. It uses the deflate algorithm, a combination of LZ77 and Huffman coding, to compress the data. LZ77 is an algorithm that replaced repeated strings in to pointer pair of length and distance and Huffman coding is a process that generates a code of bits for the literal bytes using a Huffman tree. This is just a start and the research could go on to study more compression methods such as the sdch compression that is used by Google.



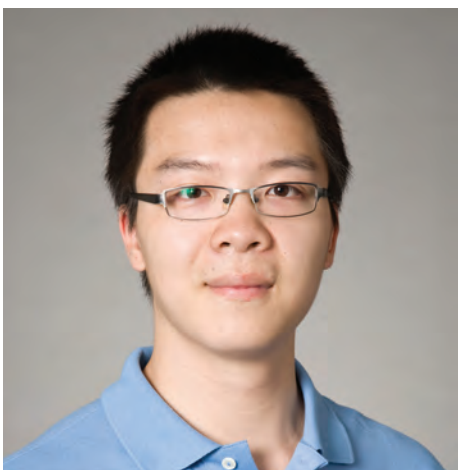
JIN LIU

Computer Science/2013

China
Tian Chang High School

Faculty
Kang Xi and Jonathan Chao

NYU-Poly



CHI ZHANG

Electrical Engineering/2013

China
Huipu High School

Faculty
Kang Xi and Jonathan Chao

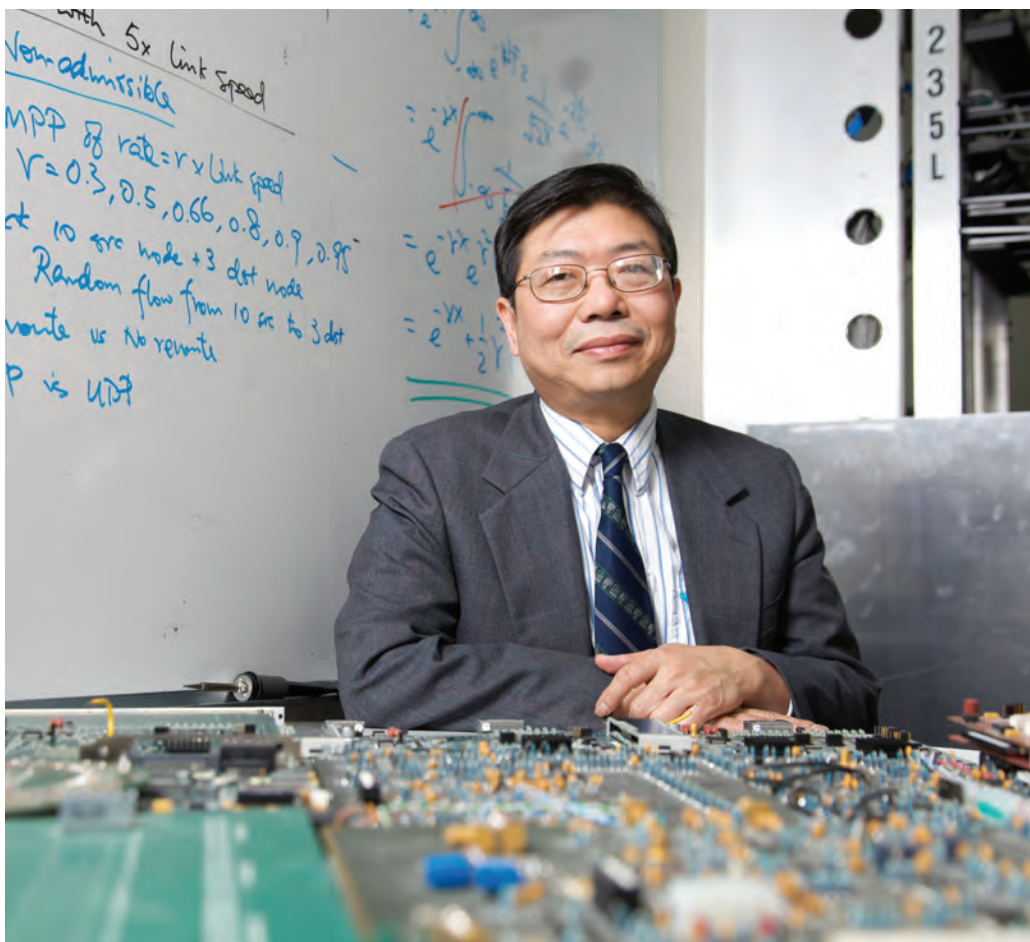
NYU-Poly

RECOVERY FROM SHARED RISK LINK GROUP FAILURES USING IP FAST REROUTE

Failures are common and unavoidable in today's computer networks. Statistics show that failures, caused by maintenance activities, router-related and optical layer problems, occur quite frequently even in well-managed backbones. A connection error of YouTube might ruin the user experience. What's worse, failures may happen in the networks of NASDAQ, which could cause a tremendous loss. A fast recovery technique is needed.

IP Fast Reroute is an emerging technology trying to rapidly repair failure conditions in Internet Protocol (IP) networks. The routers that are the neighbors of the failure repair the failure. These repairing routers have to steer packets to their destinations. In IP over wavelength division multiplexing (WDM) architecture, the logical IP topology is built on top of the physical networks. A failure on the physical level can result in multiple simultaneous logical link failures. These logical links are called a shared risk link group (SRLG).

This project studies how to achieve fast recovery from SRLG failures in IP layer. A scheme called multi-section shortest path first (MSSPF) is proposed by Professor Xi. This technique uses the idea of IP Fast Reroute. The reroute calculation is performed by each router before any failure occurs. So MSSPF can route packets around failed links using IP-in-IP tunnels without route calculation on the fly. The previous works show the MSSPF guarantees 100% recovery of SRLG failures. The current work is focused on applying MSSPF to practical network topologies.



Professor Jonathan Chao



BRIAN CAIRL

Electrical Engineering/2014

New York, United States
Walt Whitman

Faculty
Farshad Khorrami

NYU-Poly

A RUGGED QUADRUPED PLATFORM FOR ALL-TERRAIN NAVIGATION

This project involves the development and integration of a rugged legged robotic platform, encompassing both its mechanical and electrical subsystems of its design. The robot is a sensor-rich, quadrupedal platform capable of overcoming rough terrain environments. In its post-development stages, this platform will be applied to the design of rugged-terrain navigation algorithms incorporating mapping; dynamic gaiting; and stability features. Key features of the design include a 16 degree of freedom (DOF) joint configuration, with 4 DOF per legs; a medium range scanning laser distance sensor; high definition cameras; joint position, velocity and load sensing; an integrated inertial measurement unit; and a multi-processor configuration (1-GHz processor, as well as a 60-MHz and 16-MHz auxiliary processing units). The platform will allow up to two hours of operation via 20 amp-hour Lithium-Polymer batteries. The platform will also include remote control takeover capabilities with a line-of-sight control range of up to one mile; dedicated safety monitoring and emergency shutdown measures; and an implementation of the Robot Operating System. A simulation platform; a high-level application programming interface; and several monitoring and control interfaces are being developed to facilitate faster open-ended development and multiple modes of hardware control.



FAHD IQBAL

Electrical and Computer Engineering/2013

New York, United States
Al Nahda National School

Faculty
N. Sertac Artan

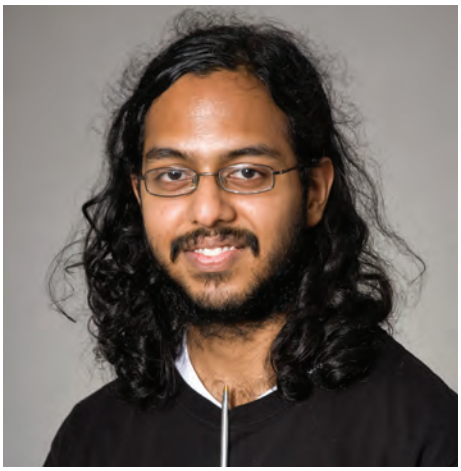
NYU-Poly

SEIZURE DETECTION USING NON-LINEAR ENERGY OPERATOR

Epilepsy is among the most common neurological disorders. It is characterized by spontaneous and recurrent malfunction of the brain that manifests as seizure. Approximately 1% of the world's population has epilepsy, and up to 5% of people have at least one seizure during their lifetime. An electroencephalogram (EEG) is a record of electrical potential resulting from ionic current flow within nerve cells. When a seizure occurs, action potentials are generated as neurons fire. These neuronal firings are seen as sharp-pointed spikes on an EEG recording.

At the on-set of a seizure brain activity is intensified and becomes sporadic, resulting unpredictable high amplitude spikes on an EEG recording. If these spikes can be detected with high accuracy, we will know when a seizure occurs. In this project, the goal is to study the performance of a spike detection algorithm known as Non-linear Energy Operator (NEO).

NEO is a technique used to detect spikes when signal-to-noise ratio (SNR) is very low. Output of NEO is proportional to the product of the instantaneous amplitude and frequency of the input signal. NEO was implemented on a 10 min EEG recording containing 5092 spikes. A predetermined threshold of 800 was used to calculate false positive and false negative ratios and evaluate the algorithm's performance. A key variable in spike detection is the threshold value and as there is no hard-and-fast rule to find the best threshold, values from 700 to 1500 with step value 50 were used to calculate the corresponding false negative and false positive ratios. Results suggest that NEO not only has high efficacy for accurate seizure detection but also requires less computational power compared to its counter parts, making it a possible candidate for seizure detection implants in the brain.



ABHIMANYU GHOSH

Mechanical Engineering/Computer Engineering/2015

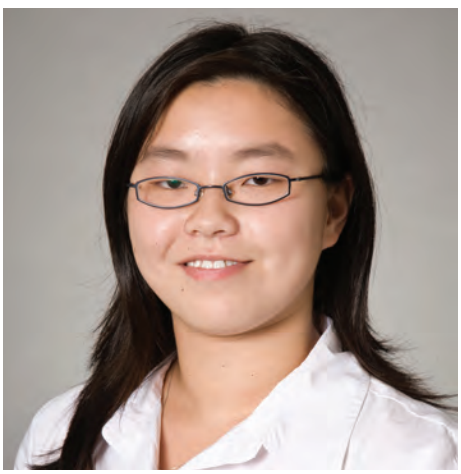
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Faculty
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DEVELOPMENT OF A SENSOR FUSION ALGORITHM FOR ATTITUDE AND RATE DETERMINATION

The primary objective of this project is to develop a sensor fusion algorithm that takes inputs from an array of sensors, and combines them to produce the best possible estimate of the current attitude of a vehicle. The sensors used in this implementation are a three-axis accelerometer, gyroscope and electronic compass. Together, the sensors form an Attitude Heading Reference System, similar to the "artificial horizon" used on aircraft, submarines, and space vehicles. A major challenge of such a system is the fact that most consumer-grade inertial sensors have their own drift and noise characteristics. Accelerometers, for example, generate relatively noisy data, but their readings tend to average out to zero over the long term. Gyroscopes are not as noisy, but due to the fact that their output must be integrated, drift slowly over the long term. Various methods exist to combat these issues, with Kalman Filters being a popular choice. Kalman filters rely on a "predict-update" cycle, where the filter generates a prediction of the next state of a system, using a model, and subsequently "updates" the state, using actual data from the sensors. The errors between the predicted and actual states are then taken into account when computing the weights given to the inputs of the filter. The primary application of this system will be in autonomous vehicles. However, use of low-cost inertial sensors also makes it possible to generate orientation and position data over a short term in GPS-denied environments (tunnels, combat zones), enabling both military and civilian (search and rescue operations) applications as well as for use in game consoles and cellphones.



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CREATING A SIMULATOR OF A FLEXIBLE ELECTRODE ARRAY

An electrode array was created to be placed on the surface of the brain to observe the brain signals that occur during a seizure. The current electrode array used in surgery is usable but has some faults. The electrodes are attached to a rubbery base that is as thick as a credit card. The electrodes are widely spaced which means that the array have low resolution interface with the brain. The other problem is how each passive sensor at the electrode-tissue interface requires its own wire. However, new research is being performed to improve the electrode array. A group of researchers developed a new high-density, flexible electrode array. The new electrode array incorporates ultrathin, flexible silicon nanomembrane transistors that enable amplification and multiplexing on the array. More sensors can be placed in the same amount of space as the old electrode array so it allows higher resolution interface with the brain while requiring fewer wires (thousands of sensors only need tens of wires).

A simulator of the flexible electrode array is currently in the progress of being made. The purpose of the simulator is to reliably simulate the array and to test the data acquisition system. The printed circuit board (PCB) is being built by using the softwares, OrCAD Capture and PCB Editor. OrCAD Capture is used to build the circuit of the electrode array while PCB Editor is used to determine the placement and connection of the circuit components.



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HIGH-SPEED PACKET INSPECTION ON COMPRESSED HTTP TRAFFIC

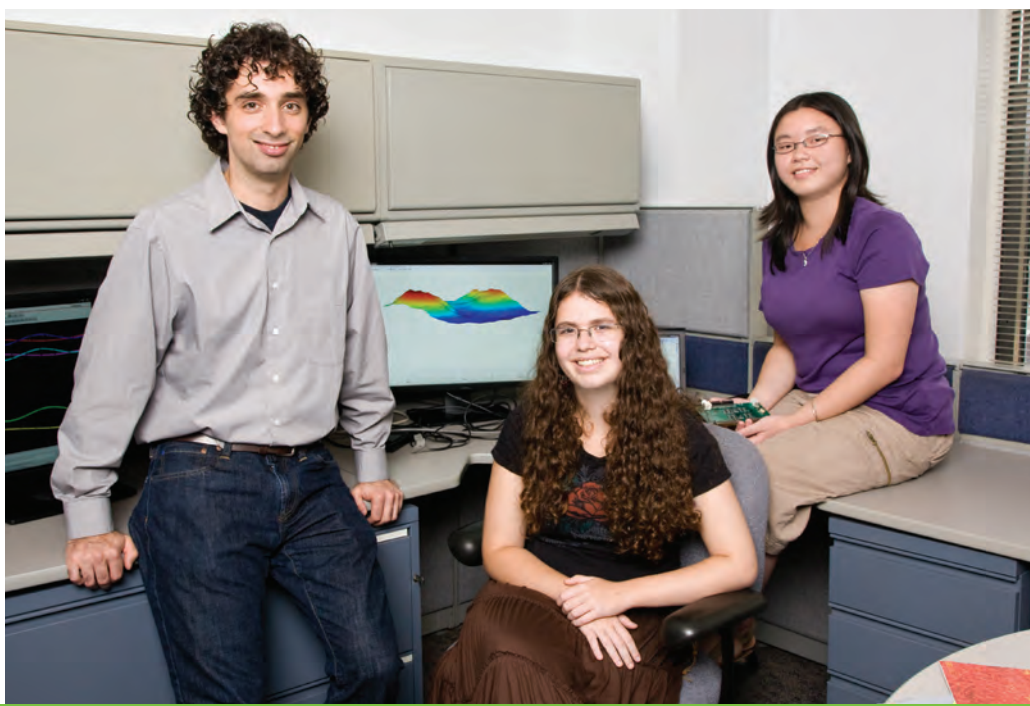
Deep Packet Inspection uses pattern matching algorithms to inspect compressed traffic, where exists predefined criteria to determine if the payload, actual data, of a packet should be passed, dropped, or re-routed. Packets are small pieces of data sent from network to network. The amount of compressed traffic throughout the Internet traffic is constantly increasing. Thus, to speed up the process of inspection on compressed traffic, Google introduced a new algorithm called SDCH, Shared Dictionary Compression over HTTP. SDCH is an algorithm that takes advantages an inter-response redundancy, where plethora of common data is shared among several pages. With compression methods like inter-file, a shared dictionary can be referenced by many files. The shared dictionary contains data that are common to these files and delta files are the differences.

A pattern matching algorithm that inspects SDCH-compressed traffic without decompression of the traffic was developed into two phases: offline phase and online phase. The offline phase starts with the scanning of the dictionary for patterns with a string matching algorithm, Aho-Corasick. Delta files are then scanned in the online phase, where references to the common strings in the dictionary is scanned once. Thus, inspection performance was improved in comparison to decompressing the traffic before inspecting it.

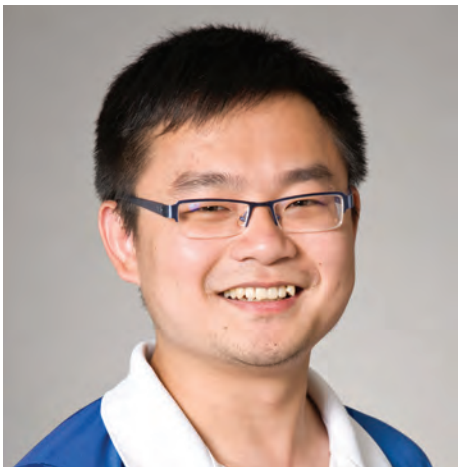
The trend of many sites compressing their traffic in recent years proved that Decompression-Free Inspection is essential for better performances. An important task ahead deals with the speed or the algorithm used to inspect the decompressed traffic. At the same time, seek improvements to the algorithm.

SPATIAL AND TEMPORAL TRACKING OF EPILEPTIC SEIZURE ACTIVITY

Previous studies of epileptic activity have identified a characteristic spiral waveform that propagates across the cortex during seizures. A quantitative analysis of the neural dynamics of a feline electrographic seizure recorded by a 360-channel electrode array is presented. A threshold of 0.001 volts was used to isolate the spike waveforms. Although seizure activity is largely chaotic, when the coordinates of the center of the waveforms are examined over time, simple, regular patterns of position and velocity are revealed. The y center position exhibits periodic motion that loosely fits a $|\cos(t)|$ curve, while the x position changes linearly, with steady velocities during each event, which vary from 14 to 52 cm per second. The ability to precisely track seizure activity is critical to develop feedback control devices that deliver targeted stimulation to treat epilepsy.



Nicole Rivilis and Helen Huang with Professor John Viventi use spatial temporal tracking to identify epileptic activity.



KUANG ZHANG

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MODELING, COMPUTATION AND MEASUREMENT OF THE MAXIMUM TRANSFORMER INRUSH CURRENTS: THE PHASE-HOP TEST

Inrush current is a phenomenon that occurs because the AC source voltage may drive the flux in the transformer to build up to a maximum theoretical value of twice the steady-state flux plus any residual flux. Usually, the maximum value of inrush current occurs when the transformer is energized at the moment when the AC source voltage is zero, known as "zero-crossing." Some negative effects of high inrush current include the faulty trigger of circuit protection and damage to the transformer and other devices. In order to minimize those negative effects, the worst-case scenario needs to be modeled in order to measure the maximum inrush current.

The phase-hop test is to have a voltage at zero-crossing on the transformer and disconnect AC source only between the two upcoming zero-crossings. To perform the test, three zero-crossings need to be detected and then acted upon accordingly. A combined switch of zero-crossing and phase-hop based on digital logic was designed and built during this research project. However, due to the delay of hardware and the remanance of the transformer, test result has some discrepancies compared to theoretical values. A digital signal processing circuit (DSP) is used to compensate for the delay. As for reducing the remanance in the transformer, a demagnetizer based on a microcontroller was designed and built.

By combining a demagnetizer with DSP phase-hop switch, a more precise maximum inrush current will be generated and measured. Based on those experiments, more reliable components can be designed to increase power network performance.



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PATRICK LIN

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MATHEMATICS

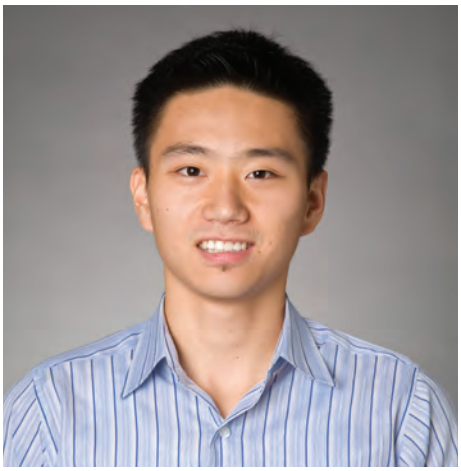
LANGUAGE DETECTION USING THE MAHALANOBIS-TAGUCHI SYSTEM

The field of Natural Language Processing (NLP) within Computer Science involves computational processing of human languages. One of the challenges in NLP deals with language identification: for example, if a computer were given a string of text, the task would then be to identify what language the string of text comes from. The Mahalanobis-Taguchi System (MTS) is a multivariate pattern recognition method that, for NLP, can be used to find variables that separate one language from another, and then, using a system of orthogonal arrays, determines which variables contribute the most to the separation.

For this project, the application of MTS in a simplified model is investigated. The languages tested are limited to English, Spanish, French, Italian, and German. By analyzing characteristics of each language, different sets of variables are found that effectively separate one language from another. The variables used are instances of substrings, normalized by string length: for example, “instances of ‘ing’ at the end of a word.” Sets of variables are found for “English vs. Spanish”, “English vs. French”, “Spanish vs. French”, etc. MTS calls for as few variables as possible, with a sample size of 30 samples per variable; the sets have an average of 15 variables, thus, 500 string samples are used for each set. After optimizing variables, the system can then use the results of previous tests in another Mahalanobis-Taguchi test to determine the actual language of the string. If successful, this application of MTS can then be adapted to a greater variety of languages.



Patrick Lin uses the Mahalanobis-Taguchi System to find pattern recognition between each language.



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MECHANICAL AND AEROSPACE ENGINEERING

FEATURE INTERACTION DETECTION AND RESOLUTION IN HIGHLY COMPLEX ENGINEERED SYSTEMS: APPLICATIONS IN AUTOMOTIVE SAFETY SYSTEMS

In the past decades the number and complexity of advanced features, such as adaptive cruise control, collision avoidance and electronic stability control, implemented in automobiles as distributed embedded control systems, has increased dramatically. A modern luxury automobile today includes approximately 100 million lines of software code distributed across 70-100 microprocessor-based electronic control units [1]. The current industrial practice for the verification and design of such complex systems is based on extensive system-level simulation and testing and on heuristic and "ad hoc" methods employed separately on various subsystems. When features, developed and tested separately, are integrated into a complex system, potential conflicts can arise (feature interaction problem) [2] because the logic employed by these individual systems may interact unexpectedly. For example, having from two different features simultaneous requests to apply to the same mechanical system (e.g. throttle, braking or steering) in a given situation, can create contradictory physical forces and prevent the desired behavior. Current industrial practice, then, needs novel techniques and tools to guarantee correctness and system performance of features interacting in the highly interlinked automotive system.

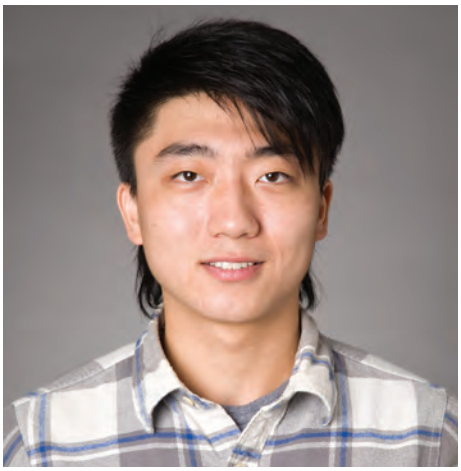
Our goal is to develop formal techniques for the design and verification of model-based automotive control systems using a system engineering approach based on properties of dynamical systems (stability, passivity, etc.). In this work, we present a preliminary study of the effects (feature interaction detection) produced on the vehicle dynamics by undesired interactions between two automotive active safety features: the yaw stability control, which tries to track a given vehicle yaw rate profile, and the electronic stability control, which limits the vehicle body sideslip angle. Both the features can request a steering control input to the steering system. However, in some driving and road surface conditions and under some driver steering inputs, the two features interact creating undesired oscillations in the vehicle dynamics.

A simple planar bicycle model with linear tires is used to describe the vehicle in this study. After designing separately the two controllers using a state feedback approach, we present the analysis of the effects of their interactions under different driving scenarios and external driver inputs through numerical simulations in Matlab/Simulink and CarSim. Further investigations of this research will address the design of a supervisor switching controller that prevents and mitigates the effects of the undesired behavior (feature interaction resolution).

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YINAI FAN

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AN OPTIMAL CONTROL FOR A NOVEL ANTI-BRAKING SYSTEM BASED ON THE VEHICLE DYNAMIC LOAD TRANSFER EFFECTS FOR REDUCING THE STOPPING DISTANCE

The anti-lock braking system (ABS) is one of the most important and common vehicle active safety systems present in modern passenger cars. Its goal is to assist drivers in maintaining vehicle steering control under heavy braking and preventing wheels from locking during an emergency stop or on slippery surfaces and, in most situations, in shortening braking distances [1-2]. Recently, Consumer Report (CR) rated the ABS stopping distance as the most important factor for Accident Avoidance. The CR rating, which can influence the customer's choice, has renewed the interest of automotive companies in ABS technology enhancement and in current ABS stopping distance quantitative characterization. By answering the question "How can optimal ABS braking distance be achieved?" our work provides a reference for ABS stopping distance performance through optimal control strategies.

In contrast with the current standard practice which considers steady-state static tire models for ABS control design, we propose a novel electronic braking optimal control, based on dynamic and transient factors between the tire/wheel and the vehicle, for a four in-wheel motor electric vehicle. In particular, to improve the ABS braking stopping distance performance, in this study we take advantage of the load transfer effect between the tire/wheel and the vehicle systems. A longitudinal vehicle model with nonlinear tires and vehicle dynamic load transfer is, then, considered. To minimize the ABS braking stopping distance we solve an optimal control problem, which consists in finding a sequence of optimal voltage control profiles in each wheel motor driver (an then optimal braking torque control profiles for each wheel) that minimizes the traveled distance. The numerical global optimal solution is obtained through the nonlinear dynamic programming (DP) [3] based on the Bellman's Optimality Principle. The dynamic programming approach is very resource intensive. The time and memory needed for numerical simulations increases exponentially, as the states of the system increase. To surpass the limitation of the usage of the memory needed, in this work, we implemented the DP through the combination of a sequence of dynamic programming optimization sub-problems.

We present the complete ABS optimal control problem formulation for a longitudinal bicycle model with dynamic load transfer and show the computed optimal voltage control (and optimal braking torque control) profiles for different driving scenarios and road surfaces. Analysis of the benefits of the proposed optimal strategy in terms of reduced stopping distance is also provided. Numerical simulations in Matlab/Simulink and in CarSim environments validated our results.

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[2] http://www.trw.com.

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CHARLES BU

Mechanical Engineering/2012

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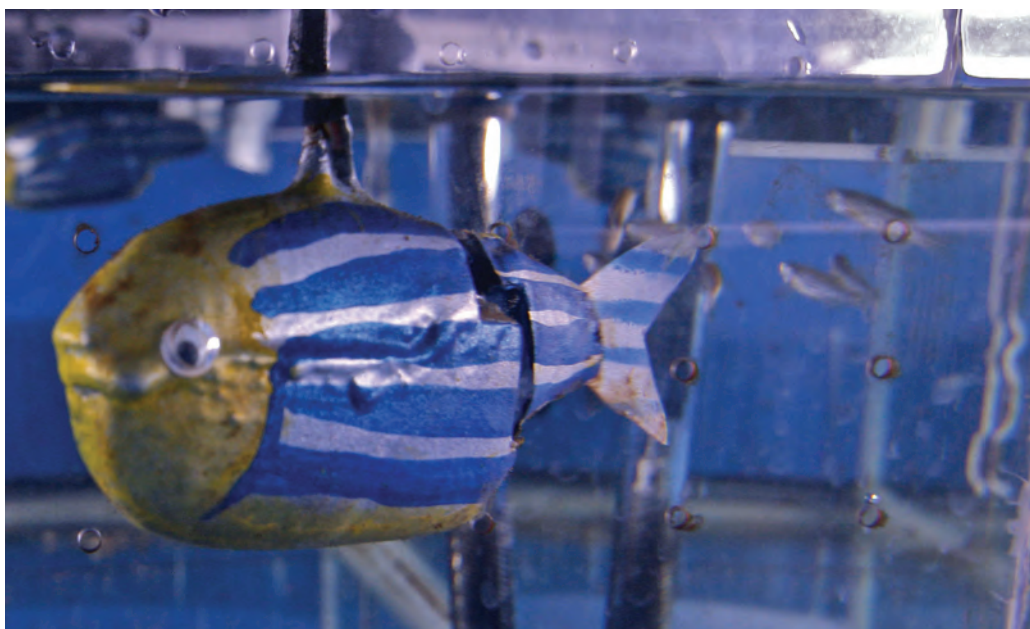
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NYU-Poly

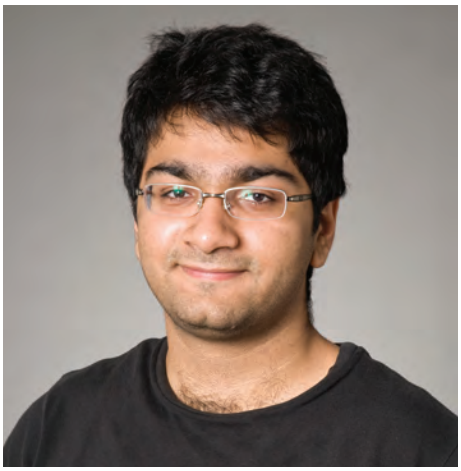
ZEBRA FISH RESPONSE TO ANIMATED IMAGES USING DIFFERENT MODELS OF SCHOOLING

In this project, a biologically inspired mathematical model of collective behavior through the behavior of zebra fish is explored. This model, which takes into account the individuals' perception of numbers, has been shown to capture psychological factors that are not considered traditional models. Here, the interaction between live zebra fish and an animated fish shoal, where the animated stimuli are life-sized photographs of zebra fish moving along trajectories determined by the model, is studied. As dictated by the model, the five zebra fish images seek to align their velocities subject to a random noise which confounds the alignment. Parameters regulating speed and random noise are systematically varied in the study.

The testing of the zebra fish was carried out with a total of nine experimental conditions, comprising three combinations of velocities and three random noises. Zebra fish were tested individually in a dichotomous preference test consisting of a test tank abutted by two video screens. In each trial, one screen shows the animated stimuli while the other shows a static image of zebra fish. Video data is recorded to track the movements of the experimental fish in synchrony with the animated stimuli. Fish are considered to "prefer" stimuli near which they take positions and to "interact" with stimuli with which they align their velocities. The differences in fish preference and interaction as functions of the model parameters were studied. Using fish behavior as a meter stick, it is expected that this work will afford insight into animal perception of this collective behavior model.



Robotic Zebra fish used to track the response patterns of schools of fish.



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OPTIMIZATION AND TESTING OF A FIRST GENERATION CAVITATION HEAT PUMP

With growing environmental concern and the cost of energy rising, scientists and engineers are eagerly seeking to develop new technologies that are both cost effective and energy efficient so that the carbon footprint can be minimized. Despite the availability of renewable energy resources such as solar and wind, the innovations that rely upon these alternative sources are not viable due to economic factors. However, the recent advent of the cavitation heat pump serves as a promising beacon to engineers as it may be the answer as to how to heat water for commercial and residential purposes efficiently.

The cavitation heat pump decreases the pressure of the working fluid, in this case which is water, to a point below its saturation pressure, which consequently induces cavitation. Energy is released in the form of heat when the bubbles collapses, which in turn causes the water temperature to rise.

Over the course of the project, a tank containing thirty gallons of water was heated from 30°C to 70°C. The temperature, time and the amperage were recorded at five degree Celsius intervals and were analyzed to determine correlations between them after each trial. The cost of heating using a cavitation heat pump was compared to that of conventional heating methods such as natural gas and electricity. The cavitation heat pump was modeled using AutoDesk Inventor Fusion while the thermal and fluid analyses were conducted using AutoDesk Simulation Multiphysics. The heating system, comprised of the water tank, cavitation heat pump, motor, pump and piping, was altered after a few trials were conducted with a given setup to determine the optimal design, performance of the system and to minimize the cost.



Bilal Gill and Syed Mohammad Tahmid with Professor Lee operating the cavitation heat pump.



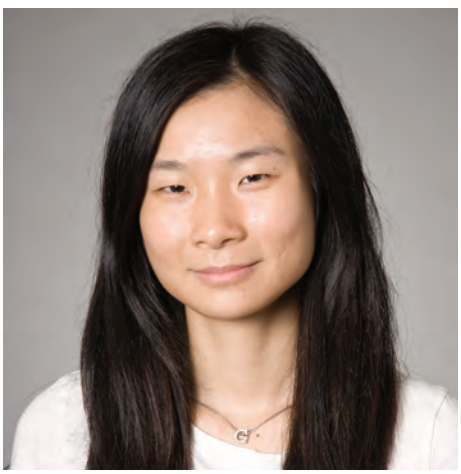
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INTERACTION OF FISH AND BIO-INSPIRED ROBOTS WHEN SWIMMING TOGETHER IN A WATER TUNNEL

This research analyzes a robotic fish and individual Golden shiners *(Notemigonus crysoleucas)* swimming together in a water tunnel at a constant flow velocity. The positional preference of fish, with respect to the robotic-fish that vary in tail-beat frequency, is determined. Furthermore, the flow structure is studied using a digital particle image velocimetry system (PIV)- an optical technique for instantaneous flow visualization.

The scientific goal of the study is to investigate how fish interact with robots as their hydrodynamic advantage increases. In a second experiment, the role of the robotic-fish color pattern in the fish-robot interaction is also analyzed. High-definition cameras in both vertical and horizontal plane are used to record the fish activity. Videos are processed by using a specific program (Observer) to discriminate for the fish position in both the two dimensional planes. Notably, relevant parameters such as water flow velocity, presence and absence of the robotic fish, and robot tail-beat frequency and robot morphology, are varied based on precedent experiments developed in the Dynamical Systems Laboratory. This work aims at improving the understanding of the determinants of robot–animal interactions and offer insight into design of robotic-fish to regulate animal behavior.

DESIGN AND FABRICATION OF MARINE VIVARIUM

This project entails the construction of a freshwater animal vivarium that will house different fish populations selected for research purposes. The species-specific environmental needs are optimized on a smaller scale with controls for fundamental parameters, such as temperature, light intensity, humidity, salinity and pH.

The housing system seeks to maximize high animal density while amply complying with fish well being. In other words, the project's main objective is to reduce laboratory space allocated for animal housing and to guarantee optimum housing conditions to the animals while ensuring high ethical and experimental standards. The engineering challenge is to design and build a vivarium within the limited budget of approximately $2,000.

The principle of the vivarium is to hold several tanks with a water pump system, which connects all the tanks to a central biological filtration system. For each of the two independent sections of the vivarium, water is distributed to a total of 28 mini-tanks and 8 medium-tanks via a submersible pump with an option of flow-control and a PVC piping system consisting of a series of valves. Each tank is fitted with an overflow valve whereby the water is drained into a U-Channel. The drain system is designed to be gravity-assisted. Water is collected and drained to the central filtration system after which it flows through mechanical filtration, consisting of two distinct biological filtration systems, a chemical filtration, heating, and UV sterilization. The central filtration system also hosts a suite of real-time environmental monitoring facilities, such as temperature and pH sensors, to ensure suitable conditions for the subjects.

This project is sponsored by the help of the National Science Foundation Grant CMMI-0745753.



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UNDERWATER ENERGY HARVESTING FROM SMART MATERIALS SUBJECTED TO PERIODIC IMPACT FROM VORTEX RINGS

This project focuses on fluid energy harvesting through smart materials subjected to periodic impacts from vortex rings in water. Ionic polymer metal composites (IPMCs) are selected for this project. IPMCs are a novel type of smart materials which produces electricity by chemo-electro-mechanical response. IPMCs are tested under two distinct clamping conditions, including cantilever setup and a circular clamp (drum-like) setup. Findings from this project may aid the understanding of fluid structure-interaction in unsteady conditions and inform future studies on the integration of smart materials for the fluid energy harvesting.

A vortex facility powered by an actuating piston/cylinder is designed and built for this project. The piston/cylinder produces a thin wall of fluid which increases in vorticity as it is emitted from an orifice, producing a vortex ring. Actuation is provided by a compressed air linear actuator mounted at the end of the piston/cylinder. The facility has the capacity of producing vortex rings at a frequency of up to 10 Hz. In order to calculate the circulation of the vortex ring experimentally, the formation number of the vortex cannon is analyzed.

IPMC-based harvesting is analyzed by monitoring the short circuit current. High-speed imaging and particle image velocimetry (PIV) are used to elucidate the structural vibration and flow physics.



AMANDA SETIAWAN

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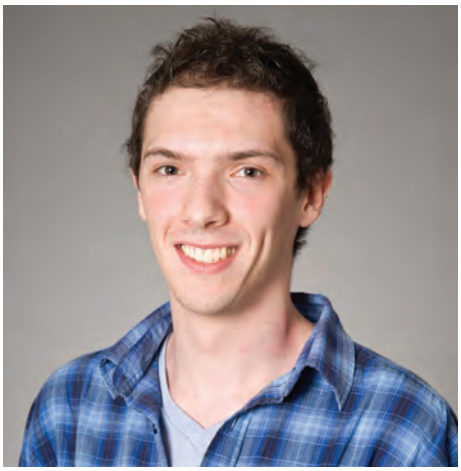
Faculty
Joo H. Kim and Dustyn Roberts
(Graduate student mentor)

NYU-Poly

BIOMECHANICAL MODELING AND TESTING OF HUMAN ENERGY CONSUMPTION

The human body derives its energy from by consuming food, water, and oxygen, which is then either converted into mechanical work, dissipated as thermal energy, or is stored as a part of the body's reserves. Indirect calorimetry performed during a particular activity measures the amount of energy consumed, by comparing the amount of oxygen inhaled by the subject to the amount of oxygen exhaled. Other established approaches to measuring energy expenditure are similarly limited to particular activities, such as normal gait or running, or do not account for heat loss due to muscle states. A more rigorous mathematical model of predicting metabolic energy expenditure is needed that can be used for a breadth of generalized tasks rather than specific activities.

This research builds on previous research on human motion dynamics to translate the measurement of energy expenditure into joint space. The amount of energy converted by the body into mechanical work in a certain amount of time, the active metabolic rate (AMR), is dependent on the power about each joint, the metabolic cost associated with heat loss due to the muscle shortening and lengthening (Q_{sl}), heat loss due to muscle activation and maintenance (Q_{am}), and a co-contraction factor (Q_{cc}). The heat loss factors of the metabolic cost, Q_{sl} and Q_{am}, are proportional to power about the joint, and to the torque about the joint, respectively. This particular study aims to optimize the heat loss coefficients of proportionality, h_{sl} and h_{am}, by comparing the energy expenditure rate between the new formulation of the AMR and established gait energy expenditure formulas. Using a motion capture system with floor force plates and Visual3D inverse dynamics system, the torques (τ_i) and angular velocities (q_i) about each joint and in all three planes of motion are found for multiple subjects, and are used to calculate the energy consumption.



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CYCLIC IMPACT OF RIGID AND ELASTIC WEDGES WITH THE WATER SURFACE

This project entails experimentally assessing the effect of repeated loading on hull slamming of marine vessels. This work is specifically conducted to understand the energy exchange between a falling compliant wedge hosting active material and a quiescent fluid, and is sponsored with the help of the National Science Foundation Grant CMMI-0926791.

An experimental apparatus is developed to study the dynamic loading conditions of an aluminum wedge fitted with ionic polymer metal composites (IPMCs) from cyclic impact. The cyclic action of the impact is provided by a pneumatic linear actuator. This motion is limited using linear guide rails and the force of impact is measured using a load cell. Experiments are conducted to determine the effect of cyclic impact on the loading that is experienced by the wedge. The effect of tank size, frequency, and amplitude of the motion are consistently explored.

Similarly, the energy harvesting capabilities of the IPMCs during the impact are optimized by exploring the relationship between the impact frequency and amplitude and the IPMC response. The harvested electrical energy through the IPMCs is determined using the short circuit current measured through an in-house developed electrical circuit. The deflection of the IPMCs obtained using high speed cameras and tracking software is compared to the time trace of the electrical current to understand the ability of IPMCs to react to dynamic loading.

ENVIRONMENTALLY FRIENDLY FLOURESCENT PARTICLES FOR FLOW VISUALIZATION

In-house fabricated environmentally friendly fluorescent particles are used to study complex surface flow phenomena, such as the circular hydraulic jump produced by the impact of a water jet on a rigid wall. This work aims at determining the feasibility of using fluorescent particles as flow tracers for environmental applications, including overland flow paths and flash flood forecasting. Flow visualization techniques, including particle image velocimetry (PIV) are used for this project.

An in-house experimental setup is constructed to perform flow visualization analysis on the circular hydraulic jump. Specifically, a piping system is fed water using a Vera Gold Series submersible pump. Flow is regulated through valves whereas discharge is determined by a flow meter attached to the system. The fluorescent particles are injected and mixed into the flow and sprayed out of a nozzle.

The fluorescence response of particles synthesized from Rhodamine WT and Rhodamine B is characterized by using a GloMax Jr. Fluorometer. The effects of weathering agents on the particles are assessed by conducting two experimental tests. The first test exposes the particles to UV light. The second exposes the particles, mixed with tap water within a beaker, to both heat and rotating motion of a stirring magnet. Every other day, fluorescence measurements are taken using the fluorometer and the values are compared to determine their relationship to the two agents.



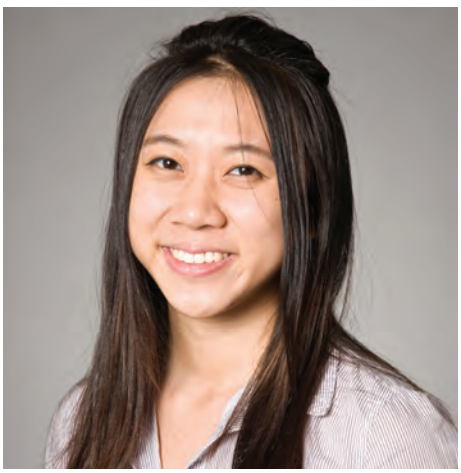
MAMADOU DIANKO

Electrical Engineering/2013

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Cours Sainte Marie de Hann

Faculty
Joo H. Kim and Dustyn P. Roberts
(Graduate student mentor)

NYU-Poly



SANDY SHEN

Physics and Mechanical Engineering/2016

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NYU/NYU-Poly 3+2 program
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ENERGY CONSUMPTION OF DC MOTORS IN ROBOTIC MANIPULATORS WITH APPLICATION TO HUMANOID ROBOT

One of the most essential features in a robotic system is its use of electrical energy. Understanding the mechanism behind the energy consumption of a robot is key to reducing its electrical energy footprint. For instance, on a human measure, moving from point A to B or repetitively raising an arm to lift an object are among several routines preferably performed with the least amount of energy. Comparably, mobile robots and redundant manipulators, when not optimized in their movement patterns and operating times, are prone to higher operating costs. Nonetheless, a consensus has not been reached yet regarding the prediction of energy consumption of a robotic system driven by high-torque DC motors performing both positive and negative work.

This research explores ways to accurately predict the energy consumption of a two-degree-of-freedom manipulator, which behaves like a robotic arm. This is done using current sensing on the two DC motors running the manipulator while it is simulating a vertical motion. Current sensing evaluates how much amperage each DC motor operating respectively the shoulder and the elbow uses. The energy consumption is then determined using Ohm's law. Ultimately, this conceptual process is extended to a multi-degree-of-freedom simulated humanoid robot. Mastering the ability to predict the energy consumption of robotic devices will extend their operating time, reduce their cost of operations and prolong their battery life.

CARBON-NANOFIBER REINFORCED EPOXY

As the technological field evolves and flourishes, materials that will be able to accommodate our rapidly growing needs are constantly in demand. This research sets out to discover new materials that will solve the issue of the thermal stability of marine and aerospace vessel materials. When a submarine or a boat travels from anywhere between Africa and the Arctic, it encounters a wide degree of temperature change; prolonged exposure to this degree change causes the material on the boats to expand and contract, ultimately making them weaken and break. When a material is more thermally stable, it does not experience as much warping under extreme temperatures, and will show better performance for longer periods of time.

This project examines the thermal conductivity of carbon-nanofiber reinforced epoxy. Syntactic foam specimens were created using epoxy reinforced with varying densities and volume percentages of glass microballoons and carbon nanofibers, and dynamic mechanical analysis testing on those samples was performed. The material is strong and very lightweight, and tests well for thermal stability. The goal of this research is to be able to use the new material in aircraft and marine transportation, as well as perhaps in electronics that experience a wide fluctuation in temperature, such as computers and laptops.



Mamadou Dianko with Professor Joo H. Kim, using current sensing to develop a way to measure energy consumption based on Ohm's Law



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CATALOGING COLLECTIVE BEHAVIOR IN URBAN CONTEXTS

Collective behavior of animal groups is a phenomenon that is driven by genetic and environmental causes and is observed in both captive and wild environments. Even in large animal groups, this phenomenon can be viewed as a group response in which each individual performs a specific task. Specifically, individuals behave harmonically within the group and from a macroscopic point of view their synchronized movements are perceived as a single unit.

The aim of this project is to investigate the features of collective behavior in different social species that characterize animal evolution. Namely, social behavior in fish (mosquito fish), insects (ants), birds (chicks), amphibians (underwater frogs) and mammals (humans) are analyzed. The motions of the animal groups are recorded for ten consecutive days to analyze their species-specific interactions. In particular, animal behavior is studied when natural interactions occur in the group and when interactions are simulated by the presence of one or two sources of attraction. Video frames are acquired and stored into a digital image library. Images are analyzed through dimensionality reduction in large data sets, which insight into similarities and differences in collective behaviors between species.

WRESTLING HEADGEAR

Two million wrestlers suffer from a concussion each year, out of which close to 400,000 happen in high-school athletics in the United States. Brain injuries (concussions) affect motor functions such as speech and body. Athletes who have been concussed are three times more likely to suffer another concussion in the same season. Moreover, multiple concussions have shown to have lasting negative brain development consequences in children and can lead to permanent brain damage. Furthermore, 50 percent of athletes who return to play prematurely after suffering initial brain injury die. Therefore the lack of proper head-protecting equipment threatens not only the health of wrestlers, but the future of the sport itself.

Since current wrestling headgears are ineffective in head, brain, face, and skull protection, we aim to design the first wrestling headgear of its kind. With unique, patent-pending features such as a replaceable rim-lock poly-carbon lens system and special quick-return foam materials, our headgear will be the first of its kind not only in wrestling but also in the general headgear market.

Our lab is currently performing 3D impact testing after scanning the head of a 19 year-old boy, and estimating the thickness of his skull. This analysis of a finite element model in ANSYS allows us to determine the right materials and accurate geometry of the impact absorbing foam, and develop a sensitivity analysis that would track the critical strains that occur during impact. The results will determine the final geometry of our design as well as the best materials to use. Next steps will include prototyping by printing the current model in NYU's Connex 500 3D printer, and performing physical lab tests to determine the functionality and necessity of our design in comparison to existing headgear equipment.



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TECHNOLOGY, CULTURE AND SOCIETY

HISTORY OF THE INTERNET

Today, many people around the world use the Internet to share and transfer information, ideas, and entertainment. However, the Internet was not conceived to become a groundbreaking communication tool. The idea to connect multiple computers across the country started out as the Advanced Research Project Agency's attempt to reduce redundancy in computing research. However, with the innovation of email over the ARPA-Net, the network became more communication oriented. To determine whether this change was more user driven or forced because of the innovation of email, the early email lists are being quantitatively and qualitatively analyzed.

The Human-Nets, one of the early mailing lists, sent out digests which were compilations of email discussions which tried to focus on the human factor in networks and other technological sectors. To help tell the story of Human-Nets, the conversations were categorized and sorted using Excel. Some of these categories were informative science and technology discussions, helpful and troubleshooting discussions, and discussions concerning human interactions with computers and technology. The contents of the discussions were also considered under historical lenses, to determine the historical significance and impact of these discussions.

Currently, Volume 3 and Volume 5, totaling near three hundred emails, have been analyzed and examined. One of the more important trends that appeared was the repeated criticism or flaming of the attempts to censor the discussions. This fight for free speech continued on throughout the years through the mailing lists, through the predecessor networks, and through the modern Internet. The quantitative analysis reveals that Human-Nets mostly operated as a forum for scientific and intellectual discussions and for lending a helping hand with technological difficulties.

VISULIZATION IN THE DIGITAL HUMANITIES

Visualization allows for a much deeper, more insightful, and visually guided analysis of data that a simple tabulation could not provide. By applying visualization to the Digital Humanities, this research creates a dynamic representation of events of historical significance that would normally only be available in a static form.

The goal of this project is to create an archive of the works of Gertrude Stein, but not just any archive. This dynamic archive will be complemented with a compelling visualization that effectively displays the year and location of any Stein-related publication on a map. By visualizing Stein's works in this fashion, new possibilities for analysis arise, particularly for the chronology of her works. The project also aims for Stein scholars and enthusiasts to collaborate by submitting their own data.

The first step was to collect and tabulate the massive amount of data. To develop the prototype, data involving Stein's Tender Buttons was collected. This included original publications, criticisms, translated editions and more. The data was then plotted on the interactive map in different symbols and colors that correspond to the type of publication. Each entry was then hyperlinked to a more informative page, where an in-depth description of the data can be found. In addition, a collaborative platform can be found on the same page.



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TECHNOLOGY MANAGEMENT

BROOKLYN ATLANTIS

Brooklyn Atlantis is a collaborative project between scientists, engineers, and the community created to learn from and aid the Gowanus Canal. Brooklyn Atlantis carefully designed and constructed a buoy that will reside in the Gowanus Canal. Whilst in the canal, the buoy will collect sensor data and images both above and below the water surface. These images and sensor data are then simultaneously transferred to the online BOSSA based server. Instead of having qualified scientists scan through all of these images to identify the wildlife and objects, this project brings it to the online community. This is known as citizen science, where non-professional or amateur scientists conduct the bulk research. Anyone can create an account at the Brooklyn Atlantis site and start tagging anytime, granting everyone with Internet access the ability to participate.

However, Brooklyn Atlantis is not only about studying the Gowanus Canal. This online team is also studying the effects of user-interface design on user response/contribution time. In the online portal, each user belongs to an administrator-controlled group, and each group of users is presented with different options/capabilities such as 'Friends', 'Missions', or 'Points'. By logging user credentials such as time contributed and number of tags, this project has allowed the researchers to see which group and configuration of options/capabilities corresponds to the largest user response and time contributed. By studying the users, this project can continue to improve the site and further expand the online community.

UNDERSTANDING TRENDS IN INVENTING THROUGH PATENT ANALYSIS

As contemporary technologies continue to progress, engineers are required to work on increasingly complex social-technical systems that are built upon earlier inventions. Working on such systems often requires contributions from different professions and collaborations between different individuals, organizations and sometimes across regions. In an attempt to better understand such trends, this research project explores this trend through an extensive analysis of the USPTO Patent Data from 1975 to 2011.

The results have shown several major patterns. First, the average numbers of inventors per patent and the inventors' residing regions per patent both increased over time. Second, the average number of references on each patent also increased exponentially over time, indicating a widening scope of existing solutions for new inventions to draw upon. In addition, the portion of system patents (estimated as patents with the words "system" or "systems" in patent titles) in all patents increased exponentially. Taken together, these results indicate that inventions are involving more people and more diverse knowledge over time.

Underneath this phenomenon are several plausible factors. On one hand, the increase in technological complexity is making inventions more difficult and challenging. On the other hand, globalization, alongside with the advances in communication and transportation technologies and the weakening of regional and political boundaries, has allowed inventors from different regions to share ideas and collaborate in R&D more effectively. These changes demand potential inventors to possess the skills of communication and collaboration in addition to their own domain-specific technical skills.


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