NJIT
New Jersey Institute of Technology

BOOK OF ABSTRACTS

Ninth International Undergraduate Summer Research Symposium

Thursday, July 28, 2016

Book of Abstracts
Ninth NJIT International Undergraduate Summer Research Symposium

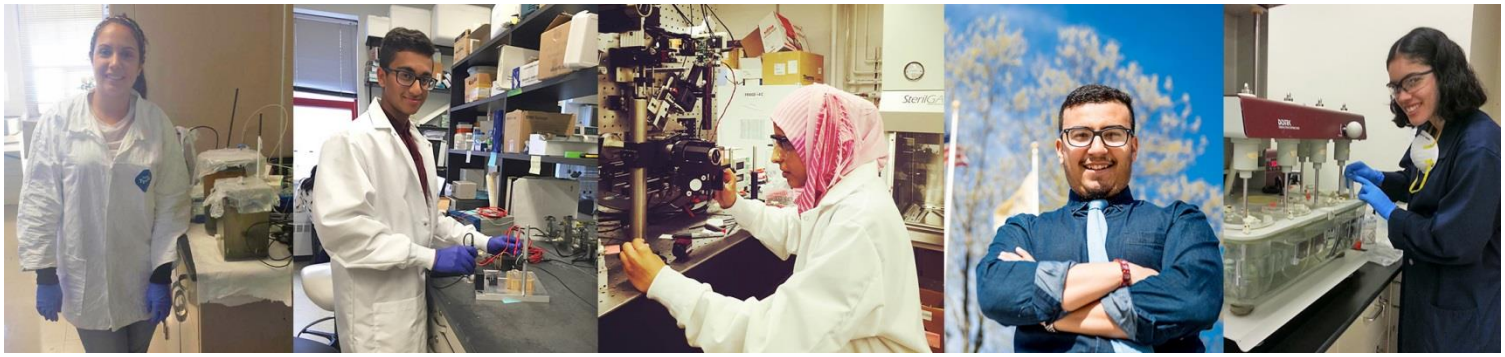
Thursday, July 28, 2016

Symposium Coordinator: Angela Retino
McNair Coordinator: Zara Williams

Sponsors

National Science Foundation, NASA, U.S. Department of Education, Ronald E. McNair Achievement Program, PSEG Foundation, The Hearst Foundation, Needham Foundation, Pfeiffer Foundation, James Stevenson and Family Foundation, Heritage Institute of Technology (India), Brazil Scientific Mobility Program, Capital One Bank, Brian Kiernan and Family, Peggy McHale, NJIT Office of the Provost, and NJIT Office of Research

Office of Research
New Jersey Institute of Technology



New Jersey Institute of Technology
University Heights
Newark, NJ 07102-1982

Joel S. Bloom
President

July 28, 2016

Welcome all – students, faculty, industry mentors, sponsors and friends of the university – to NJIT's Ninth International Undergraduate Summer Research Symposium. It is exciting to see so many ingenious inventions, and the bright, enterprising minds behind them, gathered in one place. That some of you have joined our innovation hub from as far away as Brazil and India is a testament to the power of collaboration in the service of progress – not just in our own state or country, but across the globe.

I want to especially thank the Provost's office for making undergraduate research a high priority on our campus, the students' advisors for their ideas and precious time over the summer, and our many sponsors for their generosity and commitment to helping forge the problem-solvers of tomorrow – today.

And to the more than 120 of you exhibiting your work at the symposium, congratulations! By thinking creatively, following through with diligence and tenacity – and even retooling when the evidence requires it – you have embraced the rigors of professional science. You make us proud, and we look forward to following your successes in the years to come.

Sincerely,

Joel S. Bloom
President

NJIT New Jersey Institute of Technology

University Heights
Newark, NJ 07102-1982
973.596.3220
973.642.4079 fax

Fadi P. Deek
Provost and Senior Executive Vice President

July 28, 2016

A message from the Provost:

Welcome to NJIT's Ninth International Undergraduate Summer Research Symposium. I would like to congratulate all undergraduate summer research students, their faculty advisers and program directors for the impressive research exhibited here. The symposium demonstrates excellent interdisciplinary research and innovation by undergraduates who are honing their expertise as they prepare for leadership roles in science and technology. As it is critically important for all of our students to develop such skills, undergraduate research and innovation has been identified to be an integral part of NJIT's *2020 Vision* Strategic Plan.

I thank all staff members, faculty advisers and program directors for organizing this impressive international symposium. Through the Undergraduate Research and Innovation (URI) initiative established by Atam Dhawan, vice provost for research, this year's program has been significantly expanded, and includes more than 120 students from NJIT and partner institutions.

The online publication of the Book of Abstracts of NJIT's Ninth International Undergraduate Summer Research Symposium is excellent, as it showcases the wonderful research work done by our students and faculty, and will be archived through the URI website.

NJIT is committed to excellence in undergraduate education and research to provide our students exceptional learning experiences that enable them to become leaders in our global society.

I look forward to meeting summer research teams at the symposium and learning more about their exciting work.

Sincerely,

Fadi Piene Deek

Fadi P. Deek
Provost and Senior Executive Vice President

New Jersey Institute of Technology
323 Martin Luther King Blvd.
Newark, NJ 07102-1982
Phone: 973-596-8566
dhawan@njit.edu

UNDERGRADUATE RESEARCH AND INNOVATION

July 28, 2016

I would like to extend a warm welcome to all students and faculty advisers participating in NJIT's Ninth International Summer Research Symposium. Congratulations to all of the university's undergraduate students, international students, high school students, faculty advisers and mentors for their impressive research projects, spanning core and interdisciplinary areas, including science, technology, engineering and mathematics (STEM), as well as the arts and architecture.

This summer's projects focus on the discovery of new knowledge, along with applied research addressing the needs and challenges of our global society. Relieved of their packed schedules and heavy course loads, the summer program affords students the rare chance to focus exclusively on a research-intensive, high-impact problem. These opportunities give students valuable experience working closely with fellow students and faculty that opens doors and enhances their career prospects, whether they are applying to graduate or professional school or seeking a job in industry. The posters presented at the Symposium reflect their high-level work and outstanding results, as well as their advisers' exacting standards.

I am very pleased to present the Book of Abstracts of NJIT's Ninth International Summer Research Symposium, which contains nearly 100 abstracts submitted by symposium participants. We expect it will serve as a resource and window into research on campus long after the symposium as an online publication.

Organizing such a symposium requires tremendous effort and time. I am very grateful to President Joel Bloom and Provost Fadi Deek for their critical support for undergraduate research and innovation at NJIT and for their customary enthusiasm. I would also like to give special thanks to Symposium coordinators, Angela Retino, from the Undergraduate Research and Innovation (URI) program, Zara Williams, from the Ronald E. McNair Achievement Program and staff members from the Office of Communication and Web Services.

Again, let me just repeat my heartfelt congratulations to all students, faculty advisers and mentors. I look forward to next year's symposium for more exciting and innovative research.

With best regards;

Atam P. Dhawan, Ph.D.
Vice Provost for Research and Distinguished Professor
Executive Director, Undergraduate Research and Innovation

New Jersey Institute of Technology

University Heights
Newark, NJ 07102-1982
973.596.5590
973.596.5201 fax
McNair@njit.edu

Ronald E. McNair
Postbaccalaureate Achievement
Program

July 28, 2016

Welcome to New Jersey Institute of Technology's Ninth International Summer Research Symposium. It is indeed an honor and a privilege to be part of this exciting event and to join with all of the other individuals that are a part of it.

In particular, I would single out Zara Williams of the Ronald E. McNair Achievement Program and Angela Retino of the Office of Research for their efforts in coordinating the numerous summer activities culminating in the Symposium. Without them, we could not achieve the success this special showcase enjoys.

The 2016 Research Symposium is the 16th summer symposium presenting the research efforts of undergraduate students from NJIT's Ronald E. McNair Program. From its modest beginnings it has grown into today's event, which includes more than 120 presentations by students from the United States, Brazil and India. This undergraduate research symposium is the largest such event ever held at NJIT. We are extremely proud of the research efforts of all of these students, the quality of their research presentations and the support of the NJIT faculty and staff in contributing to the success of today's event.

Angelo J. Perna,
Professor of Chemical Engineering
& Environmental Engineering,
and
McNair Program Director

Book of Abstracts

Ninth NJIT International Undergraduate Summer Research Symposium

Thursday, July 28, 2016

Table of Contents

RONALD E. MCNAIR POSTBACCALAUREATE ACHIEVEMENT PROGRAM

NSF RESEARCH EXPERIENCE UNDERGRADUATE SUPPLEMENT

HERITAGE INSTITUTE OF TECHNOLOGY-NJIT SUMMER RESEARCH

LEAN STARTUP ACCELERATOR PROGRAM

BRAZIL SCIENTIFIC MOBILITY PROGRAM

Provost Undergraduate Summer Research Program

Development of a Microfluidic Cell Culture System

Paul M. Abatemarco, Michael Fredericks, Ryan Rayman; Adviser: Dr. Roman Voronov
Department of Chemistry and Environmental Science
Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

For human investigators, prolonged cell culture experiments are impractical due to their microscopic scale and length. It is desirable to run them for up to four weeks to observe long-term development, and the optimal feed dosage may be on the order of microliters. Therefore, it is essential to build a microfluidic cell culture system that can run these experiments independently and collect data given instructions. This project is a collaborative effort with several steps that require different skillsets to see to completion.

For the planned experiments, the microfluidic device should be suited for analyzing single cell behavior in response to a diffusion gradient using chemoattractant. The design features a central cell loading chamber with four small channels to transport cells to separate diffusion chambers, where their behavior will be monitored. These chambers are connected to a nine unit array consisting of two layers, one containing the chambers and channels carrying cell media and another beneath it with pressurized air. A thin membrane sits between the two layers. The arrays are equipped with bypass channels to purge unnecessary fluids.

To drive cells and fluid through the microfluidic device, a pumping system is required. The initial design concept was taken from Dr. Gómez-Sjöberg and Dr. Quake's work, which can run up to 96 independent cell culture experiments.[1] While the general layout will remain the same, there will be far fewer outlets since the final chip design only requires nine cell chambers. Feed outputs will also receive individual pressure regulators so that they can be fine-tuned. The resulting pump system will have a lower capacity, but enable greater precision and be less expensive than the parent design.

In addition, cells are transparent in their natural state, so there must be a way to make them visible. Traditionally, dyes are used to observe cells, but these are not designed for *in vivo* experiments. By incorporating fluorescent proteins into the cells ensure visibility, they can be made to emit a bright color when exposed to certain frequencies of light. These proteins can be transplanted into the cell's genetic code so that future generations will also express them. Other factors such as the photostability, resistance to photobleaching, brightness and expression rate must also be considered[2]. As there are many different methods of transfection, the introduction of foreign molecules to a cell, the pros and cons of each approach must also be weighed.

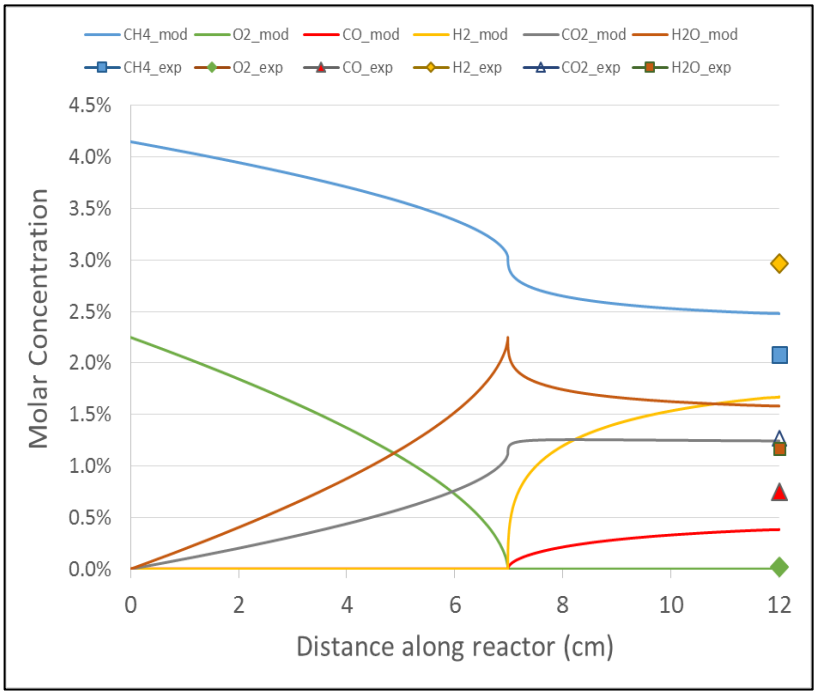
[1]Chen, C; Gómez-Sjöberg, R; Leyrat, A; Pirone, D; Quake, S. Versatile, Fully Automated, Microfluidic Cell Culture System. *Analytical Chemistry* 2007, 79, 8557-8563.
[2]Shaner, Nathan C., Paul A. Steinbach, and Roger Y. Tsien. A Guide to Choosing Fluorescent Proteins. *Nature Methods Nat Meth* 2.12 (2005): 905-09.

Detailed Reaction Mechanism Simulations of CH_4 Partial Oxidation

Nadia Al-Ebbinni, Juan Arias, Yuan Zhu and Prof. Robert Barat
Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

The purpose of this study is to understand the essential chemistry in order to achieve high yields of synthesis gas (CO, H_2) by the catalytic partial oxidation (POX) of methane (CH_4) in a packed bed reactor. These computations are the continuation of a previous experimental study[1] of the conversion of CH_4 into a synthesis gas by catalytic POX over a ruthenium phthalocyanine catalyst. The data of this previous experimentation had been acquired over a range of temperatures (523-648K) and CH_4/O_2 feed molar ratios (0.5-5) at constant pressure. A detailed understanding of reactant consumption and product formation is being developed by using the software tool CHEMKIN 3.6 to simulate the experiments. CHEMKIN 3.6 solves a complex system involving gas-phase kinetics accompanying a solid surface mechanism. A simulation of a packed bed reactor has been created within the CHEMKIN structure, including the reaction functions within it. A detailed elementary reaction mechanism accounts for the O_2 and CH_4 activation on the catalytic surface, as well as the formation of all products. While a mechanism for our exact catalyst is not available, reasonable results are obtained in our study with a mechanism for CH_4 partial oxidation and reforming over a nickel-based catalyst.[2] Two other similar mechanisms based on other metals (rhodium, palladium) are also under consideration. Evaluation of the suitability of a mechanism to simulate our POX data includes computational variations of the temperature, catalytic site density, and the internal surface area per unit length. The alteration of the site density offered the best overall agreement with the experimental data. The figure shows model-based (*_mod) stable species profiles along the reactor, along with the experimental data (*_exp) measured at the reactor outlet. The experimental conditions: feed (He 93.6%, CH_4/O_2 = 1.84), temperature = 375°C, pressure = 64.7 psia, CH_4 conversion = 49.9%. Model: site density = 3.0E-9 mole/cm^2.

The model shows CO and H_2 do not form (i.e., "activation") until all O_2 consumed (by ~ 7 cm). Fairly good agreement with the experimental data (at reactor outlet 12 cm) exists. The H_2 is underpredicted. Once the O_2 is gone, some H_2O is used as the oxygen source to continue conversion of CH_4 to CO and H_2. This path is limited since H_2O is not nearly as reactive as O_2 in this catalytic setting. Other model results, not shown here, indicate that the activation does not occur within the 12-cm reactor with a catalytic site density of 2.0E-9 mole/cm^2.



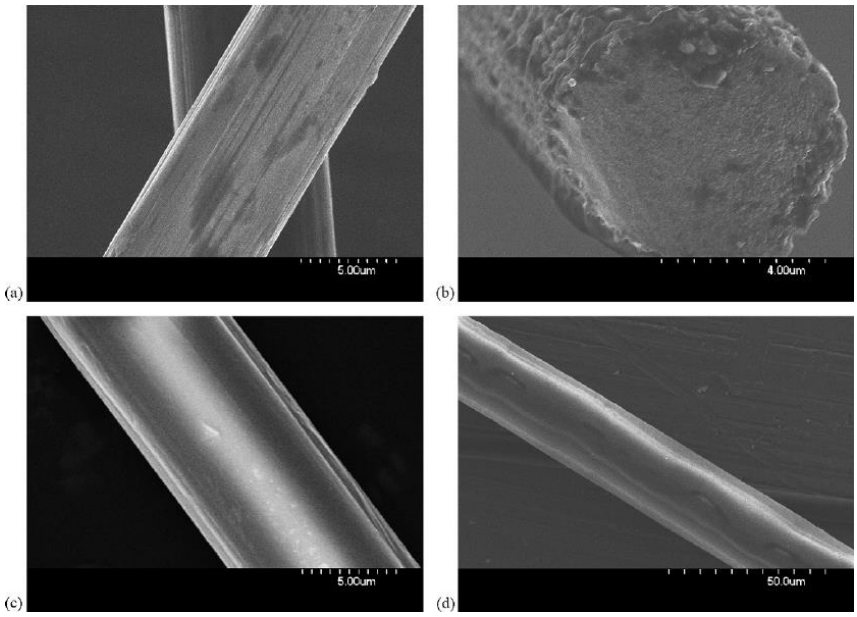
The Fabrication of a Novel Carbon Fiber Microelectrode for Interfacing with the Brain

Ayesha F Ali, Adviser: Dr. M. Sahin, and Mentor: E. Cetinkaya, Ph.D. Student
Department of Biomedical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Neural degenerative diseases, such as Parkinson's and Alzheimer's, and Traumatic Brain Injuries (TBI) can cause loss of neurons which are imperative for neural communication. These impairments are known to cause loss or uncontrollable movement or loss of memory. Previous microelectrodes have been created to remediate these damages, but after implant in the cerebellum, they cause further neuronal loss and astrocytic and microglial cell death. Carbon fiber microelectrodes will not encourage further cell death, but rather increase the neural density within that region. Usage of carbon fiber microelectrodes in the long-term recording of neuronal activity is significant in treating the brain and traumatic nervous system injuries. This research facilitated a novel fabrication process that utilizes superior properties of carbon fibers over currently used electrode materials such as silicon, titanium and stainless steel. The carbon fibers, which will be coated with Parylene-C, will be more durable than the other materials. After creating the carbon fiber microelectrode and implanting *in vivo* in a rat subject, our primary focus consists of recording the neural activity levels and analyzing the occurrence of further cell death. When the carbon fiber microelectrode is interfacing with the brain, different neural recordings are delivered to restore neural activity in the cerebellum and moved on to interact with the spinal cord to restore the degenerating or traumatically injured brain region. With this innovation, we can successfully restore neural density, quadriplegia and paraplegia. In addition to movement restoration, this research will provide a treatment to the neural degenerative diseases. Further research will consist of continued long-term analysis of the carbon fiber microelectrode to make it more durable and longer lasting.

(a) (b): Uncoated Carbon Fibers

(c) (d): Carbon Fibers Coated with Parylene-C



Bendikov, T. A., Miserendino, S., Tai, Y., & Harmon, T.C. (2006). "A Parylene-protected nitrate selective microsensor on a carbon fiber cross section." *Science Direct, 123, 127-134.*

Activation of Cardiac Fibroblasts *In Vitro* Using Static Mechanical Stimulation

Sugosh M. Anur, Adviser: Dr. Eun Jung (Alice) Lee
Department of Biomedical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Following myocardial infarction, cardiac fibroblasts become activated into myofibroblasts and rapidly proliferate and migrate into the necrotic myocardium to synthesize new extracellular matrix and initiate the remodeling process. However, there are no existing tissue models mimicking this remodeling process by cardiac fibroblasts after myocardial injury. The goal of this study is to stimulate the conversion of cardiac fibroblasts into cardiac myofibroblasts in engineered tissues to develop an injury tissue model mimicking post heart attack conditions.

Primary cardiac fibroblasts were isolated from an adult rat heart and culture for up to 17 passages. The expression of α-smooth muscle actin as passage number of cardiac fibroblasts in culture increases was first examined. We then examined cardiac fibroblasts cultured in unstretched three-dimensional (3D) collagen gels (Fig. 1A) as well as in 3D collagen gels subjected to 10 percent static stretch for up to two weeks in culture.

Cardiac fibroblasts in 2D culture especially after nine passages, expressed alpha smooth muscle actin, which is a known marker for activated cardiac fibroblasts as shown in Fig. 1B. Indicating that cardiac fibroblasts can be activated with a prolonged *in vitro* culture. The 3D gels were successfully created with cardiac fibroblasts either in the unstretched or stretched condition for either seven or 14 days without major tears, holes or tissue damage. The unstretched gels served as a control since there were no mechanical stimuli applied. The fibers showed no sign of being pulled in a given direction. Cardiac fibroblasts in the stretched gel exhibited alignment in the stretched direction as shown in Fig. 1C.

The cell slides proved to show that with a high passage number, the expression of the alpha smooth muscle actin would be much stronger. While it was observed that cardiac fibroblasts maintain their activated phenotype in 3D gels through immunofluorescence images, further analysis including protein assay needs to be performed to quantitatively determine the effect of static mechanical stretch on cardiac fibroblast activation. Future studies include applying cyclic mechanical stimulation to assess protein expression, collagen deposition, for a prolonged duration.

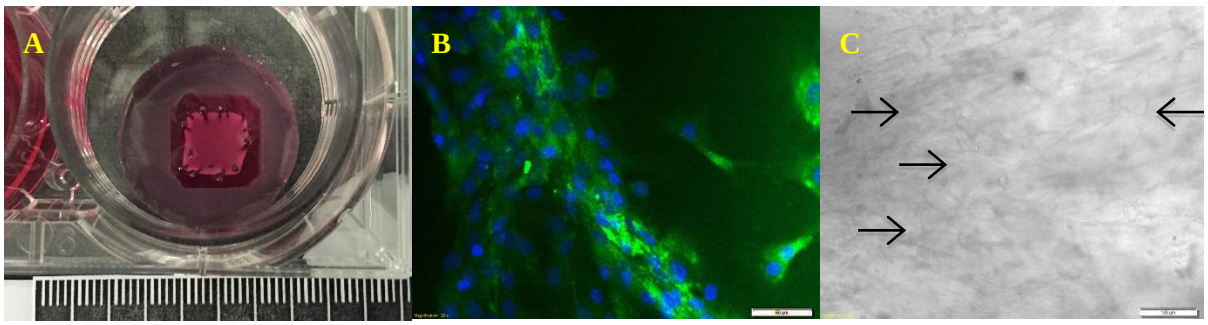


Fig. 1 (A) macroscopic image of an unstretched, cell-seeded 3D collagen gel constrained by pins cultured in fibroblast medium. (B) A 4', 6-diamidino-2-phenylindole and green fluorescent protein image showing cells and their expression of the alpha smooth muscle actin. (C) A phase contrast image of a 10 percent static stretched gel showing cell presence.

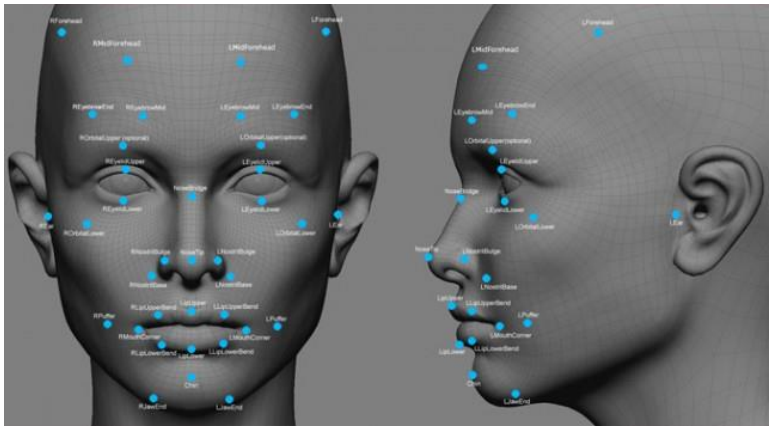
Computer Vision

Nahian Basith, Wilmin Ceballos, Adviser: Mohammed Feknous
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark N.J. 07102

Humans are able to easily identify faces in different scenes with little or no effort. In contrast, it is not a simple task for computers to identify and authenticate human faces. What is the process involved for humans to be able to recognize another person's face? People do not often think about the many factors involved in this complex process. Some of these factors include identifying facial structures (nose, eyes, ears, etc.), contours, shadows, hair, distinguishing marks and so forth. The process of computers performing facial recognition is in the growing fields of computer vision and machine learning. Computer facial recognition involves purely mathematical methodologies.

Computer vision is a field that includes methods for acquiring, processing, analyzing and understanding images in high dimensional data from the real world in order to produce information or numerical analysis that can be used to form decisions. In the technologically advanced world we live in today, many companies have been exploring the benefits of computer vision and machine learning methodologies, which train computers to analyze complex information and understand them.

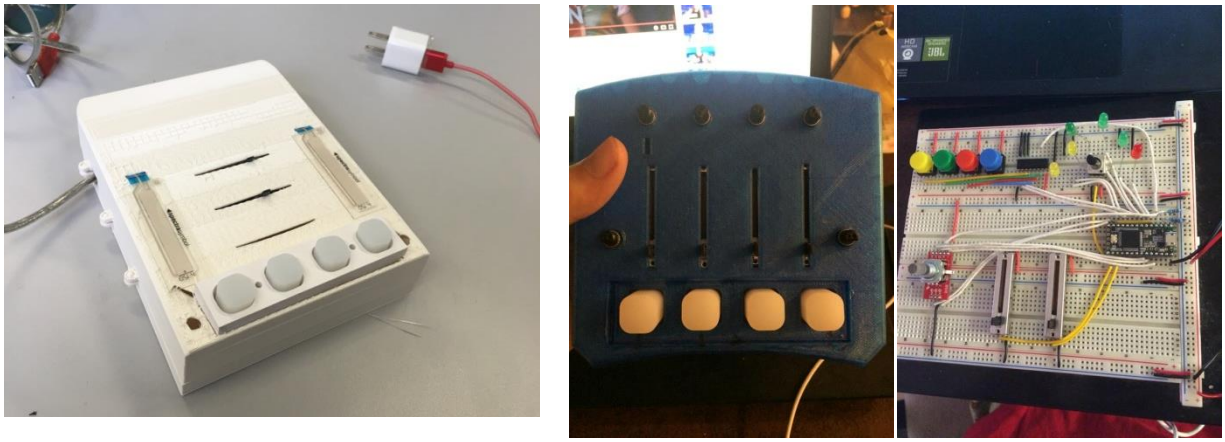
Conducting a deep-dive analysis on this topic to create a methodology and optimized algorithm that works on a variety of environments and conditions is a feat that will further excel the field of Computer Vision. Facial recognition is necessary for security, such as police operations and authentication.



Modular Electronic Control Surface for Percussive Instruments

James Basuino
Adviser: Dr. Durgamadhab Misra
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Music Technology has been advancing the ways that music is produced and performed and now new technologies are seeking ways to bridge the gap between acoustic instruments and electronic MIDI controllers. Controllerists are the people who perform with these controllers and this form of musicianship is a growing trend and thrives on innovation. This project aims to make a hybridization of controllerism and traditional instrumentation by developing a MIDI controller that offers some of what conventional controllers on the market offer already but without sacrificing the assumed play style of an acoustic percussive instrument. The goal of prototyping is to experiment with different designs, dimensions and controls that would lend themselves the most to the percussive instrument we are designing for, the tabla. Rather than making it modular in respect to controls, each controller can work synergistically. In the design and prototyping process, the most successful results have come from using the Brain Jr. microcontroller, but we are also experimenting with the harder to use, but more flexible, Teensy microcontroller. By building and testing our prototypes with an experienced tabla player and DJ, we see where the controller can improve and be more robust for the future market. This project should be a valuable step towards a smaller, more sensible controller for percussive instruments.

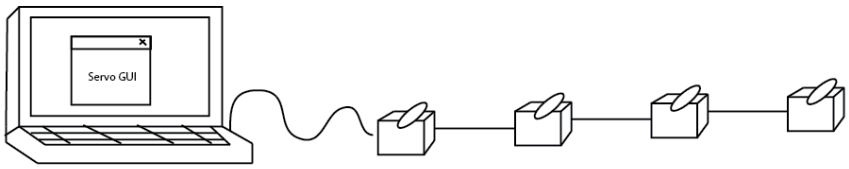


From left to right: First prototype (using Brain Jr.), latest prototype (7/7/16 using Brain Jr.), Breadboard prototype (using Teensy).

A Reconfigurable Open-Architecture Servo System for Research on Advanced Robotic Manipulation

Walter Berreta, Dylan Davies, Daniel Tokarczyk, Adviser: Dr. Cong Wang
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

This undergraduate research project develops a reconfigurable open-architecture servo system. The servo system will enable the construction of a high-maneuverability miniature robot manipulator which provides full access to torque-level motor control, and allows efficient implementation of advanced machine learning and control algorithms to realize advanced robotic manipulation functions. Currently, the controllers used by most low-end hobby servos on the market provide only basic PID control with primitive analog external position command. Meanwhile, the controllers of the select few high-end professional servos, although allowing gain scheduling and digital communication, are still incapable of supporting more advanced control algorithms and high-speed real-time distributed control network. By comparison, the proposed controller features optimized computing configuration that allows the implementation of advanced sensing and control algorithms as well as high-speed real-time control network. Each servo in the network uses an embedded reconfigurable micro servo controller placed in a PCB layout designed for this system. A graphical user interface GUI was developed to coordinate multiple units on the servo network. Using serial communication to the controller, the GUI gives the user the ability to have full control of each servo's parameters, such as velocity, torque control and position. Having access to such parameters gives way to advanced manipulation of a robot's movement that utilizes this servo system.



Portable and Scalable Microbial Fuel Cell-powered Lighting Systems

Andrea Cano, Likun Hua, Ashima Agarwal, Wen Zhang

John A. Reif Jr. Department of Civil and Environmental Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Developing alternative renewable energy technologies has become important for the conservation of natural resources and the environment. We design a Microbial Fuel Cell (MFC) that uses waste water such as human urine to generate renewable and sustainable power sources that power up LED lighting. The main research objective is to further our understanding in the principles of waste-energy conversion with this technology, and to study the feasibility of implementation in real-life conditions (e.g., mobile toilets). Our URI phase I and phase II projects have focused on assembly prototype systems which uses cost-effective materials and optimizes the energy production as indicated by the open circuit voltage (OCV) and ultimately LED lamps. The first step was to monitor the OCV fluctuation in the previous assembled prototypes as shown in **Fig. 1a**. For one of the MFC the OCV increased from 100 mV to 378 mV, which remains relatively stable and constant after bacteria was inoculated. The second step consisted of assembling a new MFC with major changes in anode that is replaced by carbon brush (see **Fig. 1b**). Long carbon brushes are expected to boost power production due to the higher surface areas for bacterial growth and electron transfer. Once the new prototype is able to produce a constant power, we want to connect a number of these MFC units to provide sufficient power to light up a light bulb. For example, about five or 10 of new prototypes will be assembled in series and will be then connected to another set in parallel to enhance both voltage and current outputs.

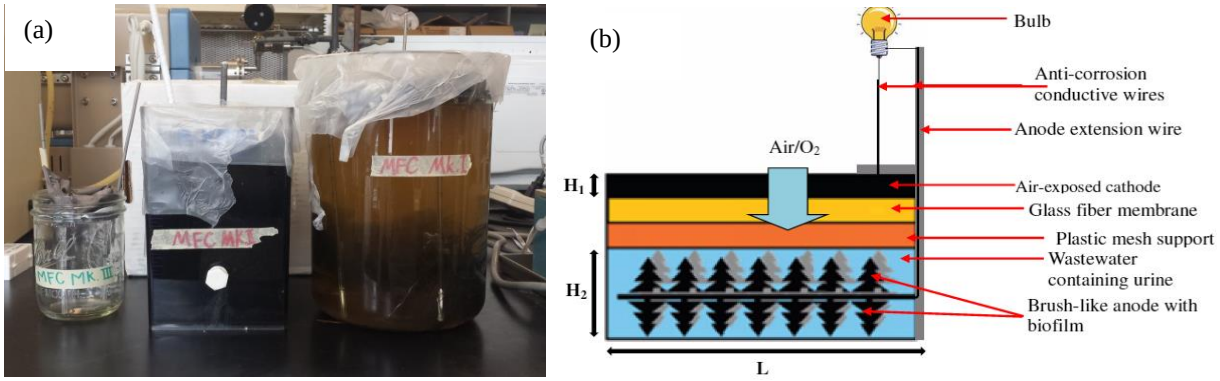


Figure 1: (a) previous two prototypes and one newly modified prototype on the left. (b) MFC schematic of major components.

Protein Aggregation

Albert Fraser V[1], Farbod Mahmoudinobar[1], Jiajie Xu[1], Cristiano L. Dias[1]
[1]Department of Physics, New Jersey Institute of Technology, Newark, N.J. 07102

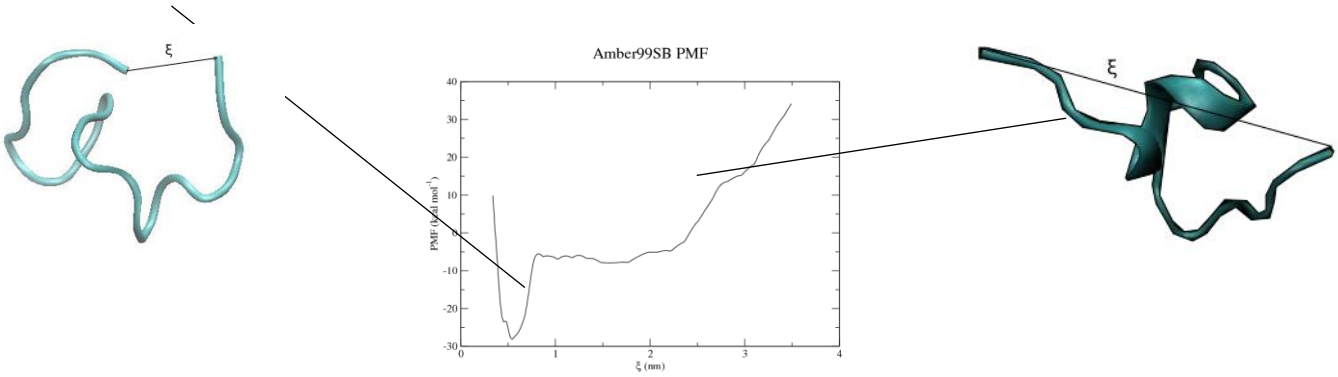
Protein misfolding has been related to many neurodegenerative disorders, for example Alzheimer's disease. Therefore, it is important to understand the folding process at the atomic level. This is the objective of this project. My researched utilized the synthetic protein known as the Trp-cage mini protein (20 residues). Trp-cage is a protein that folds very quickly (~4.1 μs and T ~ 300K)[1] and is stable (free energy difference between native and unfolded states ~ 1.5 kJ/mol)[2]. Therefore this protein is amenable to be studied in silico which can simulate proteins up to a few microseconds.

Using the program GROMACS, I have proceeded with a three-step process to observe the folding behavior of trp-cage using different parameters. In order to save time computationally, I used an implicit solvent, which represents the solvent in molecular dynamic simulations as a continuous medium, as opposed to explicitly having solvent molecules in the system. The three steps I proceeded with were unfolding the protein, umbrella sampling and replica exchange. I also used two different force fields: CHARMM27 and Amber99SB.

The first step, unfolding the protein, was done to ensure that the initial confirmation did not provide bias when the next two steps were executed. In order to unfold the protein I ran a normal molecular dynamics (MD) simulation at a high temperature (580K). I ran the simulation and selected the frame which presented the most unfolded state of the protein.

The second step, umbrella sampling, was then performed. The protein was then pulled back together slowly at 310K and 23 different frames were chosen at different end-to-end distances ξ (see figure) ranging from 0.3 nm to 3.5 nm. Each of these frames went through a 100 ns umbrella sampling MD simulation.

The third and final step was then performed. On all of these frames, replica exchange was used in attempt to improve my results and error. Thirteen replicas on each frame were used ranging from 273K to 706K. After all these finished, I analyzed potential of the mean force (PMF), which yields the free energy. Results are promising.



Implementation of Electroencephalography to Generate Digital Instructions

Einreb Funda, Umar Rao, Adviser: Mohammad Feknous
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

The goal of this project is to produce a universal instruction signal to different types of machines and electronics with the use of an Electroencephalography (EEG) headset. EEG is a well-known monitoring method used to inspect the electrical activity of the brain. EEG today is mostly used by doctors to help detect brain-related disorders including epilepsy and comas. We believe that we can introduce EEG to a new field where we adapt the neural results of an EEG headset and translate it into digital code that will allow us to control certain mechanical objects. By finding patterns in the electrical impulses that a human brain produces, we can maximize accuracy of a certain electrical impulse and use it to send a specific code that can instruct, for example, a mechanical limb to move in a certain way. Of course, the first step to our goal is to get a prototype to move at a direction based on our brain's electrical activity, but we can improve our code and average out the electrical impulse graphs to be able to find a pattern that we can reproduce.

With the utilization of open source microcontrollers and microprocessors, we plan on creating a more cost-effective way of using EEG technology. Our project is purely based on collecting large amounts of brainwave data. By understanding how frequencies from the brain behave during an action or emotion, we are able to use signals based on those frequencies and initiate a signal to another machine or computer by sending various amounts of digital instructions to a machine. This opens up different possibilities of controllerless technology, by controlling different machines through a person's thought process. And through our research, of creating this universal link, we can create a solution that will remove the need for proprietary language that creates a road block that prevents the further development of EEG from a diagnostic tool into a more mainstream technology that can be used for a myriad of different functions.

Differences in Neural Processing of Small and Large Moving Sensory Images

Hannah Gattuso, Adviser: Dr. Eric S. Fortune
Department of Biomedical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

The size of moving objects is an important cue in behavior. Consider your response to a baseball moving toward you at 20 m/s and to a car moving at the same rate. Animals including humans rely on the detection and processing of the size and velocity of moving sensory images for survival. Despite advances in computer vision, we do not understand how animal nervous systems extract this information. In this study, I investigated the mechanisms used by neurons in the central nervous system to process and represent movement in the sensory world. My work focuses on how differences in the size of moving sensory images are represented in the spiking activity of midbrain neurons in a well-suited model system, the weakly electric fish *Eigenmannia virescens.*

Eigenmannia are a species of Amazonian fish that use modified muscle cells to emit an electric field, known as electric organ discharge (EOD), for communication and to detect and characterize nearby objects. The EOD is detected by specialized electroreceptors located on the skin of the fish. Objects that have resistances that are different from the surrounding water perturb the electric field of the fish, which is encoded by changes in firing rates of electroreceptor afferents. The information from these receptors enters the hindbrain where it is processed in a cerebellar-like circuit known as the ELL. From there, information is transmitted to the midbrain where information related to velocity of movement is first extracted.

Eigenmannia exhibit dramatic differences in behavior in relation to the size of moving objects. For small objects (< 1mm) such as prey, *Eigenmannia* make swimming movements that result in the object being moved rapidly (~ 10cm/s) toward their mouths For larger objects (> 10cm) such a refuges, fish will match the movement of the object to minimize the relative velocity. In other words, the fish stabilizes the moving image on its body surface.

I used neurophysiological and mathematical analyses of the activity of midbrain neurons to understand how size and speed are encoded and processed. I made extracellular and intracellular recordings of midbrain neurons in awake, behaving fish using patch-type pipettes. I used three objects that differed in the size of the electrosensory image. The objects were moved at velocities between 1cm/s and 10cm/s. I found neurons that were sensitive to velocity and size. In the future, both the neurophysiological data and mathematical models can be used to better understand fundamental neural strategies that can be translated into improved algorithms for artificial systems.

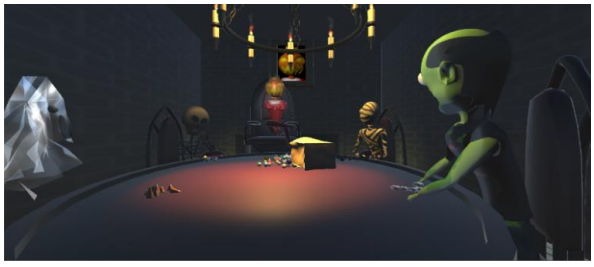
Novel Video Game Development for Oculus Rift Platform to Therapy Children with Traumatic Brain Injury and Vision Disorders

Rob Gioia (IT), Advisers: Tara L. Alvarez (BME), Marc Sequeira (IT), Mitchell Scheiman
New Jersey Institute of Technology, Newark, N.J. 07102

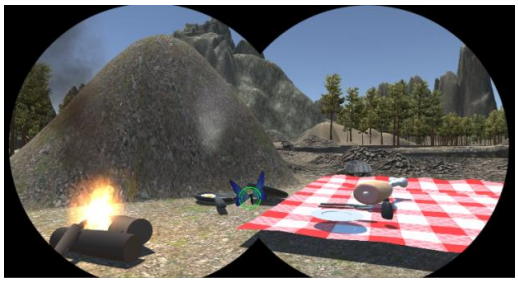
The goal of this project is to create video games that are clinically effective at treating eye movement dysfunctions. Current forms of vision rehabilitation use a repetitive pattern that can easily result in patient boredom. As a result, many home-therapy methods result in poor patient compliance. By developing virtual reality video games that are sophisticated, graphically interesting and exciting, patient compliance is hypothesized to be improved as the once tedious repetitive movements become a core mechanic of engaging gameplay. The games developed for this project do not require the player to use any peripheral device like a mouse or keyboard. These games are played only with a person's eye position. Flexibility and modularity of code allows for future development so that the platform can be adapted for different age groups and patients with various vision dysfunctions. These games are being tested at VNEL in a clinical trial to determine efficacy.

This summer, a number of new games were developed and older games were refined and polished. *Bug Eyez*, the 3D space shooter developed for the Provost Research Program, was completed and is currently undergoing clinical testing and refinement based on player-clinician feedback. Two new games, *Revenge of King Pumpkin* and *Outdoor Adventures: Bug Catchers*, were conceptualized and developed. Each game is meant to appeal to a different demographic in the 5-18 age range. *Revenge of King Pumpkin* is a Halloween-themed game aimed at children and teens where the player must fight off zombies, mummies, ghosts and skeletons and save Halloween from the evil King Pumpkin, who is determined to obtain all of the candy in the world and thus end Halloween forever. *Outdoor Adventure: Bug Catchers* is meant for toddler and child players. The game involves catching fireflies and butterflies by converging the player's eyes on the insect and then releasing the insect back into its natural habitat. The games created for this project will also serve as the basis for my undergraduate thesis project which will culminate in fall 2016 with a public defense at NJIT at the end of the semester and publication in video game research journals as well as biomedical engineering journals.

The Bug Eyez logo for the 3D Space Shooter game.



King Pumpkin tells his cronies that he will end Halloween forever by obtaining all of the candy for himself in the game Revenge of King Pumpkin.



The player explores a virtual nature environment and spots butterflies by day and fireflies by night in Outdoor Adventures: Bug Catchers.

A zombie emerges from the graveyard, ambushing the player in an exciting action sequence from Revenge of King Pumpkin.

1,4-Dioxane-Degrading Properties of Activated Sludge Mixtures

Beverly M. Glasgow
Advisers: Mengyan Li, Ph.D., and Daiyong Deng, Ph.D.
Department of Chemistry and Environmental Science
New Jersey Institute of Technology, Newark, N.J. 07102

Within the past decade, 1,4-Dioxane (dioxane) has emerged as a probable human carcinogen and a ubiquitous contaminant in aquifers, compromising drinking-water safety. Its unique hydrophilic characteristics contribute to the swift formation of large and deep groundwater plumes exceeding the range of conventional treatment methods. Previous efforts revealed that a culture mixture enriched from contaminated site materials was capable of co-metabolizing dioxane while fed with propane as primary substrate. Naturally-evolved attenuation consortia hold promise for inexpensive in situ treatment of dioxane.

While initial co-metabolic dioxane-degrading results of the sample proved promising, prolonged maintenance of the aqueous sample *in vitro* was shown to erode propanotrophic activity of the mixed cells, even in the presence of continued degradation of dioxane. Subsequent transfer of the cells to agar media confirmed the presence of microbial activity, inspiring the observation that the nascence of suitable degrading strength was dependent upon the biodiversity within the original sludge medium *in situ*. Indeed, the surviving cells present as degraders of dioxane as primary substrate. Hence, further work proceeds in the direction of

1. Identifying the surviving cells and testing their degrading abilities across the variety of emerging contaminants that co-occur with 1,4-dioxane.
2. Acquiring and testing a broad variety of industrial sludge mixtures from dioxane-contaminated sources.
3. Exploring the formation of biofilms within the consortia, and their contribution to enhanced biodegradation of 1,4-dioxane.
4. Quantifying the effects on dioxane removal by the amendment of auxiliary substrates such as 1-propanol and 2-propanol.
5. Formulating and testing synthetic consortia.

Hand-Written Digit Recognition on an Embedded GPU Platform

Ravindu Gunawardana, Adviser: Dr. Bipin Rajendran, Mentor: Ms. Shruti Kulkarni, Ph.D.
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

The human brain is composed of billions of interconnected neurons, which form its basic computing unit. This biological neural network processes information using short-time duration pulse-like signals called spikes. The third generation of artificial neural network, closely mimicking the spiking characteristics of the biological network is known as Spiking Neural Network (SNN). In this project, we demonstrate the ability of SNNs to autonomously learn to identify handwritten digits. Though trivial for human beings, this problem of mapping the image of a handwritten digit to the corresponding single digit is a non-trivial task for a computer. We have developed an SNN architecture (Fig. 1) that is able to learn and identify handwritten digits from the MNIST database, using a supervised learning algorithm called NormAD that was recently developed in our group. Using the embedded GPU platform, we showcase a real-time standalone system that identifies the digits written by a user. As neural networks are inherently parallel processors, we have chosen an embedded GPU processor from Nvidia called TX1, which has 256 CUDA cores to implement the SNN so as to incorporate parallelism for speedup. The Jetson TX1 development board, which incorporates a 5-megapixel camera captures images of the handwritten digits. The pre-processing of the images of the handwritten digits is performed using the OpenCV image-processing library of C++, by centering the image captured by the camera and resizing it to 28x28 pixels. We developed a script that integrates the process of turning on the camera, preprocessing it through OpenCV and classifying it using the CUDA-C implementation of the SNN. Using the codes that we developed, we conducted numerous tests on different samples of handwritten digits ranging to quantify the accuracy of the network's classification performance. The network's output is displayed as a graph showing probability measure from the different output layer neurons, depicting the network's prediction for the digit as seen by the board's camera.

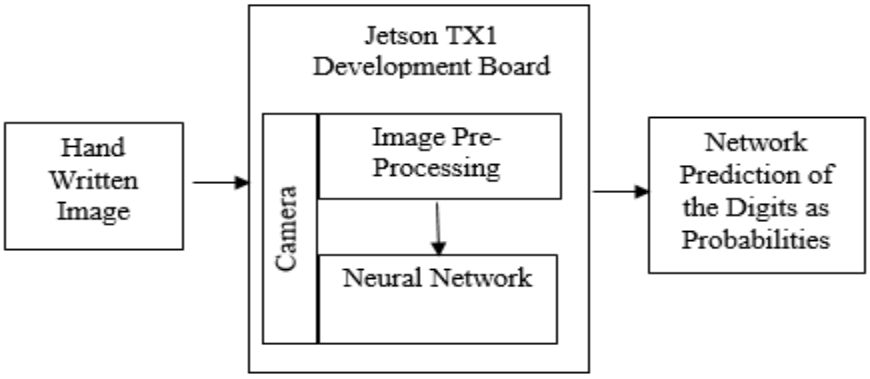


Figure 1: Block diagram showing the process of real-time handwritten digit classification using the Jetson TX1 development board. The input image is converted into a grayscale, centered and resized to 28x28 pixels. It is then applied to the SNN running on the parallel cores of the TX1 GPU. The network has 10 neurons in the final layer, which show the probability of predicting the image to be one of the 10 digits (0 to 9).

Organ-on-Chip: Microfluidic *In-Vitro* Blood-Brain Barrier Model (μTRANS Chip)

Victoria Harbour[1], Bhuvana Mohanlal[1], Sagnik Basuray[1]
[1]Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

The blood-brain barrier (BBB) is an immunological, regulatory tissue, composed of specialized endothelial cells that selectively permits molecular passage between the luminal (blood) and basal (brain). Molecules are actively and passively transported through the BBB by paracellular (tight junctions) and transcelluar pathways. The BBB, together with neurons, pericytes, glial cells and astrocytes, make up the neurovascular unit (NVU) The NVU maintains homeostasis and promotes optimal brain function by delivering essential nutrients to the brain. The highly specific molecular selectivity of the BBB restricts NVU permeability to compounds smaller than 500 Daltons, preventing the passage of 98 percent of molecules and drug therapies into the brain. Difficulties in drug delivery to the brain, as well as an incomplete understanding of BBB biochemical mechanisms, necessitate the development of *in vitro* BBB models to better characterize the BBB.

Organ-on-chip devices are an emerging class of *in vitro* models that combine microfabrication and spectroscopic techniques with cell culture to study organ physiology. We have developed an organ-on-chip model of the BBB, the μTRANS chip that analyzes real-time BBB dynamics in a controlled microenvironment. The μTRANS chip incorporates human brain endothelial cells (hBECs), astrocytes and neuronal cell lines to mimic the NVU. The device contains a pair of 30nm gold deposited, interdigitated electrodes that form the top and bottom layers of the μTRANS chip. Each electrode is flush to a 500μm by 1800μm microfluidic channel, laser cut from diagnostic PMMA tape. The top and bottom electrode/channel pairs sandwich a pre-coated Transwell® membrane seeded on one side with hBECs and on the other with neurons/astrocytes, respectively forming the luminal and basal sides of the NVU. The microfluidic channels give rise to flow generated shear across the hBECs, astrocytes and neurons. Flow-generated shear is a key component of the *in vivo* BBB environment. For the preliminary test, we seeded a pre-coated Transwell® membrane with hBECs. The seeded Transwell® is flush to a 500μm microfluidic channel, laser cut from diagnostic PMMA tape. The channel and Transwell are sandwiched between a pair of 30nm gold deposited, interdigitated electrodes, forming a chamber that mimics the luminal side of the BBB.

The fabricated device is characterized using optical imaging, permeability assays, such as fluorescence microscopy, and electrical impedance spectroscopy (EIS). We expect optical imaging to confirm hBEC adhesion and confluency and fluorescence microscopy to signify presence of key BBB proteins and membrane permeability. We also expect EIS to measure sufficiently high resistance values across the seeded hBEC membrane. High-resistance values are indicative of a functional BBB. Characterizing μTRANS with EIS values provides capacitance and resistance measurements of transient BBB activities in real time. Additionally, EIS capacitance data distinguishes transcellular resistance from paracellular resistance. This novel approach provides insight to transcellular as well as paracellular (tight junction) kinetics of the BBB. The μTRANS chip will also characterize the interaction and mechanical pathway of drug-loaded nanoparticles.

Excitatory and Inhibitory Nerve Study to Generate a Therapy for Traumatic Brain Injury

Zohour M. Hassan, Adviser: Dr. B. Pfister, Ph.D., and Mentor: Dr. J. Berlin, Ph.D.
Department of Biomedical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Traumatic brain injury (TBI) is defined as a head injury caused by a blow to the cranium, disrupting the function of the brain. Long-lasting and even permanent symptoms may result from TBI. These symptoms include speech abnormalities, paralysis, loss of limb function, and vision and hearing loss. These symptoms can take years before patients see any significant results from current treatments. As such, therapies for TBI are not guaranteed to bring patients to full recovery. The behavior of neurons after injury is still poorly understood and, as a result, there are no reliable solutions for patients suffering from consequences of TBI. In this study, neo-cortical neurons, obtained from rat fetuses, are cultured on silicone wells and stretched in order to mimic TBI. The behavior of the cells before and after injury is analyzed using a fluorescent dye, a fluorescent protein and protein identification approaches using antibodies. By understanding how these neurons signal their response, advanced drugs and treatments can be developed to speed up the healing process for TBI. This research can be applied in future experiments to repair damaged neurons and regenerate healthy neurons in TBI patients.

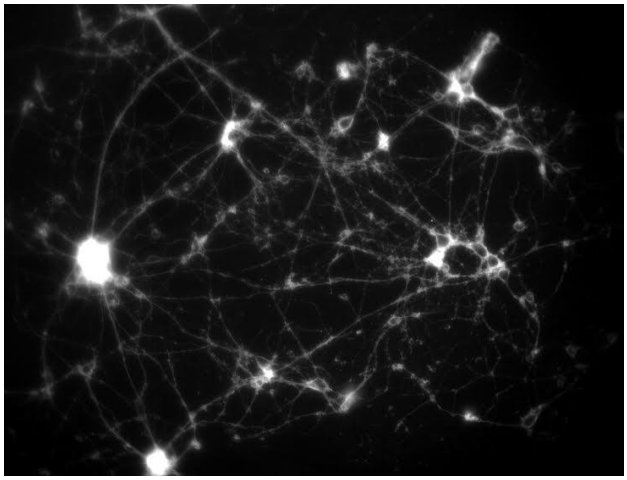


Figure 1: Rat neo-cortical neural network after being stained with Di-4-ANNEPDHQ fluorescent dye (without injury).

Map and Expand: Connecting Patients to LGBTQ Friendly Healthcare Providers

Liem Ho, Adviser: Professor Michael Lee, High School Student Assistant: Eric Schneider
Ying Wu College of Computing Science
New Jersey Institute of Technology, Newark, N.J. 07102

With the gender-neutral bathroom debate and the recent nationalization of same-sex marriage, LGBTQ healthcare equality is at the forefront of national issues. Additionally, in a national survey conducted by Lambda Legal, a national civil rights nonprofit organization, it has been found that "19 percent of patients surveyed reported being refused care due to their transgender or gender nonconforming status" and "50 percent of patients reported having to teach their medical providers about transgender care." When a healthcare provider fails to show understanding of a certain demographic of patient, the trusting relationship that needs to take place between a patient and their care provider is not established. These major discrepancies in healthcare services create gaps in relationships between patients and their healthcare providers.

The goal of this project is to create an interactive database in which users will be able to search for providers by location, cost and LGBTQ friendliness. Healthcare clients will also rate and submit their personal experiences with providers, and these reviews will be publicly accessible. Creation and utilization of this database will increase transparency between healthcare providers and patients, and also will protect members of the LGBTQ community from discrimination. Users will also be able to view a map run by Google API which plots the location of user submitted LGBTQ friendly healthcare providers. Sample data of LGBTQ-friendly healthcare providers has been provided by Garden State Equality, New Jersey's largest civil rights non-profit organization. This purpose of this project is to encourage increased awareness and consideration of the LGBTQ community as a demographic of patients by healthcare providers, as well as to create more trusting relationships between healthcare providers and patients of the LGBTQ community.

Micro Total-Analytical System for Studying Polymeric Film-based Drug Delivery System

Andrew House and Sagnik Basuray
Department of Chemistry and Environmental Science
Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark N.J. 07102

Traditionally, pharmaceutical thin-film dissolution studies have been performed exclusively in apparatuses more suitable for other dosage forms. The techniques suffer from serious disadvantages, such as requirement of large amounts of active pharmaceutical ingredients (API), film floating, not using physiological fluids (only buffers due to large volume requirements) and no surface measurements. Hence, we have developed the µFILM chip, which will use microfluidics for *in vitro* study of thin-films and drug dissolution. µFILM is portable and low cost, allows for scrutiny of film surface, open flow, provides high throughput, and uses physiological fluids. Preliminary results show that the µFILM chip can be used to study thin film dissolution.

The construction of the µFILM chip (Figure 1) consists of a Transwell® static membrane placed between two glass slides, forming two distinct chambers above and below the membrane. Each chamber contains a channel, 81 µm X 80 µm X 2 cm. The channels are laser cut from diagnostic double-sided PMMA tape and are sealed by a glass slide "cap". The channels contact 30 nm gold deposited, interdigitated electrodes that have been applied to the glass slide by an SU-8 spin coating and etching process to analyze the disintegration of thin films using electrochemical impedance spectroscopy (EIS). The design is transparent for viewing purposes and is both simple as well as cost effective. The primary task of this project is to further optimize the µFilm chip to undertake permeability and thickness studies using EIS. EIS can be used to monitor the film dissolution under shear flow. We are using an in house-developed MATLAB code to interpret and model the EIS data using an equivalent electrical circuit approach. The goal of this project is to eventually conduct experimental studies on different films and observe the responses to chemical and mechanical perturbations in detail.

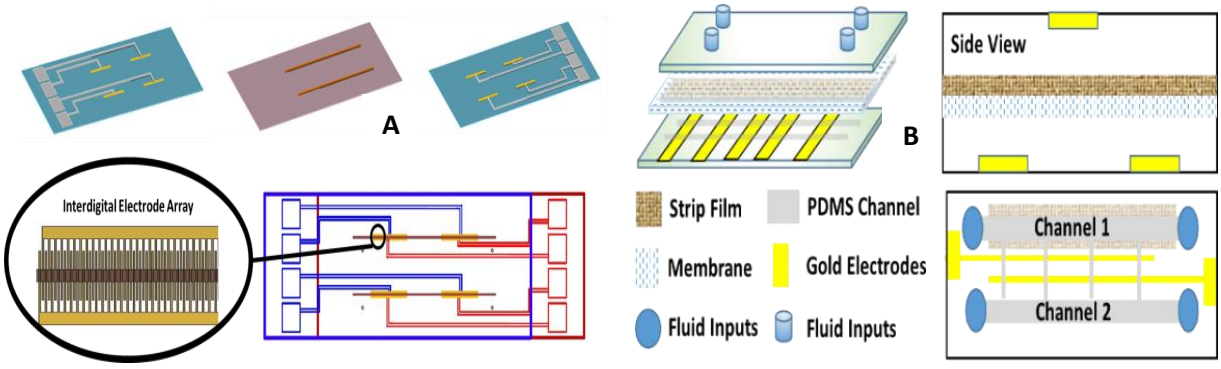


Figure 1: (A) Layout of the µFILM device, (B) Strip Films on Transwell® membrane

Role of Specific Inhibitory Motoneurons in *C. Elegans* Locomotion Examined Via Microfluidics, Tracking, and Calcium Imaging

Assma Itani and Gal Haspel
Department of Biological Sciences
New Jersey Institute of Technology, Newark N.J. 07102

Cross inhibition is the neuronal mechanism that prevent opposing muscles from being activated at the same time. It is found in many motor networks and specifically in networks that produce locomotor behavior. For example, it allows humans to walk by contracting muscle that extend the leg while preventing contraction of muscles that flex it. We hypothesize that it is found in the neuronal network that produces locomotion in the nematode *Caenorhabditis elegans*. We want to determine the role of inhibitory motoneurons on the nematode's ability to locomote in a sinusoidal pattern. We will combine microfluidics and optogenetics to restrict the animal's movement and control the activity of its specific cells to observe its locomotion behavior across a bend in a silicon (PDMS) channel. We predict that when *C. elegans* body is going through a bent channel, the inhibitory motoneuron that innervate muscle cell on the outside of the bend will be active. We expect our findings to provide evidence for the role of inhibition in the production of locomotor pattern.

We used a combination of two cutting-edge technologies to address this question. We controlled the locomotor behavior and restricted the animal to a prescribed path with a PDMS microfluidic device (Figure 1), and recorded the muscle activity with genetically encoded calcium indicators. Microfluidics is beneficial to the study of *C. elegans* for several reasons. First, it can stabilize the worm without any damage to the organism as would be caused by the use of other immobilization techniques. Second, the production of a microfluidic chip is inexpensive and relatively simple. PDMS is ideal for viewing through a microscope and is commonly used for this purpose (Duffy et al., 1998; McDonald et al., 2000; Xia and Whitesides, 1998). To study the locomotor behavior, we allowed each animal to move on its own accord through tight sinusoidal channels and single bends in similar channels. We tracked animal movement and the changes in calcium that correlate to muscle activation. We compared movement and muscle activity of wildtype animals to mutants lacking functioning inhibitory motor neurons. We expect our findings to provide evidence for the role of inhibition in the production of locomotor pattern.

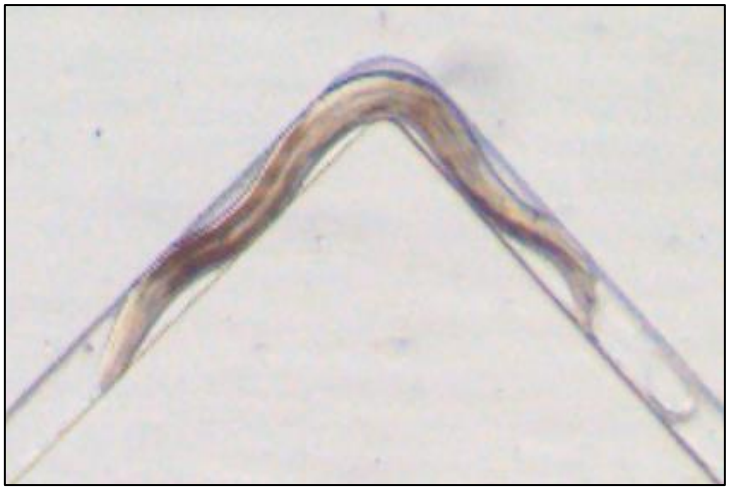


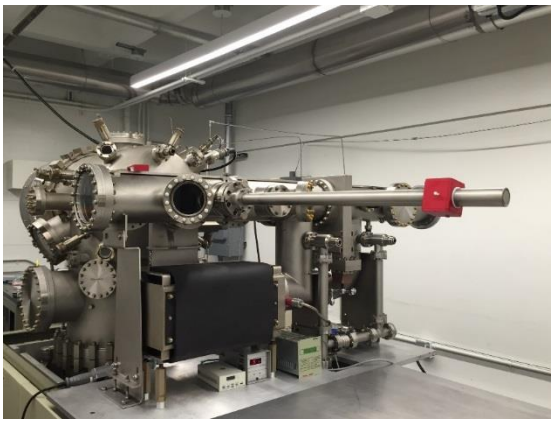
Figure 1: Wildtype C. elegans in 90 degree channel bend.

III-Nitride Nanowire Solar Cells Grown by Molecular Beam Epitaxy

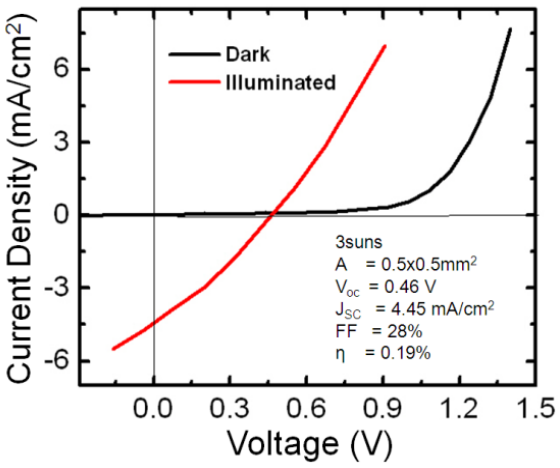
Ashish John, Nevin Varghese, Moab Rajan Philip, Dipayan Datta Choudhary, and Hieu P. T. Nguyen

Nano-Optoelectronic Materials and Devices Laboratory
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

III-nitride semiconductor has been intensively studied as a promising candidate for future full-solar-spectrum solar cells due to the large absorption coefficient, excellent carrier transport properties, and the tunable energy bandgap that can capture nearly the entire solar spectrum. Additionally, compared to their conventional planar counterpart, III-nitride nanowire structures offer several advantages for photovoltaics applications, including significantly enhanced light absorption due to the increased surface area, drastically reduced dislocation densities and polarization fields, and the compatibility with low-cost, large-area Si substrates. However, the presence of large surface states and defects can contribute significantly to the carrier loss in nanowire solar cells. As a consequence, the nanowire solar cell performance including open circuit voltage, short-circuit current, fill factor and efficiency currently are limited. To improve the device performance, the nonradiative surface recombination should be minimized by employing a proper surface passivation technique, either using dielectric material or large energy bandgap semiconductors. In this context, we have developed the molecular beam epitaxial growth of high quality III-nitride nanowire structures for photovoltaics application. High-quality InGaN/GaN nanowire solar cells with high efficiency of ~ 0.19% was recorded. The results encourage our approach on expanding to multijunction solar cell on silicon substrate. Such high-performance solar cell will lead us to smart solar-energy devices. Applications and experimental results will be discussed in the poster.



(a)



(b)

Figure 1: (a) Molecular beam epitaxy system located in FMH003, (b) Current-voltage characteristics of InGaN/GaN nanowire solar cell under dark (black curve) and illumination (red curve) conditions.

Design of a Testing Methodology to Measure the Polymer/Ceramic Interface

Richard Johnson, Adviser: Dr. Siva Nadimpalli
Department of Mechanical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

One of the main causes of battery degradation is the interface failure between the active materials and the polymer that holds the active materials together. Understanding this interface failure is crucial for the advancement of next-generation high-energy density-rechargeable batteries which can be used in grid storage for solar and wind power as well as in electric cars. The objective of this project is to design an experimental method to measure the fracture energy of the polymer/active material interface in a battery electrode. This experimental method consists of fabricating a double cantilever beam sample (Fig.1) comprised of a thin film of polymer sandwiched between a silicon wafer and a fused silica wafer. A folded piece of aluminum foil was then added between the two wafers to create a linear crack front. This sample mimicked the interface between the polymer binder and active materials found in a battery. The test set up was then created by using a linear actuator to apply a force to the end of the sample, while a camera recorded the behavior of the crack front, the area of interest, such that crack propagation could be monitored. The testing method was designed to be applicable to current and future batteries.

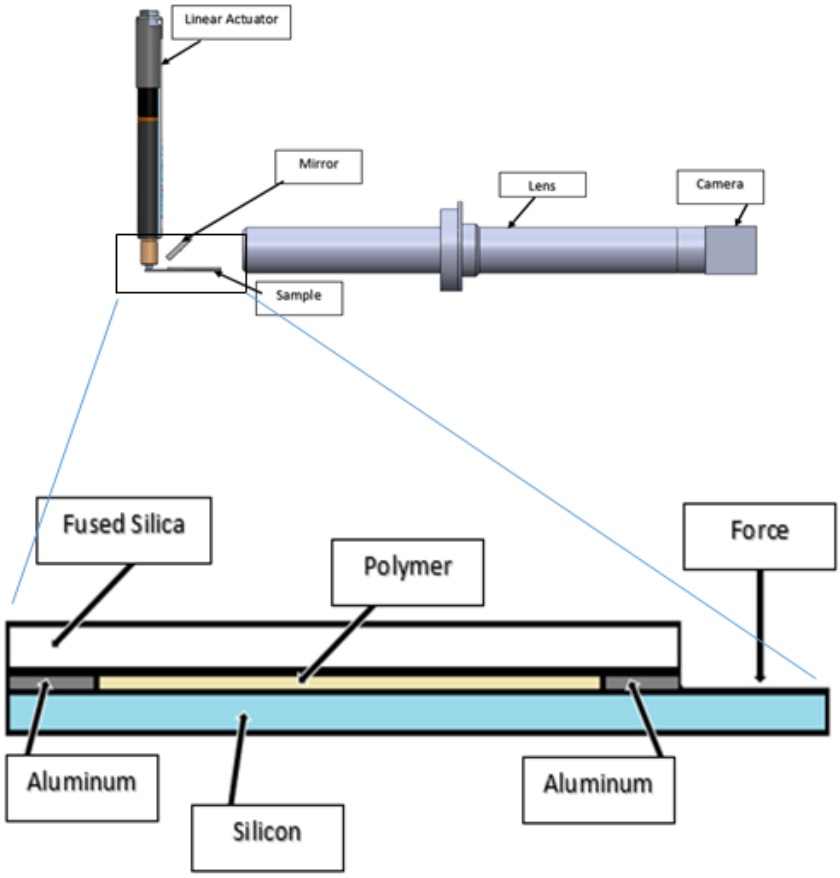


Figure 1: Schematic of Testing Methodology

Chaotic Circuits and a Method for Semi-Chaotic Encryption

Ian Jordan, Adviser: Dr. Denis Blackmore, Mentor: Aminur Rahman, Ph.D. Candidate
Department of Mathematical Sciences
New Jersey Institute of Technology, Newark, N.J. 07102

Using research from last summer, extended analysis on logical RS flip-flop circuits[1] is being performed via a bilinear component map model, which provides a two-dimensional representation of the chaotic behavior obtained from the three-dimensional continuous model. After constructing a physical realization using standard factory-grade electrical components, it became apparent that a multitude of directions could be taken to extend the model, allowing for the discovery of various mathematical phenomena related to certain chaotic regimes. The first addition considered, discussed in Rahman and Blackmore,[3] was to add another degree of freedom to the system. Consequently, the two-dimensional discrete map portraying the circuit becomes three-dimensional. This of course requires that a fourth dimension be added to the continuous system of differential equations governing the dynamics of the circuit.[3] As of now, this has been studied using two separate Chua circuits. However, it will be a goal of further investigation to determine a way to design this system with a single Chua circuit. With the model of the extended system (Chaotic Ring Oscillator), any further generalizations to the dynamics should be fairly straightforward. A variety of extended topologies were looked into, allowing for comparisons between standard logic algorithms and their chaotic equivalents. The NOR gate is the fundamental building block in all binary logic, and since the RS flip-flop is created out of two NOR gates, with the feedback of each fed into the input of the other, any possible combination of chaotic Boolean algebra can be created.

Based on the chaotic behavior of this system, a variety of potential methods for semi-chaotic encryption were developed. While the chaotic circuit would prove in theory to be an excellent way to impose cryptography, it would require a highly controlled environment, and all integrated circuits would need to come from the same silicon wafer to ensure that the parameters of the system be undisturbed. In addition, a purely chaotic encryption scheme would be nearly impossible because of the limitations in numerically analyzing a chaotic system, as well as the difficulty in properly bounding many of the models.[2] One favored idea for tackling these problems is the use of a simple binary map, such as the bit shift map, or any of its topological conjugates (tent map, logistic map, etc.). Using the bit-shift map as an example, the system would take the form,

$$d\colon [0,1) \to [0,1)^{\infty}, x \to (x_0, x_1, x_2, \dots)$$

$$\text{where } x_0 = x, \forall n \geq 0, x_{n+1} = (2x_n) mod 1$$

So long as the input to the system produces an irrational binary output, the key cannot be broken by conventional means using a sequence of stacked methods layered within the output time series of this map, including that of standard symmetric encryption.

CNIM Scale UP

Kabir Mitra, Adviser: Dr. Mitra, Mentor: Dr. Sagar Roy
Department of Chemistry and Environmental Science
New Jersey Institute of Technology, Newark, N.J. 07102

The objective of this project is to utilize carbon nanotubes (CNTs) to synthesize Carbon Nanotube Immobilized Membranes (CNIM) with breakthrough membrane properties for the generation of pure water from sea and brackish water via membrane distillation (MD). This fundamentally new approach will reduce the energy requirements and cost for desalination. MD can be operated at relatively low temperatures (60-90^{o}C) and can be powered by low-grade heat. This enables an MD system to utilize waste heat and alternative energy sources such as solar energy. MD offers several advantages over traditional desalination techniques, including the ability to handle higher salt concentrations, less stringent pretreatment requirements, less energy consumption, significantly less fouling, and longer lifetime for the membranes. This technology it will dramatically change the competitive landscape of conventional methods such as Reverse Osmosis (RO) and thermal evaporation.

This project also focuses on ***issues related to power plants.*** Due to their high cooling water requirements, the power plants are the largest consumers of fresh water. The global water crisis is a major problem facing power generation, and CNIM-MD offers several opportunities to help alleviate this issue. In addition to utilizing sea and brackish water, the utilization of waste heat will reduce the cooling water requirements, and by treating the saline cooling tower effluents, CNIM-MD will allow the towers to operate at higher cycles of concentration. The effluent from CNIM-MD is pure enough to be used as boiler feed water, with minimal additional treatment. ***The specific goal for this phase of the project is to study the scale up of membrane modules for eventual power-plant applications.***

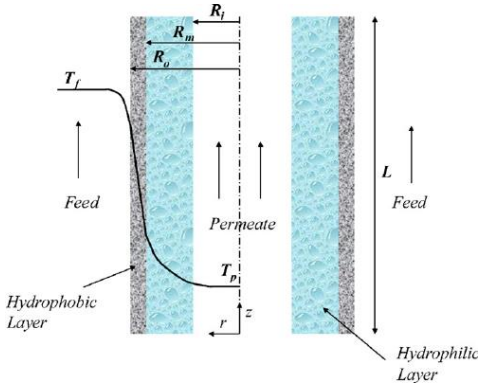


Figure 1. Membrane distillation schematic

Microwave-Assisted Antifouling Membrane Filtration Technology

Undergraduate student: Mehnaz Moon
Mentors: Wanyi Fu (Ph.D. student); Adviser: Dr. Wen Zhang
John A. Reif, Jr. Department of Civil and Environmental Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

During the last few decades, membrane filtration has been extensively used in water and wastewater treatment, desalination, dairy making, biomass/water separation and recovery of rare metals. The current challenges associated with membrane filtration are mainly related to membrane fouling that requires sophisticated membrane design and fabrication to mitigate fouling and costly backwash or membrane cleaning strategies to recover the permeate flux. Both membrane fouling and defouling processes cause increased energy consumption and inevitably physico-chemical damage to membrane materials. Our research objective is to develop a microwave irradiation-based technology that offers chemical-free and in-situ membrane defouling or mitigation. The experimental setup in **Fig.1** shows our bench filtration unit placed inside a microwave to irradiate filter once fouled to investigate the potential antifouling performance. Currently, the research has identified high-energy location (wave peak or valley that transmit the highest order of magnitude irradiation energy for water molecules to absorb) inside microwave oven, calculating water flowrate through a membrane, proving existence of nanobubbles by measuring particle size distribution and zeta potentials. For example, **Fig. 2**. shows that with at high water volume and low power modes, the efficiency of microwave energy absorption by water was higher under the same time of microwave irradiation (10 s). Our research outcomes aim to develop novel approaches for membrane fouling control and membrane cleaning, which potentially transform and upgrade current membrane filtration practices and industry.

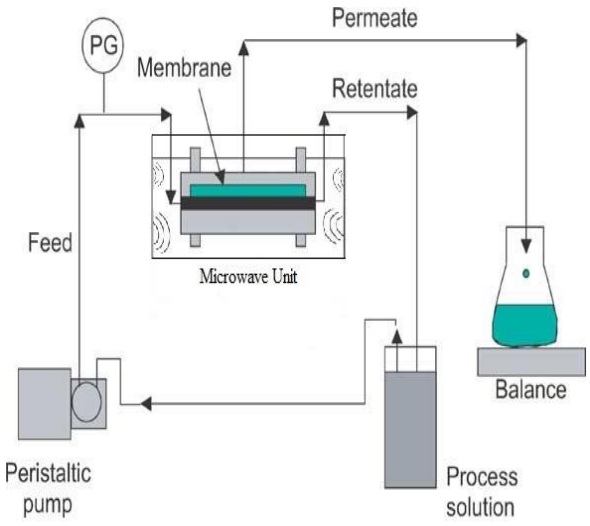


Fig. 1. Experimental set-up for microwave cleaning of membranes. PG represents the pressure gauge.

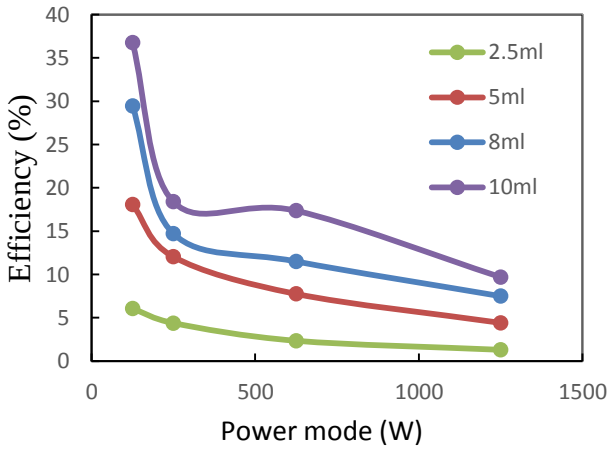


Fig. 2. Efficency of different volumes and different modes at 10 s.

Analysis of Stress and Strain in a Depressurized Tank with Wall-Embedded Channels

Jorge Murgueytio, Adviser: Dr. Z. Ji
Department of Mechanical Engineering
New Jersey Institute of Technology, Newark N.J. 07102

It has long been realized that attaining and maintaining a sub-atmospheric pressure environment is essential to many industrial processes, including electronics, chemical, petrochemical and pharmaceutical applications. A system and method was recently invented to generate vacuum through condensation of steam. During the operation of such a system, the pressure inside a cylindrical tank reduced from the ambient pressure to a rough vacuum. The tank also experiences large temperature variations due to the heating and cooling cycles in the process. The specific aim of this project is to analyze the stress and strain in the cylinder wall as a result of different pressure and temperature conditions.

Selected wall materials and cylinder structures were designed and constructed using computer aided design (CAD) software PTC Creo Parametric 3.0. Engineering analysis was performed under various pressure/thermal loading conditions using PTC Creo Simulation. The stress and strain results obtained from the simulations were analyzed using knowledge learned from classes such as Stress Analysis, Heat Transfer and Intro to Computer Aided Design.

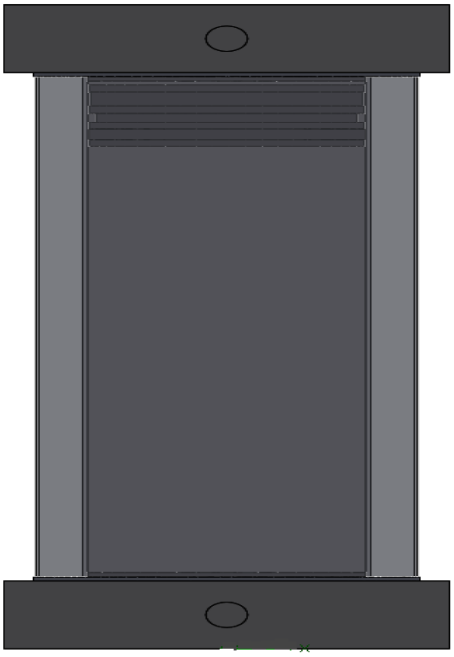


Figure 1. Stress - Strain Analysis for Depressurized Tank

Phonon Spectra of Simulated Microtubules and Their Relationship to Cancer

John Palmieri, Advisers: Dr. Camelia Prodan, Dr. Gordon Thomas
Department of Physics
New Jersey Institute of Technology, Newark N.J. 07102

This research project will study the effects of a simulated chemotherapy drug, Taxol, on the dynamic instability of simulated microtubules. By representing a microtubule and drug with a mechanical model, we seek to gain insight into the vibrational properties of microtubules and how they are changed by Taxol. Specifically, the mechanical behavior of the simulated system will be analyzed by generating a phonon spectrum. A phonon spectrum shows the response to different frequency stimuli. We believe that cancer drugs function by changing this phonon spectrum and interfering with the normal behaviors of structures that are vital to cell survival.

Our proposed model consists of a theoretical representation of a microtubule that is composed of various mechanical structures, including springs, magnets and 3D-printed parts. By modifying this 3D-printed model, the effects of Taxol on the microtubules can be simulated in various ways, such as altering the spring constants between certain dimers. Based on the results gathered from this model, we hope to elucidate the functioning of Taxol within the cell. The observations and discoveries of this research can have significant effects in the fields of life science and medicine.

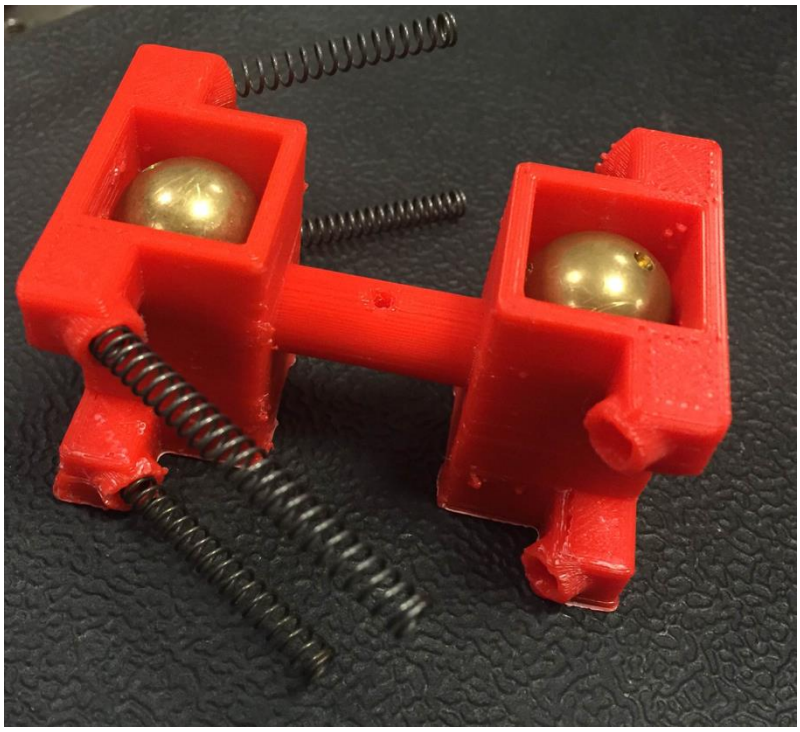


Figure A: An individual subunit of the system, depicting a dimer consisting of brass spheres encased in a 3D-printed model. Springs can be seen attached to the dimer at 45 degree angles.

Circadian Clock in Cyanobacteria

Shyamal Patel and Aesha Shah, Adviser: Dr. Yong-Ick Kim
Department of Chemistry and Environmental Science
New Jersey Institute of Technology, Newark N.J. 07102

Earth's rotation about its axis occurs within a period of 24 hours. Life on Earth, in return, is able to predict and adapt to fluctuations in light intensity, temperature and humidity. The circadian clock generates rhythmic patterns that control temporal programs of cellular physiology which are entrained by environmental stimuli. Many organisms display circadian clocks in their genome including human beings as is evident by our sleep-wake cycle. The simplest circadian clock known is that of the cyanobacteria *Synechococcus elongates*. The circadian clock can be divided into three components: the input, the oscillator and the output pathway. The focus of this research is on the central oscillator that generates rhythmic patterns in cellular physiology and behavior. The oscillator can be reconstituted *in vitro* by three proteins: KaiA, KaiB and KaiC. The *in vitro* reaction begins as the purified proteins are reacted in a test tube with ATP. Rhythmic oscillations begin as KaiC is phosphorylated and dephosphorylated. During the first 12 hours, KaiA binds to the C-terminus residues of the A-loop on KaiC, promoting phosphorylation. This causes a conformational change of KaiC, which exposes the KaiB binding site. Once KaiB binds to KaiC, it inhibits KaiA promoting dephosphorylation. The A-loop of KaiC is critical to this oscillation process, since without it KaiA and KaiB cannot bind and thus KaiC cannot phosphorylate. Past studies have found that the A-loop is stabilized by a network of five hydrogen bonds. In theory, by breaking a hydrogen bond in the network, the A-loop will destabilize and cause change in the phosphorylation state of KaiC. The goal of this experiment was to make a mutation at the Arginine-488 (R488) residue of the A-loop, changing it to Alanine. Arginine contains a guanidino group, which contains nitrogen atoms capable of hydrogen bonding, whereas alanine possesses a methyl group, which cannot participate in hydrogen, thus causing a break in the network. It is expected that this mutation will not only destabilize the A-loop, but will change the phosphorylation pattern of KaiC, possibly even allowing phosphorylation without the presence of KaiA. Another such mutation is made to the A-loop of KaiC at site R488. A point mutation is performed at the site whereby the arginine is substituted by glutamine. This substitution mimics the KaiC residue sequence of the marine cyanobacterial genus *Prochlorococcus* which has displayed circadian oscillations without a significant portion of the KaiA genome. By inducing a point mutation, a *Prochlorococcus* like KaiC can be mimicked in the *Synechococcus* organism to reconstitute a two-component circadian oscillator.

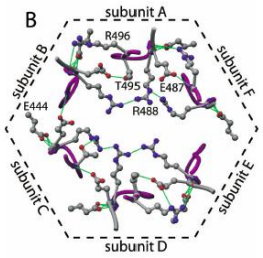


Figure 1. Hydrogen bond network on A-loops in hexamer seKaiC (From Kim et al., 2008, PNAS) [7].

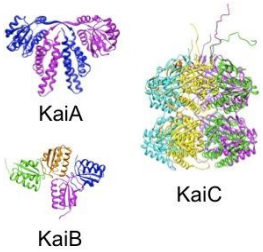


Figure 2. Crystal structures of Kai Proteins.

Modulation of Crustacean Pyloric Rhythm by Red Pigment Crustacean Hormone (RPCH)

Rohit Premkumar, Department of Biological Sciences
Faculty Mentor: Dirk Bucher Ph.D., Department of Biological Sciences

Activity in neural networks is altered through neuromodulators. Most neural pathways are complicated and difficult to study. However, there exists the stomatogastric ganglion (STG), a cluster of only 30 neurons, found in crab (*Cancer borealis)* stomachs. Due to the relative simplicity of the stomatogastric system, it was selected as the focus of our study.

The neuropeptide, red pigment crustacean hormone (RPCH), has been known to affect the pyloric rhythm generated by the STG. Therefore, while the STG was exposed to an RPCH solution, I examined the components of the pyloric rhythm in several nerves found in the stomatogastric network such as: LVN, MVN, PYN and PDN. I did this by isolating portions of nerves by making a Vaseline well and then placing one electrode inside the well and one outside to measure voltage differences. As a result, I was able to record the rhythm.

Not only did the investigation confirm that RPCH functions as a neuromodulator upon the STG, since a positive correlation between RPCH concentration and signal frequency was seen, but it also determined the quantitative changes in the electrical signals that are distributed throughout the system. This included changes in signal frequency and the relativity of particular signal components.

Mapping the Neural Connectivity of Midwater Amphipod Phronima

Omar Qari (Biology), Adviser: Dr. Daphne Soares (Biology)
Department of Biological Sciences
New Jersey Institute of Technology, Newark N.J. 07102

Animals that live in the deep ocean have developed a wide range of visual strategies for life in a dimly lit to completely dark habitat that lacks hiding places and is illuminated mostly by pinpoint bioluminescence. Processing this type of information is a completely different task than what nervous systems on the surface face, where there is a lot of information and the visual system has to filter out clutter. Often deep-sea amphipods have multiple sets of eyes. Why is this so prevalent? Nothing is known about how visual information is segregated in various sets of eyes and how it is then integrated in the central nervous system. Specifically, the genus Phronima is attractive because it contains only 10 species that all have a set of four compound eyes: two smaller pigmented lateral eyes and two large transparent dorsally oriented eyes. Gross morphology of Phronima eyes has been documented in only a handful of species. Phronima's eyes are classified as apposition type, which is one of the oldest fossil eye types known, relying heavily on photoreceptors that allow them to have high light-gathering power. These large and exceptional eyes are completely different than vertebrate visual systems. Since the environment in which Phronima live receives little sunlight, it is likely to have a very sensitive visual system. This research is significant because nothing is known about the organization of the nervous systems of midwater invertebrates, or what kind of computations it has evolved to perform.

I have examined the neural connectivity of the visual circuit of Phronima sedentaria to set the framework for functional studies. My research describes the visual pathways in the genus Phronima by using micro-CT scans, neuronal tract tracing and histology experiments to determine the connectivity of its multiple eyes.

Figure 2: A lateral view of Phronima sedentaria; Jamme, S. (Photographer). (2006, March 30).

The Role of Trimethylamine N-oxide in Preventing Protein Misfolding during Alzheimer's Disease

Gopal Ravindhran, Adviser: Dr. Cristiano L. Dias
Department of Biological Sciences
New Jersey Institute of Technology, Newark, NJ 07102 USA

Alzheimer's disease is a deadly illness that affects over five million people every year. It accounts for over 80 percent of dementia cases and is the most widely studied neurodegenerative disease. Alzheimer's disease results from the misfolding of proteins, which are large molecules that carry out the functions essential for human life at the cellular level. When these proteins misfold, they often clump into large aggregates called amyloids, inhibiting protein function and causing disease. Recently, research has been done into whether specific molecules can be used to slow down and possibly prevent the misfolding of these proteins. The goal of this project was to assess effects of trimethylamine N-oxide (TMAO) on protein folding.

The Molecular Dynamics Software GROMACS was used to simulate the aggregation of eight proteins related to Alzheimer's disease in pure water and aqueous TMAO solution. The goal is to see if TMAO can prevent proteins from aggregating into clumps characteristic of Alzheimer's disease. The results were analyzed for the average number of hydrogen bonds of the protein aggregate. In particular, we compared this quantity for simulations performed in pure water and in aqueous solution with different concentrations of TMAO.

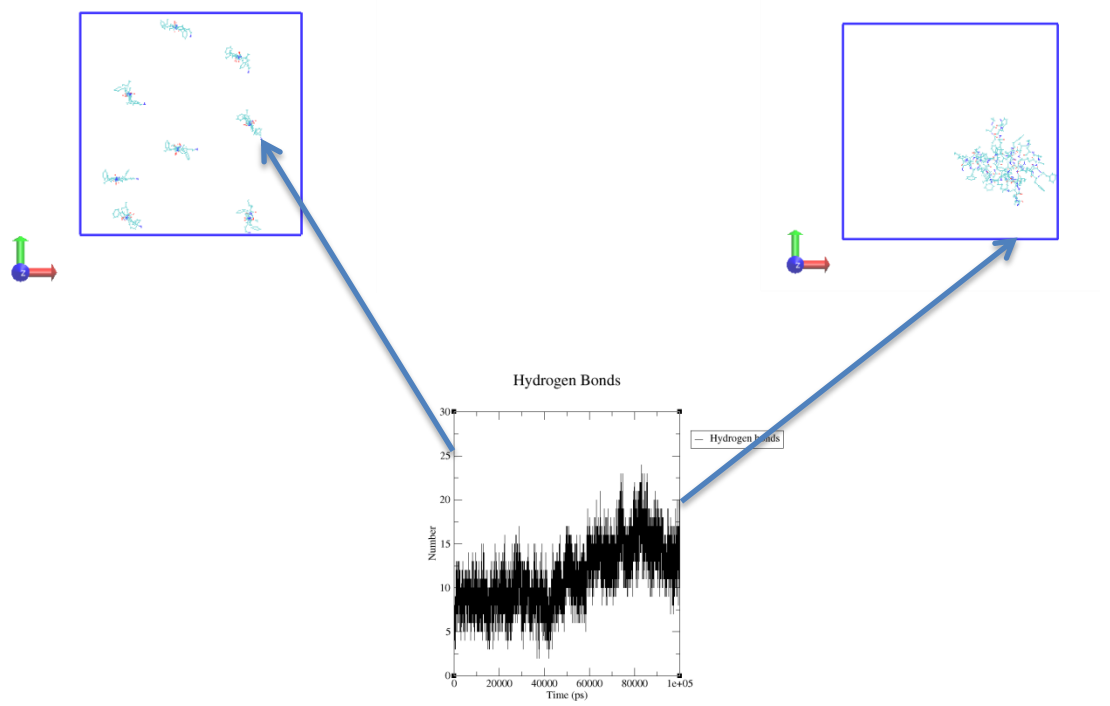


Figure 1. Graph of number of hydrogen bonds vs time for 0M TMAO in water and protein. Arrows shown are pointing to the structure of the protein at t = 0 ns and t = 100 ns, respectively.

Autonomous Snow Removal

Matthew Reda (ME), Ramone Sangster (BME), Adviser: Dr. Lu Lu (MIE)

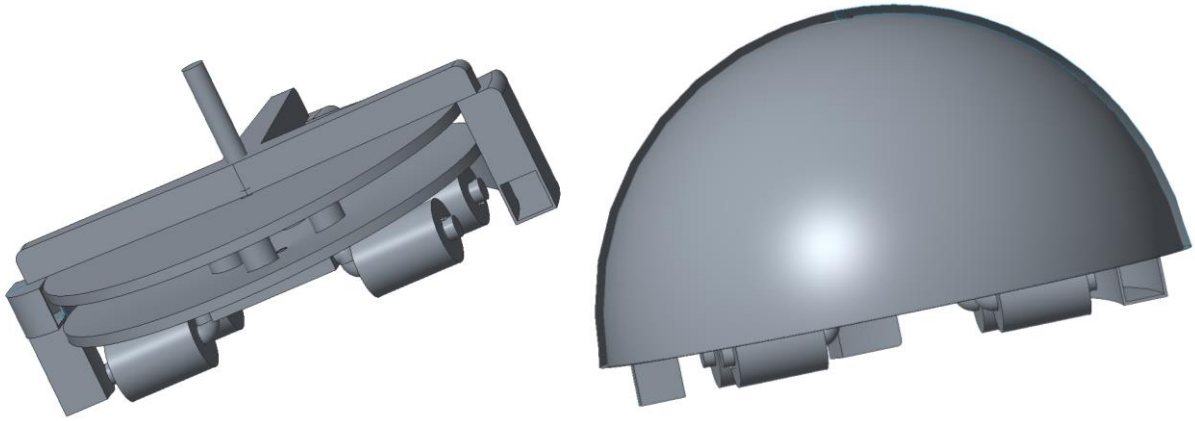
Department of Mechanical and Industrial Engineering

New Jersey Institute of Technology, Newark, N.J. 07102

The goal of this project is to create a device that will be able to remove the snow from a commercial driveway without the homeowner having to do anything more than set it up. The Roomba[1] cleans your carpet autonomously; the Landroid[2] can cut your lawn autonomously, and yet there is nothing that can clean your driveway autonomously.

Through much examination, the conventional throwing of snow would be too complex for an autonomous machine to handle, and simply plowing the snow needs a lot of strength and also tends to leave things messier than throwing or shoveling. This leads to the only alternative: melting. This entire project revolves entirely around how to collect and melt the snow and then get rid of the water. Over the course of the research, the project has taken a couple pivots and varied slightly from its original design but has not deviated from that core objective. We experimented with propane as the source of heat, with different types and amounts of batteries and much more. Even the shape has changed completely, from a big box now to a dome.

Currently, the designs include an 18- inch diameter dome with a heating chamber in the center. Rotating around the center of the dome will be a screw which will funnel up the snow into the chamber to be melted. The water will then be sucked out through a heated hose attached to the top of the dome leading back to wherever the homeowner wants it to drain, away from the driveway removing the fear of icing over. the robot will start to collect when it starts to snow and will go continuously throughout the storm, never needing to collect more than an inch or two of snow at time. Along with the heated hose, will run a power cable that will be plugged directly into an outlet, removing the need for batteries to be charged while also allowing electric heat to melt the snow.



w/o cover* w/ cover*

*pictures are simplified drawings for visualization purposes only and are not actual designs

[1]http://store.irobot.com/vacuum-cleaning/roomba-robots/family.jsp?categoryId=2501652&gclid=COG3_Mjv9c0CFclkhgodp-cKnA

[2]https://www.worx.com/landroid-robotic-lawn-mower-wg794.html

AudIQ: Auditory Cue Training to Improve Auditory Awareness and Function

Jennifer Rochette, Siddharth Iyer, Antje Ihlefeld Ph.D.

Department of Biomedical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

While hearing aids help people hear by amplifying the sounds around them, hearing-aid users often struggle to distinguish the desired sounds from noise in the background. This research project aims to answer the hypothesis that targeted training in specific auditory cues will help to improve a person's auditory selection skills and apply these to everyday surroundings. The ultimate goal of our project is to use our findings to deliver a fun and interactive way of assessing and training auditory function in people with hearing loss, so that they can more easily disentangle target sounds in everyday surroundings. Our model consists of programming a mobile-phone application as a user-friendly interface, to both train listeners and collect user data for research purposes. We aim to focus on spatial sounds as our initial targeted auditory cues. Two main acoustic cues underlie spatial sound perception. The interaural time difference (ITD) is the time it takes a sound to travel from one ear to the other, while the interaural level difference (ILD) is the difference in amplitude between both ears. In addition to allowing listeners to localize the source of a sound, ITD and ILD cues can make it easier to hear a targeted sound from background noise.

To test our hypothesis that the effects of everyday auditory cue training using our game, AudIQ, can improve hearing awareness, we will implement an experiment that involves normal hearing subjects. These subjects are separated into two test groups: one control group that trains their auditory cues using the AudIQ game, and one control group that plays a placebo game that has no auditory training components. Each test subject will receive an initial hearing test, perform an auditory assessment of identifying speech in background sound, play the corresponding game for at least an hour each day, and then a final test will be administered to be compared to the initial assessment. The expected outcome is that the group playing the AudIQ game will show a greater increase in identifying spatial cues for targeted hearing. Future work aims to focus on training hearing-impaired individuals to identify these specific cues via our mobile-phone application, in order to directly improve their auditory function for everyday listening challenges, such as identifying speech in background sound. The ultimate goal of our project is to translate scientific research into a mobile-phone application, through helping individuals with hearing loss by increasing their auditory awareness, skills and confidence.

Engineering Polymeric Nanoparticles with Targeting Ligands for Brain Drug Delivery

Kristen Scotti, Adviser: Dr. Xiaoyang Xu
Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

The central nervous system (CNS) is protected by a highly impermeable blood-brain barrier (BBB), which protects it from the invasion of harmful small molecules. The protection the BBB provides is essential to the body's homeostasis, however it prohibits normal drug delivery. The BBB inhibits the ability of treatment drugs for diseases such as Alzheimer's disease, Parkinson's disease and brain tumors from being delivered efficiently to targeted sites in effective concentrations. The aim of this project is to design a targeted polymeric nanoparticle drug-delivery system that can effectively transport across the BBB and deliver therapeutic drugs with high efficiency to the CNS, resulting in a great advantage over current CNS disorder therapies.

The polymeric nanoparticles were prepared through a self-assembly method using self-synthesized PLGA-PEG diblock copolymers by a nanoprecipitation method resulting in core-shell structured nanoparticles. PLGA provides a hydrophobic core to encapsulate insoluble drugs, while PEG provides a hydrophilic shell to which targeting ligands can be conjugated (Fig 1.). The chemical structures of the self-synthesized diblock copolymers were confirmed using ^{1}H NMR. The PLGA-PEG nanoparticles were characterized by size, polydispersity index (PDI) and surface charge using dynamic light scattering (DLS). Drug encapsulation efficiency of the nanoparticles was measured using High Performance Liquid Chromatography (HPLC).

Conjugating targeting ligands to the surface of the nanoparticles will allow the drug encapsulated PLGA-PEG nanoparticles to transport across the BBB through the receptor-mediated transcytosis pathway and deliver therapeutic drugs to the CNS. The effectiveness of the ligand targeted PLGA-PEG nanoparticles in crossing the BBB will be assessed using a transwell system in which primary human brain endothelial cells (hBECs) are cocultured with astrocytes to form a monolayer mimicking the BBB. Both ligand targeted PLGA-PEG and nontargeted PLGA-PEG nanoparticles will be tested on transwell systems to compare the effectiveness of the targeted nanoparticles in transporting across the BBB.

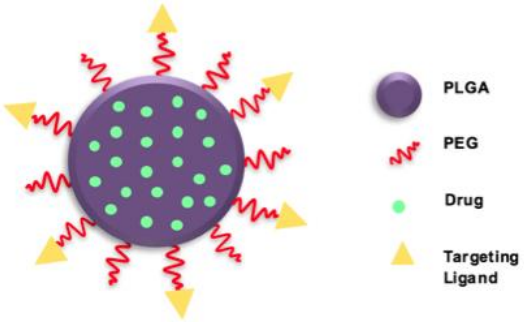


Figure 1. PLGA-PEG drug encapsulated nanoparticles conjugated with targeting ligands

Tiny Particles, Massive Impacts: The Relationship between the Morphological and Optical Properties of Soot Aggregates

Tasneem Shaltout, Adviser: Dr. Alexei Khalizov, Mentor: Chao Chen (Ph.D. student)

Department of Chemistry and Environmental Science

New Jersey Institute of Technology, Newark, N.J. 07102

Atmospheric soot, particles composed primarily of elemental carbon, organic carbon and other materials, are emitted in substantial amount from fossil-fuel combustion and biomass burning. A characteristic feature of soot particles is their ability to both absorb and scatter light, making them a key contributor to climate change, second only to carbon dioxide. Fresh soot particles are also highly susceptible to a variety of aging processes that occur in the atmosphere and alter the morphology, or structure, of soot. Aged soot particles are differentiated by a more compact structure that can be expressed as an increase in fractal dimension and effective density. Soot aging, such as the restructuring and coating of soot aggregates, is a result of a variety of different processes, including absorption of semi-volatile vapors, reactions with atmospheric gases, and coagulation with other aerosol particles. This causes a modification in soot optical properties, including the ability to scatter and absorb light.

The goal of this project seeks to establish the morphological mixing state (coating distribution) of soot aggregates and the related modification in their optical properties. This project's main focus is on (1) understanding the transformation mechanisms in aerosol soot particle morphology when exposed to different chemical materials and environments, (2) observing and relating the effect the aging of soot particles has on its optical properties, (3) collecting and producing a set of morphologist and optical data that can be used to develop and improve predictive atmospheric models. Scanning Electron Microscopy (SEM) is used to observe the coating distribution over soot aggregates (Figure 1). A better understanding of the relationship between the composition, structure and optical properties of aged soot particles will significantly contribute to the understanding of the environmental and health-related impacts of atmospheric soot aerosols.

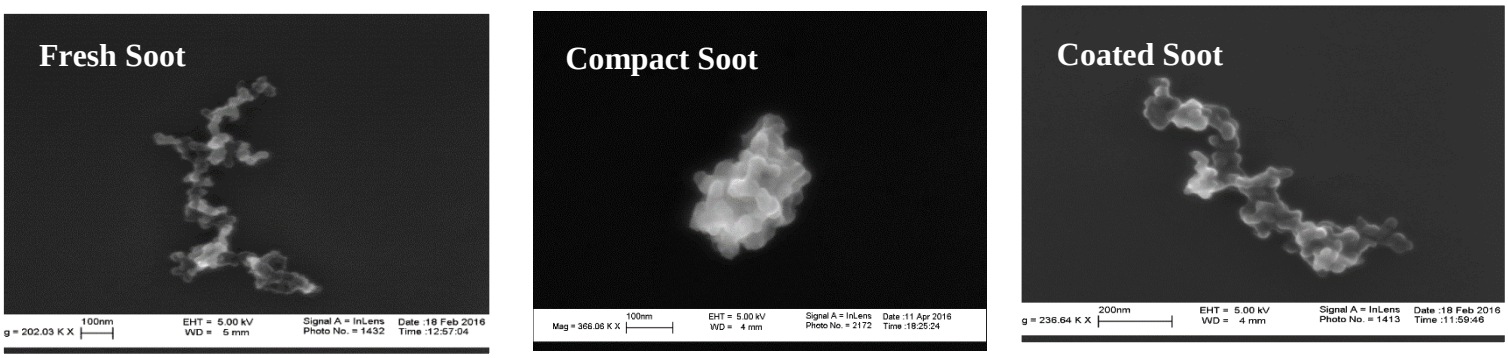


Figure 1. SEM image of freshly emitted (left), compact (middle), and coated (right) soot aggregates

Approaches to Increase Productivity of Electrospinning

Mansi Sheth, Advisers: Dr. Treena Arinzeh and Dr. George Collins
Department of Biomedical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Electrospinning is a facile method for producing macro- and nanofibers. These fibers have diameters that are similar to the fibrous proteins found in the extracellular matrix within the body, which allows for these fibers to be used for applications within tissue engineering such as cell seeding and tissue regeneration. The typical electrospinning apparatus involves high voltage applied to a conductive needle that is fitted to a syringe containing a polymer solution. This arrangement is widely used due to its ease at producing the micro- and nanofibers. The solution is composed of entangled polymer molecules. A voltage is applied to the needle, which generates electric charges into the solution. Due to the potential difference between the needle and the grounded collection plate, a narrow stream of solution ejects out of the needle and collects onto a grounded collection. As it travels from the needle to the collection plate, the charges in the solution cause the fluid stream to uniformly elongate and reduce diameter. The entangled polymer holds the stream together as a fiber, and the solvent evaporates to allow for dry nanofibers to collect on the plate. The nanofibers arrange randomly on the mat and overlap producing the mat, which is then carefully removed from the plate. This method, although easy to produce this mat, is not very efficient because there is only one ejection jet from the needle.

Our main objective was to find a method by which the throughput of electrospinning could be increased. Instead of a needle electrode, a needle-less apparatus is constructed that allows for direct charge inject into a continuously replenished pool of polymer solution. The apparatus that we have fabricated uses a brushless electrode that has allowed for the production of multiple fluid streams, which greatly increases the rate of spinning and reduces the amount of time it takes to spin a particular volume of solution. The rate of electrospinning a solution of gelatin in acetic acid/water using a the single-needle approach is about 3 ml/hour, while using the needle-less apparatus increase the rate to about 8 ml/hour. Another advantage to using our apparatus is that it becomes easier to spin more viscous solutions.

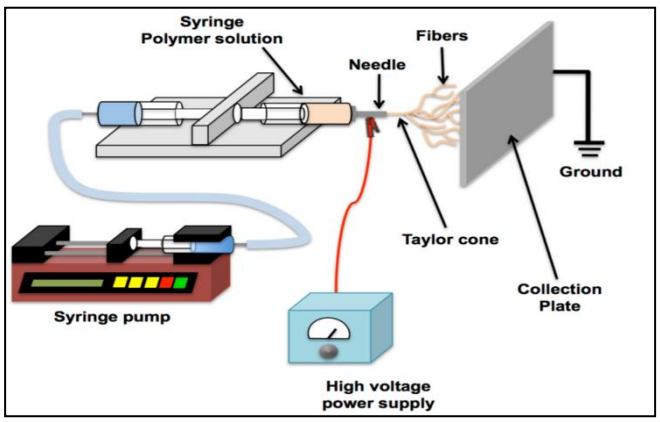


Figure 1 *Needle-less Apparatus*

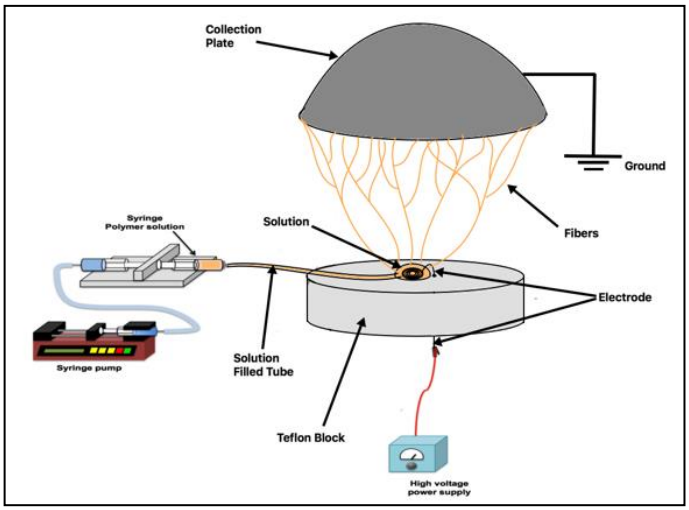


Figure 2 *Needle-less Apparatus*

Investigating the Lack of Voter Participation among the Demographic of 18-24 Year Olds

Michael Tadros
Adviser and Mentor: Dr. Elizabeth Petrick
Federated Department of History
New Jersey Institute of Technology, Newark, N.J. 07102

For my undergraduate summer research project, I planned on pursuing an answer and provide a solution to the problem with regard to the following question: ***Why is the voter turnout among the youth population (18-24 year olds) lacking when compared to other age demographics?*** This topic is of the utmost priority to the American public because if the youth are indifferent to the voting process today, imagine our society 20 years from now! The aim of this project was to investigate reasons, and to implement change based on those identified reasons, leading to the lack of voter participation among the youth population. Multiple studies have proven that when it comes to youth voting, the numbers are lacking compared to other age groups. I decided to conduct a study on our campus, and fair enough the results mirrored nationwide results. This raises the general question: Why, and what can we do to implement change? My goal is to be innovative, using the information I uncovered, to promote the voting process on our diverse campus.

Believe it or not, there is not a single publication on campus that is being produced that is encouraging the voting process! I decided to innovate by producing an educational pamphlet that will discuss the reasons behind the importance of voting and the results of my research. Further research has uncovered that there is not a single college in the state of New Jersey that includes voting promotions in the admissions packets for incoming students. *My goal is to make NJIT a pioneer in that regard.* Now that my investigative process is completed, I designed and will produce this publication to meet with my goals. I also look to coordinate with the First-Year Students' office at NJIT to include the publication in admissions for prospective students. If we work hard in trying to change the voting process today, we are hereby improving the world for the future.

Etiology, Pathophysiology and Stressor Mechanisms of Cadmium-induced Fanconi Syndrome Exacerbated to Chronic Kidney Disease in Sri Lanka

Prasanna Tati, UGY2, B.A. Biology, Albert Dorman Honors College, NJIT
Sami Shaikh, Hopewell Valley Central High School
Dr. Jay Meegoda, Faculty Adviser, Civil Engineering, Newark College of Engineering, NJIT

Access to clean drinking water is a privilege reserved for a small portion of the world. In many developing and even developed nations such as India, Cambodia, Brazil and Japan, citizens either have no choice but to drink polluted groundwater or do not understand the health hazards of such water. In Sri Lanka, much of the groundwater is polluted by fertilizers containing heavy metals and other toxic compounds that are then ingested by people. These toxins accumulate in various body tissue throughout a lifetime. An endemic of chronic kidney disease (CKD) has taken over the dry zone of Sri Lanka, affecting primarily middle-aged men in the agricultural industry with a history of tobacco use, alcoholism and unsafe pesticide use. A number of heavy metals disrupt functionality of body tissue and exacerbate existing health conditions, Cadmium in particular deposits in the renal cortex, where the heavy metal disrupts healthy glomerular flow and filtration. Cd enters the body by absorption through the integumentary membrane and travels in the blood in the form of a cadmium-metallothionein complex. Eventually, the complex is deposited in the renal cortex, and Cd accumulates in the proximal convoluted tubules of nephrons. The perpetual stress placed on the kidney by unhealthy habits such as tobacco use, alcoholism and unsafe use of pesticides worsen the effects of Cd-induced oxidative stress on the kidney. Alcohol, an anticoagulant, compromises the liver's ability to control blood flow to the kidney. An inebriated individual quickly loses fluid from the body and becomes dehydrated. The kidney is forced to take on thinned blood at a greater than optimal flow rate preventing proper filtration and cleaning of the blood. Tobacco, in the form of cigarettes and cigars, contains Cd which is inhaled through cigarette smoke and absorbed into the bloodstream at the alveoli, consequently finding its way to the renal cortex for deposition. Sri Lanka serves as a dumping ground for banned pesticides from all over the world. Unaware of the health risks, Sri Lankan farmers spray these pesticides at doses 300 percent higher and three times as often as recommended without any protective gloves, facemasks or clothing. The pesticides add further toxins to the blood and body tissue by absorption and inhalation, thus forcing the kidney to do even more work. The demographic most affected by CKD is middle-aged male farmers, who use CKD stressors and drink polluted water the most. Middle-aged male farmers spend the average day in hard labor outdoors losing fluids. In order to replace the great fluid loss, they drink relatively more polluted water than other demographics. The stress and overuse of the kidney's abilities only worsens the damage done and lowers the filter life of the organ. Over time, patients develop Fanconi syndrome, which is an amalgamation of abnormalities arising from the kidney's inability to reabsorb materials. This syndrome worsens to develop into CKD, which can be fatal. This project examines why Cd is the cause for CKD in Sri Lanka, how Cd gets into and travels through the body, the pathophysiology of Fanconi syndrome, the pathophysiology of CKD, and how CKD develops from Fanconi syndrome with a focus on Sri Lanka and support from cases all over the world.

Prototyping a Temporospatial Simulation Toolset: Case of an Ottoman Insane Asylum

Ulysee Thompson (IT/CS)
Advisers: Augustus Wendell (DD), Burcak Ozludil (CoAD)
New Jersey Institute of Technology, Newark, N.J. 07102

With rapid advancements in the field of simulation and digital scholarship, the issues of ease of access and ease of use have become primary concerns of historians and humanities scholars attempting to leverage new platforms. Scholars interested in creating platforms for the examination and discussion of historical data are now offered new This project attempts to demonstrate a prototype for how temporospatial simulation within the preexisting Unity3D software toolset may be implemented using generalized templates and object-oriented architecture. By creating an accessible plugin which requires minimal explanation, this project provides scholars with the ability to contextualize spatial data in the form of an interactive application for exploring a given space or object, explore temporal progression in the form of a mutable timeline displaying selected models representative of different time periods, and examine supporting documentation through a dynamically generated menu system.

As an initial proof of concept, this project focused on creating a suitably generalized suite of automated importer methods, prefabricated assets and dynamic asset generators within Unity3D for an existing research topic: a 19th-century Ottoman asylum. Located in Istanbul, the capital of the Ottoman Empire, this site represented an excellent, topical subject for the development of such a tool with its varied history and repeated revisions over the course of its use as a state mental hospital between 1873 and 1922. Of particular interest in this proof of concept was the ease of access for end users and ease of expansion for participating scholars who may not have had prior experience with Unity3D. By focusing development around an existing research project, it became possible to explore concepts that would be otherwise difficult to qualify, such as user experience and challenges in implementing functionality.

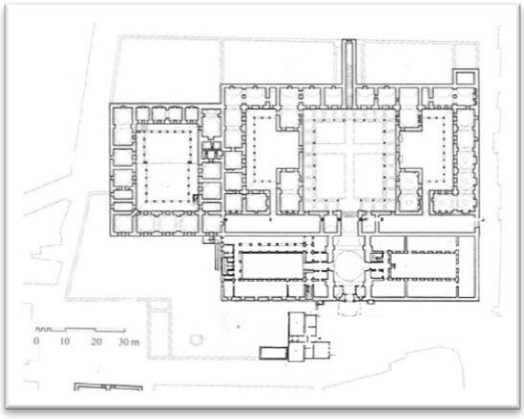


Figure 1:
Map of late period Ottoman Asylum.

Figure 2:
Early period Ottoman Asylum in Unity3D.

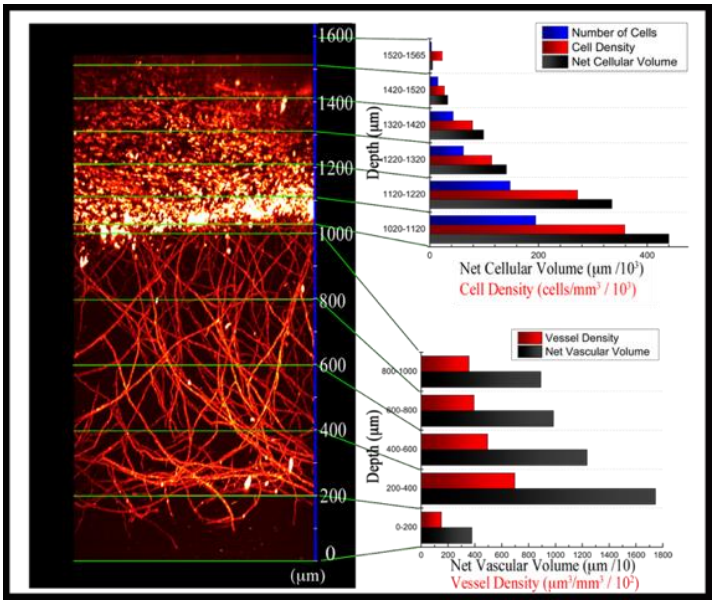
Development of Novel Two-Photon Fluorescence Probes for High Resolution Deep Tissue Imaging

Maira Valencia, Adviser: Dr. Kevin D. Belfield

Department of Chemistry and Environmental Science
College of Science and Liberal Arts
New Jersey Institute of Technology, Newark, N.J. 07102

The use of fluorescent molecules in biological research is now part of a variety of applications. These types of molecules capable of undergoing electronic transitions that result in fluorescence are known as fluorescent probes. Among their many applications, fluorescent probes can be used to monitor biological processes *in vivo*. In this case, such probes will be useful in capturing images dealing with cancerous tumors. Tumors are limited on resources and rely on the process of angiogenesis, which is the development of new blood vessels. However, techniques for the study of tumor angiogenesis *in vivo* are acutely lacking. Two-photon fluorescence microscopy (2PFM) for deep tissue imaging is a developing technology that offers several advantages for intravital microscopy. The use of two photons instead of one reduces overall photobleaching and photodamage by limiting irradiation to the narrow region around the focal plane. This reduction becomes important when collecting 3D data sets in thick specimens because it provides optical sectioning with subcellular resolution deeper within light scattering biological specimens. 2PFM is not only convenient for imaging of highly scattering tissue, it also results in a dramatic increase in viability of biological specimens. With the introduction of 2PFM, the developments of two-photon excitable probes have been applied to bioimaging.

The $\alpha_V\beta_3$ integrin is the integrin most strongly involved in the regulation of angiogenesis. Most integrins recognize their respective ECM proteins through short peptide sequences. RGD peptides are well-known to bind preferentially to the $\alpha_V\beta_3$ integrin, and the potential of $\alpha_V\beta_3$ integrin has been studied extensively as a target for tumor imaging agents. Therefore, the RGD peptide is an effective ligand for tumor targeting since it has been shown that the integrin $\alpha_V\beta_3$ is overexpressed not only on tumoral endothelium but also on cancer cells, for a lot of cancer-cell lines. Based on that, reactive probes will be created in order to be conjugated with these targeting segments, and their properties and use in 2PFM imaging will be analyzed.



Ronald E. McNair Postbaccalaureate Achievement Program

Antibiotic Encapsulated Hydrogel for Wound Treatment

Omar Abouelkhair, Xin Li, Adviser: Dr. Xiaoyang Xu, Mentor: Xin Li, Post-Doctoral Fellow
Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Since the early 1990s, many hydrogel-based drug-delivery systems have been developed. These systems have been proven to be highly controllable by external triggers such as UV light, electric fields, magnetic fields, pH and temperature change as well as internal triggers such as the degradation of polymer crosslinks. Research in this field has demonstrated that these systems allow strong control over the drug release, and current research focuses on extending its applicability while maintaining biocompatibility. This research focuses on developing a hydrogel which could release an antibiotic drug for the treatment of wounds. The hydrogel would seal the wound from further infection while allowing oxygen and water vapor to pass through, which will ultimately aid the autolytic debridement process. This newly developed hydrogel would allow for very strong control over the characteristics of the gel and the release of the drug, while also providing an ideal environment for the healing process. This new system may have the potential of revolutionizing the available treatments for wounds and post-surgical healing. Future research will work to confirm the biocompatibility of the system and demonstrate its efficacy and the control over drug release.

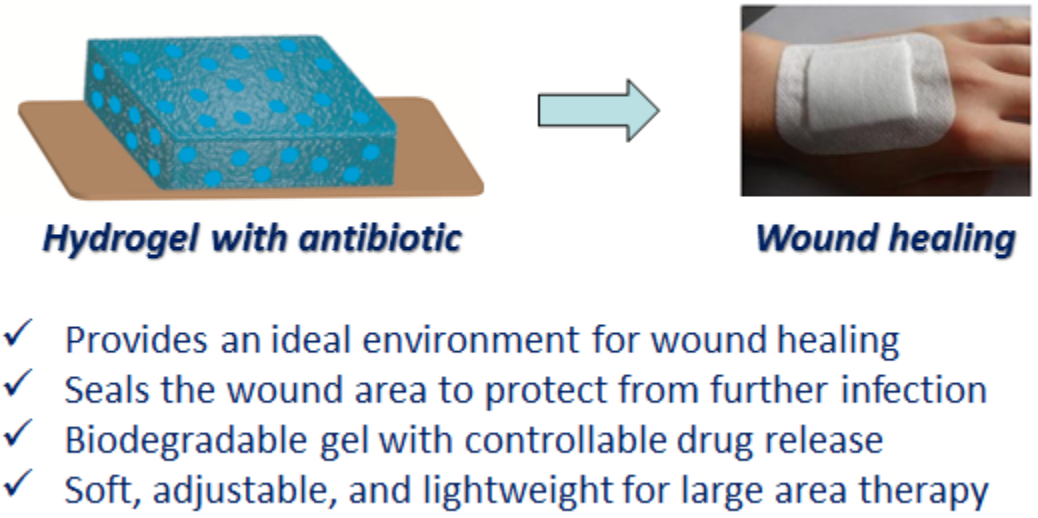


Figure 1: Demonstration of the application of the gel and highlight of its benefits.

Building a Flexible and Collaborative Online Learning System

Krzysztof Andres, Jimmy Lu, Alan Romano, Adviser: Dr. Michael Bieber
Department of Information Systems
New Jersey Institute of Technology, Newark, N.J. 07102

The Participatory Learning Approach (PLA) is an educational framework designed to promote a deeper understanding of course material [1]. It involves students in the entire problem lifecycle: create a problem using a rubric given by the instructor, solve another student's problem, grade solutions with comments and suggestions, and ultimately dispute the grade that students received if it does not meet their expectations. By assigning different roles to the students in groups and dividing a problem into multiple stages, students will be exposed to various styles of learning, such as inquiry-based learning in creating the problem and peer assessment in grading the problem. These steps will promote critical thinking [1]. The students are expected to retain more information from the coursework and to increase their interest in the subject through deep learning [1].

In PLA, an assignment is composed of one or more types of problems, which are referred to as workflows in the system. A workflow is then composed of multiple tasks of various types, e.g., create a problem, edit the problem, solve the problem, grade the solution, dispute the grades and resolve the dispute. In addition, any step in the workflow can lead to a subworkflow, which is a group of additional tasks designed to assess the quality of a particular task. These tasks can be assigned to individuals or by groups. In order to facilitate the adoption and use of PLA, an online system is being implemented to handle PLA's dynamic and complex structure. This project focuses on the design and implementation of flexible allocation and other algorithms and a database scheme for the online system, the design of a practical user interface for the system, and the design of group support in a collaborative learning environment. Interviews and user experience tests were conducted to gather feedback on the intended design, structure and features of the system. The algorithms and designs will enable instructors and students to adopt the PLA system with little overhead, while the group support that is implemented into this online system will make it easy for a group of students to work together. This will push PLA toward usage in real courses.

References

[1] Wu, D., Hiltz, S., and Bieber, M. (2010). "Acceptance of educational technology: Field studies of asynchronous participatory examinations." *Communications of the Association for Information Systems, 26*(1), 451-476.

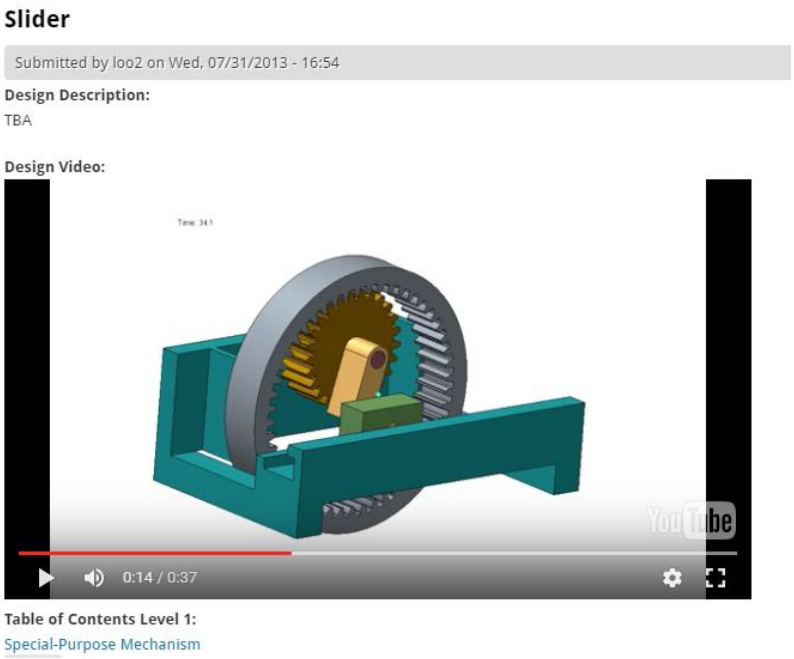
Design Well ™- Database for Animations of Mechanism Simulations

http://designwell.me/

Kevin Enriquez, Adviser: Balraj Subra Mani, M.S.
Department of Mechanical and Industrial Engineering
New Jersey Institute of Technology, Newark, NJ 07102

Databases have become the new way of searching through a plethora of information. Various databases exist to search through magazines, journals and newspaper articles. However, designers and engineers can't rely solely on readings. There is the need for more visual aids that inspire creation and innovation. DesignWell serves as a database to display animations of mechanism simulations. This database will aid product-design engineers and entrepreneurs during the conception of new ideas.

The simulations range from simple slider cranks to pneumatic assemblies and are modeled by engineering students like myself using Creo Parametric. My role is to design and contribute more simulations for the database. The information and resources are laid out as follows: Table of Contents, Contributors, Browse Mechanisms and Random Design. For example, if an engineer needed a visual on what coupler mechanism to use for a design, the engineer would go to the table of contents and then "coupler mechanism" where dozens of simulations would appear. DesignWell allows for a specialized and detailed search on a variety of mechanisms, making it much more efficient than a general Google search. Not only that, DesignWell hopes to bring 3D-printing files for over thousands of mechanisms in the near future.



Impact of Recycled Concrete on Reinforcing Bond Strength

Marco Fernandez, Adviser: Dr. Matthew Bandelt, Dr. Matthew Adams
John A. Reif, Jr. Department of Civil and Environmental Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

The use of Recycled Concrete Aggregate (RCA) has garnered attention in the construction and engineering communities as a sustainable building material that can help with diminishing natural aggregate supplies in various marketplaces. Crushing concrete from demolished building and infrastructure systems produces RCA, resulting in a recycled aggregate for use in new concrete mixtures. The purpose of this study is to investigate the influence that replacing natural coarse aggregate with RCA has on bond strength between concrete and steel reinforcement. Numerous material characterization tests were conducted to distinguish the different properties of both aggregate sources. In this research, the absorption capacity, compressive strength, moisture content and slump were all tested as part of this study. For reinforcement to carry tensile loads, it is necessary to create a suitable bond between steel and concrete. The bond ensures that there is little or no slip of the steel reinforcement to the concrete and the means by which stress is transferred across the steel and concrete. Lap-splice beam specimens were tested in four points bending to determine the bond strength of RCA and natural aggregate concrete. Results are then compared to results of other bond-testing methods reported throughout the literature.

Removal of Hydrated Oxide Layers from Boron Powder

John Gonzales, Xinhang Liu, Edward Dreizin
Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark, N.J. 07012

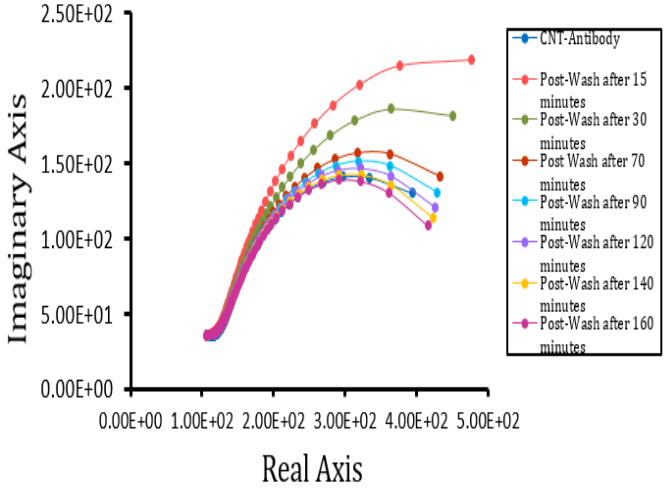
Boron is an attractive material as a fuel component in combustion applications, such as ramjets, because of its high volumetric calorific value. However, its ignition delay and extended combustion times hinder its practicality. External conditions, the properties of the boron particles, additives and catalysts have major influences on its combustion and ignition. Additionally, it has been shown that boron-powder particles exposed to air are covered with a natural oxide layer. The oxide can be hydrated, producing boric acid. Properties and evolution of the oxide layer control the rate of ignition processes. First, oxygen and boron diffuse towards each other through the oxide layer and participate in an exothermic reaction. The product is boron oxide added to the natural oxide layer, making it thicker and less penetrable for the diffusing species. The other process occurs with rising temperatures, where the boron oxide evaporates, so that the oxide layer thickness starts diminishing. Full-fledged combustion of the boron core may only occur once the oxide evaporation rate exceeds its generation rate. [1] Hence, the rate of removal of this layer from the particle surface prior to ignition will have a major impact on its practicality.

In a previous study, partial removal of the boron oxide/boric acid layer and prevention of oxidation of boron was achieved by washing an amorphous boron powder (95 percent pure by weight) with acetonitrile (ACN) and toluene/hexane (Tol/Hex) in a shaker mill. A significant portion of the oxidized surface layers was dissolved in acetonitrile and the processed boron still maintained its reactivity after exposure to an oxidizing environment. [2] The aim of this research is to better understand and improve the process of oxide/hydroxide removal from boron powders. A high intensity ultra-sonication of boron suspension in acetonitrile is compared to low-intensity ultrasonic mixing and mechanical agitation achievable in a ball mill. Approximately 1.3 g of amorphous boron powder and 30 mL of solvent were agitated in a petri dish by an ultrasonic horn. After centrifugation, the effectiveness of the process was evaluated using thermo-gravimetric (TG) analysis. There is a mass loss at about 100°C that correlates with the decomposition of boric acid. Mass losses of less than 1 percent were achieved after ACN washing and 1 & 3 mins of ultra-sonication. Samples were loaded wet and dried directly in the TG furnace. Samples dried under argon beforehand were also considered. They produced similar results. The addition of toluene showed no signs of improved mass loss, but did slow down reoxidation. Some samples were left exposed to the environment, or to "age", for a certain period of time, and then analyzed through TG methods. These samples had showed reduced mass losses but eventually returned to the 5 percent mass loss observed for the commercial as received material.

Shear-Enhanced Separation of Monoclonal Antibodies

Mengxin He, Adviser: Sagnik Basuray, Mentor: Mehnaz Mursalat
Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Monoclonal antibodies (mAbs) represent an area of active research in biotherapeutics because of their extraordinary binding affinity and specificity. mAbs are being used to treat multiple diseases including cancer (no aggressive chemotherapy), age-related macular degeneration, rheumatoid arthritis and cardiovascular disease. With increasing demand for function specific mAbs and shortening development timelines, it is *critical to develop efficient processes for mAbs purification, affinity testing and effectiveness*. Here, we propose a microfluidic platform (similar to affinity purification) to purify mAbs without post-modification damage, unlike current processes. Carbon Nanotubes (CNTs) with functionalized antigen on the surface are trapped by interdigitated electrodes in the microchannel using dielectrophoresis, a microfluidic trapping technique. The purification protocol entails passing the mAbs solution through the microchannel. At low flow rates (low shear), mAbs are captured by the CNT-antigen complex from the solution, washing away cell debris and other impurities. This binding event of the mAbs to the CNT-antigen complex triggers changes in electrochemical impedance spectroscopy (EIS) signal observed from the interdigitated electrodes. Following this mAbs filtration step, increased flow rate (higher shear force) or persistent washing of the chip (continuously high shear force) will be used to strip the weakly bonded mAbs from the CNT-antigen complex. *Thus, this modified microfluidic affinity-based separation protocol can be used to obtain purified mAbs.* Additionally, this platform will test the binding efficiency of the mAbs antigen pair, replacing diffusion-limited, operator-dependent and costly antigen microarray assay or enzyme-linked immunosorbent assay (ELISA). Furthermore, the effect of shear force on the mAbs-antigen bonding and resultant physio-chemical structural changes can be investigated in detail, which can provide new insight into their functionality in drug delivery. Initial studies were conducted with the LAM antibody functionalized to CNTs using NHS-EDC chemistry. The antigen flowed into a 100µm X 100µm X 1 mm channel that had LAM antibody functionalized CNTs trapped by the interdigitated electrodes. Observations revealed that longer washes (see figure on left) strip antigen from CNT-antibody complex, slowly bringing EIS signal back to initial bare CNT-antibody levels.



Frequency and Area Dependence of High-K/Ge MOS Capacitors

Ivan Mitevski, Mentors: Yiming Ding, Durgamadhab Misra
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark N.J. 07102

Ge substrate devices in Complementary Metal Oxide Semiconductors (CMOS) technology have been extensively studied due to their high electron and hole mobility [1]. However, most of the Ge devices are in research phase since making a good Ge/High-k interface is very difficult compared to Si/High-k interface. The purpose of this work is to further study the capacitance measurements of a MOS capacitor at different frequencies for square devices with different side lengths (10 μm, 20 μm, 30 μm, 40 μm, 50 μm, 100 μm). The corrected capacitance (C_c) for accumulation region increases on a faster pace when lower frequency (1KHz) is used than with higher frequency (1MHz) (Figure 1(a)) as a function of side length, *a*. Accumulation capacitance has a significantly strong dependence on frequency in metal insulator semiconductor (MIS) devices because of series resistance effect and it follows that behavior seen in this work as previous studies have shown [3]. On the other hand, the study shows substantial decrease of C_c per unit area in High-K/Ge in comparison to High-K/Si devices (Figure 1(b)). This decrease is attributed to the large nonuniform interface defect density [2] and high-leakage current [2] associated with Ge stacks. Capacitance at accumulation condition depends on interface capacitance (C_{it}) which changes with defect density. Defect density increases proportionally with area and High-K/Ge devices, being leakier, experience a higher decrease of C_c than High-K/Si devices. This work plans on modeling the frequency dispersion of high-k MOS capacitance in accumulation, which appears to behave in certain ways as shown on Figure 1(a), and investigating the area dependence of capacitance at High-K/Ge devices as shown on Figure 1(b).

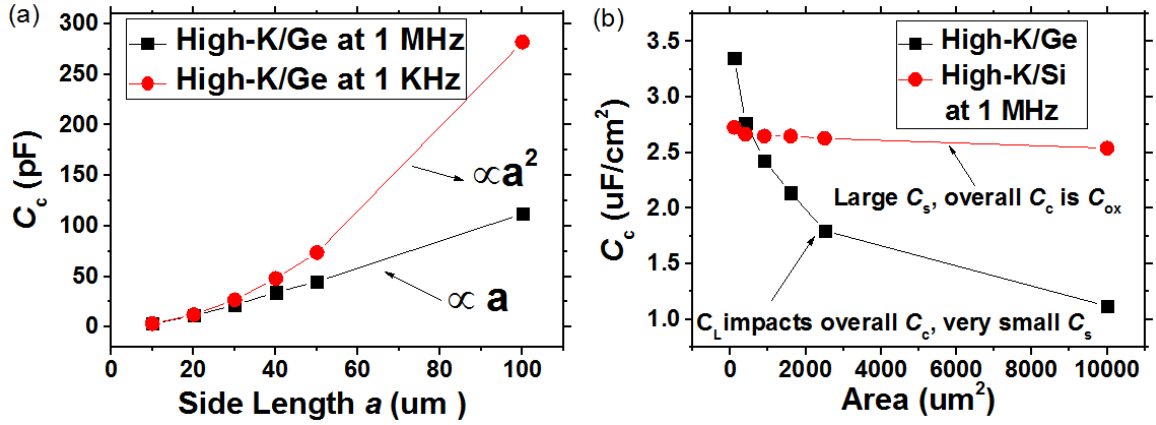


Figure 1 (a) Corrected capacitance (C_c) measured at -1.5 V (accumulation) at 1 MHz and 1 KHz shows frequency dependence. The capacitance seems to behave linearly against the area at high frequency (1MHz) and exponentially at low frequency (1KHz); (b) Unit Capacitance is plotted against area for Ge substrate and Si substrate sample for measurements at frequency of 1MHz. C_s is substrate capacitance and C_{ox} is oxide capacitance.

[1] D. Kuzum, A. J. Pethe, T. K., K. C. S, *IEEE T. Electron. Dev.,* vol. 56, p. 648, 2009.
[2] Y. M. Ding, D. Misra. *J. Vac. Sci. Technol. B,* vol. 34, p. 021203 2016.
[3] P. R. Lee, J. R. Ruzyllo. *Electrochemical Society*, vol. 9, p. 353-362, 2007.

Modeling Chemotaxis of Stem Cells in Microfluidic Maze: The Formation of Chemoattractant Concentration Gradient

Sara Mustafa, Long Quang, Vishnu Deep Chandran, Dr. Roman Voronov
Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

The purpose of this research is a combinatory study on the directional migration of mesenchymal stem cells (MSCs) toward a predefined chemoattractant concentration gradient (chemotaxis) which involves the use of both computational modeling and experimental data. The chemotaxis of MSCs is important for the cell homing and tracking and thus essential for several in vivo processes including wound healing, bone formation, immune responses and cancer metastasis. How cells find their way in an intricate and heterogeneous microenvironment has not been fully addressed. To study the cell migration in chemoattractant gradient, microfluidic devices are used and experimental data provide quantitative information on chemotaxis. Researchers have taken several approaches to study chemotaxis. However, migration studies so far have only focused on the use of linear and simple chemical gradients which neglect the sophisticated tissue structure, which the cells usually encounter *in vivo*. To better describe the complex structure, we introduced a novel microfluidic maze channel which comprises various geometries, thus allowing us to simultaneously assess the cell migration in a system with multiple gradients. In other words, this microfluidic device can generate complex gradient profiles and provide information on chemotaxis in a system similar to cell pathway in tissues. Computer simulation of the microfluidic device can yield results similar to that of experiment. COMSOL Multiphysics 5.2 was used for the simulation. COMSOL simulation provides the ability to reiterate the study for various other conditions and reduces the effort taken experimentally. COMSOL model was developed for transport of food color in the microfluidic device filled with water. The simulation will be compared with experimentally obtained data to validate the model. Upon successful simulation, it will provide an accurate prediction on the gradient formation and thus help to minimize the number of experiments needed to address the migration issues of the stem cells.

Nanoextrusion: A Platform Enabling Comparative Assessment of Nanocomposites vs. Amorphous Solid Dispersions for Drug Dissolution Enhancement

Indiana Suriel (UG researcher), Meng Li (Ph.D. mentor), Prof. Ecevit Bilgili (Adviser)
Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

A nanoextrusion process was utilized to produce extrudates of Griseofulvin (GF), a model poorly water-soluble drug, in a polymeric matrix with the ultimate goal of improving the dissolution rate. Distinct to the traditional hot melt extrusion (HME) process, the nanoextrusion process uses a wet-milled suspension of the drug as feed along with an extrusion polymer; the process disperses the drug particles in the polymeric matrix while simultaneously evaporating the water. Since the nanoextrusion process is a continuous process that can handle viscous fluids, it would be favorable compared to existing pharmaceutical drying operations in the manufacturing of solid nanoparticles-based formulation. In this study, we propose that a potential alternative usage of the nanoextrusion could be obtained by varying the extrusion polymers (with different interactions/miscibility with the drug): nanocrystalline drug dispersed in the polymeric matrix (nanocomposites) or amorphous drug molecularly dispersed within the polymeric matric (amorphous solid dispersion, ASD). Specifically, Hydroxypropyl Cellulose (HPC) and Soluplus were used to stabilize wet-milled suspensions. Feed suspension of GF was prepared by wet-stirred media milling using HPC and Soluplus in the presence of sodium dodecyl sulfate (SDS), an anionic surfactant. The milled suspensions along with additional polymer (HPC or Soluplus) were fed to a co-rotating twin-screw extruder, which dried the suspensions and resulted in the extrudates. Subsequently, the extrudates were milled into powders via mortar-pestle for further analysis. The effects of drug particle size (in the feed suspensions), stability of the drug suspensions, and polymeric matrix size on the drug dissolution were examined. In the composites, drug particle size was the dominant factor that affects the dissolution performance, whereas the matrix size appears to play a significant role in the drug dissolution performance in the amorphous solid dispersion.

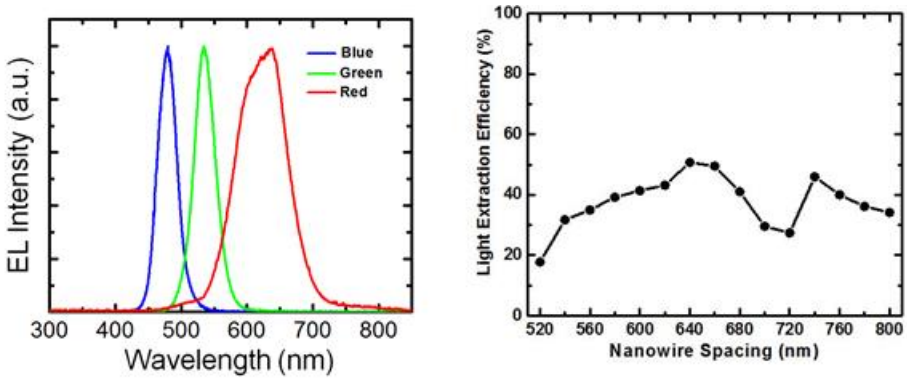
NSF Research Experience Undergraduate

Optics and Photonics: Technologies, Systems and Devices

Fabrication and Characterization of III-Nitride Nanowire Light-Emitting Diodes

Olaoluwa Akinnuoye, Moab R. Phillip, Mehrdad Djavid, and Hieu P. T. Nguyen
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

We have investigated the fabrication and characterization of phosphor-free white light-emitting diodes (LEDs) using III-nitride nanowire heterostructures. Such nanowires were directly grown on Si substrates by molecular beam epitaxy. Phosphor-free white LEDs were achieved by employing InGaN/GaN multiple quantum wells which emit the lights in the red, green, and blue ranges. The LED structure consists of InGaN/GaN multiple quantum wells which are sandwiched by p-type GaN and n-type GaN segments. By varying the indium composition in the InGaN wells, we achieved wide ranges of wavelengths covering from blue to red colors, illustrated in Fig. 1(a). The combination of red, green and blue lights from single nanowire LEDs produces white light emission. With the reduced dislocation densities, nanowire LEDs with the integration of red, green and blue emissions inside a single GaN nanowire exhibit high efficiency, truly white-light emission without using phosphor-converters. Moreover, the enhanced light extraction efficiency (LEE) of nanowire LEDs with emission wavelength of 520nm was simulated using Finite-Difference Time-Domain (FDTD) method. Presented in Fig. 1(b), the highest LEE for green nanowire LEDs with emission wavelength at 520nm was recorded up to 52 percent with nanowire radius of 250nm and spacing between two nanowires of 640nm. This study provides insight into the development of high-performance phosphor-free white LEDs for future solid-state lighting.



(a) (b)

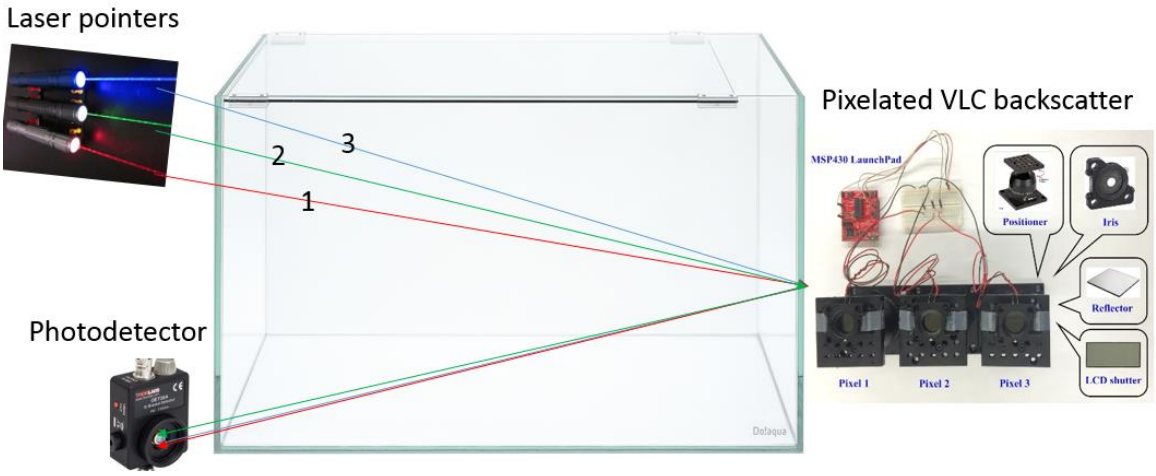
Figure 1: (a) Electroluminescence spectra of red, green and blue LEDs at 20mA injection current. (b) Simulated light extraction efficiency of green LEDs with wire radius of 250nm.

Pixelated Underwater Visible Light Communication Backscattering

Fares Al-Salim, Adviser: Dr. A. Khreishah, and Mentor: S.H. Shao, Ph.D. Student

Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

The main form of underwater communication nowadays is through acoustic waves. These acoustic waves help relay information for many divers, submarines and naval ships by using these waves to communicate underwater. However, these waves are very slow and can only travel at the speed of sound underwater, which is 1520 m/s. In addition to the slow propagation speed, these waves suffer from low transmission bandwidth, which will limit the applications that can be conducted. Optical communication has many advantages in the fields that acoustic communication lacks. We use the backscattering technique for energy efficiency. Instead of adding in new hardware in order to send another signal back to the carrier, backscattering uses the original signal and reflects it back. With any existing backscattering system, we cannot conduct any modulation scheme that is more advanced than on-off keying (OOK). For this reason we have decided to pixelate the signal in order to do more advanced forms of Pulse-amplitude modulation, PSK and OFDM. In this experiment, we are using laser pointers that have an electrical power rating of less than 5mv with different wavelengths of light (450nm 532nm and 650nm), because the different wavelengths attenuate differently underwater, and we are testing which wavelength has the least attenuation in a pure water pixelated backscatter situation. We have placed the lasers and photodetectors on one side of the tank and the backscatter mechanism on the other side. We are using a microcontroller in order to modulate the signal before it goes back to the photodetector.



Investigation of Light Scattering in Plasmonic Structures of GaAs Pillars and Its Properties Due to Environment Changes

Kely Steed Amegbor, Adviser: Dr. Haim Grebel
Electronic Imaging Center
New Jersey Institute of Technology, Newark, N.J. 07102

Plasmonic structures consist of metallo-dielectric patterns that support optical modes at the near-field. These structures exhibit strong resonance behavior and are at the root of various optical applications that have been explored over the recent years; Ramen scattering for instance. The goal of this research is to investigate plasmonic structures and the effect that stress and strain has on them.

Using a multiphysics CAD tool, COMSOL, the investigation of metamaterials and their periodic structures are examined. The hypothesis is that stress and strain are affecting the structure parameters, such as pitch, thereby affecting the light confinement and resonance characteristics within them. Preliminary studies include simulations of wave propagation within a photonic crystal consisting of GaAs pillars, which are placed equidistant from each other. Other structures will consist of an array of holes in dielectric substrates. A study will be conducted on the effect of stress and strain on the hole array and its related effects on the resonance wavelength, scattering direction, electromagnetic field distribution in the near-field, etc.).

Detecting Double JPEG Compression with the Same Q-Factors Using Convolutional Neural Networks

Shawn Billy, Adviser: Dr. Yun Qing Shi, and Mentor: Guanshuo Xu
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Detection of double JPEG compression plays a crucial role in digital forensics. There have been proven methods to detect double JPEG compression when the first and second quantization matrices are different. There have even been successful approaches to detecting double JPEG compression when both quantization matrices are the same. These approaches, however, require manual work, such as feature selection. In order to make the process of double JPEG compression detection more efficient, it has been proposed to utilize a convolutional neural network to detect the double JPEG compression with the same Q factor in this work. This is being conducted by inputting an error image generated from the rounding and truncation error blocks derived in JPEG decomposition. A back-propagation algorithm (stochastic gradient ascent) is then utilized to fix the erroneous weights increasing the success rate. Furthermore, data-augmentation such as shifting, rotations, mirroring and locally distorted version of the training data are conducted to improve the network's performance.

All Solution-Processed Flexible Fiber Solar Cells Based on Lead Sulfide (PbS) Colloidal Quantum Dots

Austin Daniel, Adviser: Dr. Dong-Kyun Ko, Mentors: Dr. Chengjun Sun, Qiongdan Huang
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

The sun outputs more than enough energy every hour to meet the annual global needs. With the ever increasing need for a reliable renewable energy resource, taking advantage of this vast amount of available energy has made solar cells an interesting and heavily researched topic. Silicon is currently the standard technology used for photovoltaics and though it is abundant, silicon solar cells are thick and brittle and have a suboptimal band gap. Furthermore, silicon solar cell fabrication requires temperatures above 900°C and installation is a difficult, costly process. Our solution is implementing colloidal quantum dots in place of silicon to make low-cost solar cell fibers using a facile fabrication process. Due to the effects of quantum confinement, quantum dots have a band gap which can be tuned by adjusting their size. Lead sulfide was used due to its sharp spectral features, large Bohr exciton radius, optimal range of band gap energies, and monodispersity of particle sizes under synthesis. These solar-cell fibers can be woven into textiles so as to integrate nanocrystal solar cell technology pervasively into everyday objects.

Our method of fabricating prototype colloidal quantum dot solar cell fibers in an entirely solution processed approach, using "hot injection" to synthesize the quantum dots and a simple dip coating process to apply layers of quantum dots and a transparent electrode to aluminum or silver wires. We have investigated two different types of solar cells using Schottky and p-n junction schemes, with zinc oxide nanoparticles as an n-type layer and PEDOT:PSS as a transparent outer electrode. The IV characteristics and power conversion efficiency of each solar cell are investigated to shed light on this facile approach to adjusting the band gap so as to improve efficiency. We compare these results to the standard Shockley Quiesser detailed balance efficiency limit and comment on how this accessible approach to solar-cell fabrication can improve the maximum solar-cell efficiency and practicality. Finally, we further modify the conventional detailed balance calculation to estimate the maximum possible power conversion efficiency for a quantum dot solar cell by considering the mismatch between phonon modes and the discrete electronic energy levels caused by quantum confinement. A very slow timescale for nonradiative relaxation may result from low electron-phonon coupling, which can potentially improve the open circuit voltage of quantum dot solar cells since electrons excited into high energy levels can be collected as highly energetic "hot carriers".

Low-Cost Applications of Visible Light Communication Systems for Intelligent In-Store Consumer Messaging

Amira Feknous, Adviser: Dr. Edwin Hou
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Visible Light Communication (VLC) is a cost-effective form of optical communication in which visible light waves are used to exchange information. VLC, a line-of-sight means of communication, presents more advantageous qualities when compared to radio frequency (RF) communication, with emphasis on cost, security and bandwidth. Light Emitting Diodes (LEDs) are often used as transmitters and various optical sensors are used to convert light waves into electrical signals so that the information can be processed using a microcontroller or microprocessor-based system. In this work, we develop a low-cost VLC system for intelligent in-store consumer messaging. In-store merchandise often uses tags as a form of display to present prices, as well as clarify any other relevant information as needed; however, these tags are changed periodically and are space-limited with regard to tag size. By transforming price tags into electronic displays powered by visible light, not only does it present a more convenient alternative to regularly changing paper displays, it also provides a more interactive and informational experience for the consumer by transmitting the merchandise information to the consumer's mobile device through VLC. Intelligent price tags used in today's consumer market—mostly in Europe—are commonly implemented with Near Field Communication (NFC). This form of technology heavily relies on radio frequencies, and by utilizing visible light communication instead, we present an alternative that will reduce the exploitation of the RF spectrum.

VLC systems will be developed to directly configure the message and transmit the message from the electronic display. Three types of transmissions were explored and tested: LED to LED, LED to frequency, and RGB LED to RGB intensity. LED to LED communication works by appointing one LED as a transmitter and the other as a receiver. LED to frequency communication works by utilizing a light-to-frequency converter, where light waves recognized by the diode inside the converter are translated into current, which is then processed by a current-to-frequency converter and thus outputs a range of frequencies. RGB LED to RGB intensity works by using an RGB sensor to detect the intensities of red, blue and green, while rejecting infrared from light sources. As a result, communication protocol and a VLC system will be designed using low-cost microcontrollers in order to create intelligent price tags.

Testing Visual Sustained Attention Capacity in Adults Using Functional Near-Infrared Spectroscopy

Ashley Fitzsimmons, Ziyan Wu and Xiaobo Li
Department of Biomedical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

As the brain responds to environmental stimuli, it undergoes physiological changes which affect its optical properties. Functional near-infrared spectroscopy (fNIRS) creates a brain activation map by detecting which regions of the brain show changes in optical properties. fNIRS uses small lasers to send near infrared light of 700-900 nanometers to the head. The lasers create a nonharmful high-intensity beam that is channeled to fiber-optic cables with small lenses on the end called optodes which are placed on the scalp. In the near-infrared range, tissues cannot absorb a significant amount of energy. However, activated tissues typically have oxygenated and deoxygenated hemoglobin present, which can absorb energy in this range. Source optodes give off light in the near-infrared range in which oxygenated hemoglobin and deoxygenated hemoglobin, if present, absorb light. Any light not absorbed creates a banana-shaped path back out of the head and is collected by detector optodes and quantified using computer algorithms for analysis. We can conclude that the regions where less light is reabsorbed by detector optodes are activated from the stimuli because there is a suggested presence of oxygenated or deoxygenated hemoglobin. Although functional magnetic resonance imaging (fMRI) can also map brain activation, fNIRS, if proven to be reliable, is advantageous for certain situations and more unique studies because it is portable, less expensive, not susceptible to movement artifact, is a minimal restrictive device and makes minimal noise.

While cross-validation studies of fNIRS with fMRI have shown correspondence between blood oxygen level dependence (BOLD) response of fMRI and deoxygenated hemoglobin of fNIRS, few studies have been in psychiatry or neuroscience. Dr. Xiaobo Li's Computational Neuroanatomy and Neuroinformatics lab at New Jersey Institute of Technology has experience mapping the brain of normal subjects, patients with ADHD and patients with TBI using fMRI. This preliminary data can be used to do a cross validation of fNIRS with fMRI.

One of our past fMRI studies showed that patients with ADHD show atypical pulvinar-cortical functional pathways during a sustained attention, continuous performance task. Based on this same task design, we plan to verify that we can use fNIRS to find similar activation in six regions of interest which were determined based on the fMRI results using AAL template in Mri cro. We hypothesize that the normal control groups will show activation in these ROIs during the same visual sustained attention task when measured with fNIRS instead of fMRI. SPM will be used for spatial analysis and Hemodynamic Evoked Response (HomER) will be used for time-series analysis. Future steps will be to test the clinical population such as adults with ADHD and patients with traumatic brain injury (TBI) and compare the resultant brain activation maps to our preliminary fMRI data.

Optical Coherence Tomography for Noninvasive Examination and Conservation of Cultural Heritage Objects

Isabella Hou, Adviser: Dr. Xuan Liu, and Mentors: Farzana Zaki and Qiongdan Huang, Ph.D. Students

Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Optical coherence tomography (OCT), a three-dimensional (3D) imaging modality with microscopic resolution, has found clinical applications in ophthalmology and interventional cardiology. Recently, OCT has been successfully applied in the field of cultural heritage conservation. OCT acquires depth-resolved profile of the sample in a noncontact manner and therefore has the potential to become a powerful alternative to invasive cross-sectional examination of paintings. Using 3D OCT signal, the surface topology for paintings can be reconstructed with high accuracy. Moreover, depth-resolved OCT signal can be used to reveal critical features for art conservation, such as subsurface damage to the artwork or invisible underdrawings beneath the superficial layers.

En-face scans of 150 x 150 mm paintings were acquired using a spectral domain OCT (SD OCT) system. To achieve a large field-of-view, we attached the sample painting to a pair of linear X and Y motors to acquire signals from different areas. Using an XPS-Q8 Motion Controller, the motors were automated to change position by varying the number of times a single motor's move was looped. The images acquired were then loaded into MATLAB as matrices and the en-face scans were isolated and stitched together using matrix manipulation. With this method, we demonstrated high-resolution, large field-of-view OCT imaging for 3D examination of paintings.

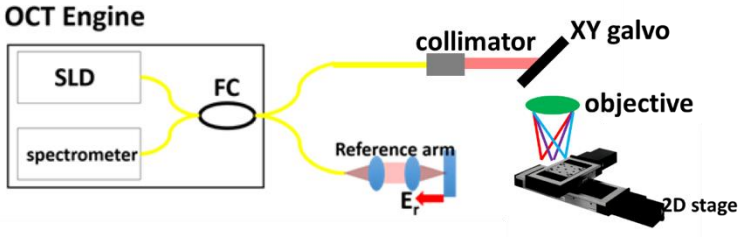


Figure 1. A schematic of the OCT system.

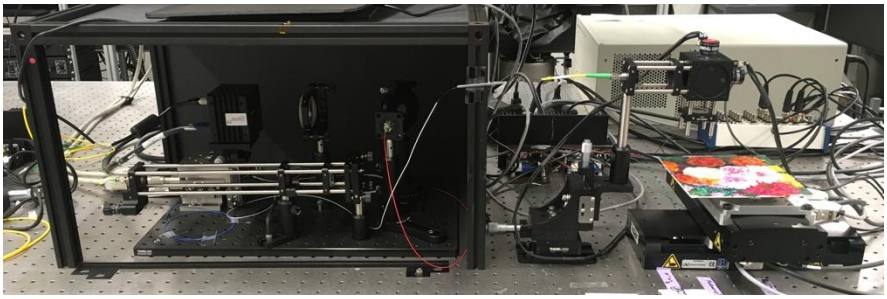


Figure 2. The actual configuration of the OCT system.

Effects of Temperature on LED and Its Reliability

Sharon Obiefuna, Adviser: Dr. D Misra
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

With the growing demand for green and energy-efficient technology, LED lighting has found itself in the forefront for the next generation of consumer lighting. Despite the present advancements made in LED lighting, improving efficiency and longevity are two important parameters in the quest to make LED a more viable commercial lighting source. This work focuses on luminosity degradation of GaN LEDs at varying stress temperatures, as well as the mechanisms that contribute to this deterioration. It is done by first investigating the chemical and quantum interactions that cause a breakdown in GaN LEDs. Specifically, the goal is to study how temperature changes the band gap and quantum efficiency of an LED. Having gathered theories and equations, we model and simulate by taking various variables such as input current and power. The effects of temperature vs. quantum efficiency for Gallium Nitride thin-film and/or Nanowire LEDs is then plotted. By having an understanding of these mechanisms that lead to long term failure, we may be able to propose solutions to temperature degradation of LEDs in order to increase durability and efficiency.

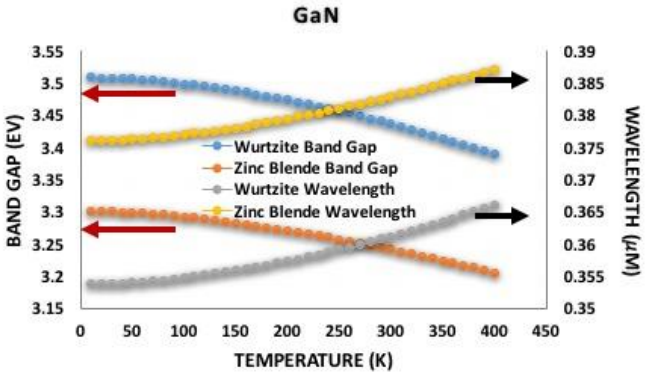


Figure 1. Temperature dependence of wavelength and band gap of GaN for Wurtzite and Zinc Blende lattice structure. The data sets are derived from the Varshni Equation $E_g(T) = E_g(0) - {\alpha T^2}/{T + \beta}$ [2]where α and β are fitting parameters dependent on the semiconductor material. For the wurtzite and zinc blende crystals the values of $\alpha, \beta, E_g(0)$ are $9.09 * 10^{-4}$ and $5.93 * 10^{-4}$, 830 and 600, and 3.507 and 3.299 respectively. The wavelength dependence is derived from the Einstein plank Relation $E_g = \frac{hc}{\lambda} = \frac{1.24}{\lambda}$ [1] where h, c, and λ are Planck's constant, the speed of light, and wavelength (in microns) respectively.

1. Parker, Greg. *Energy Bands and Effective Mass. Introductory Semiconductor Device Physics*. New York, NY: Taylor and Francis Group, 2004. 15. Print.

2. Vurgaftman, I., Meyer, J. R., & Ram-Mohan, L. R. (2001). "Band parameters for III–V compound semiconductors and their alloys." *Journal of Applied Physics*, *89*(11), 5815. doi:10.1063/1.1368156

Optics and Photonics Awareness Application Embedded with User Interaction Analytics

Joel Stauffer, Advisers: Dr. Abdallah Khreishah and Dr. John Carpinelli
New Jersey Institute of Technology, Newark, N.J. 07102

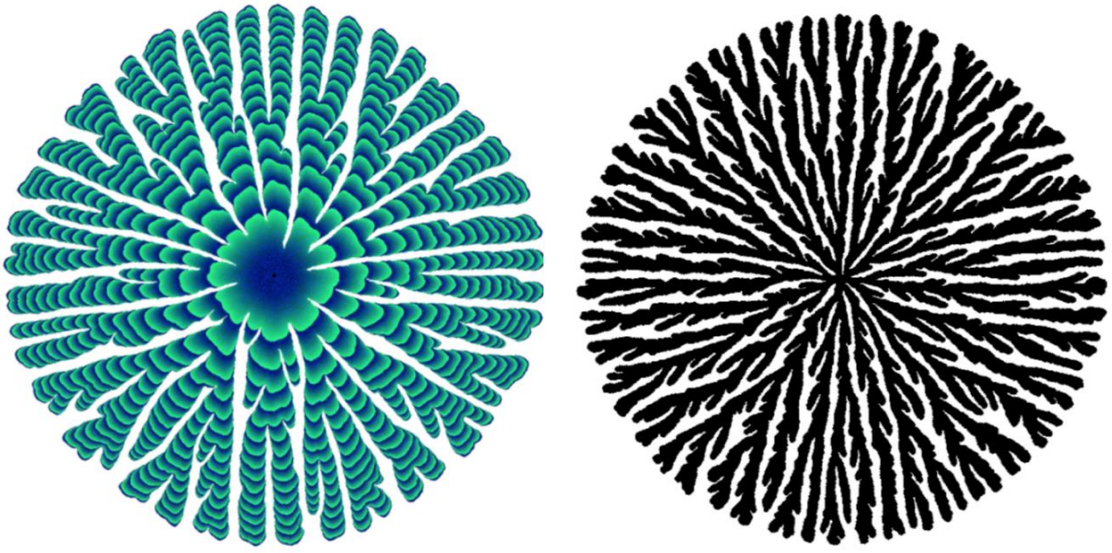
The subject of optics and photonics is regarded as a difficult subject for education. Typically, a high school student will not have exposure to optics unless that student enrolls in an AP Physics course. Even then, the topic of optics and photonics will only be a small section of a greater ensemble of subjects. Exposing high school students or freshman college students to optics and/or photonics earlier and to a greater degree will better prepare students for college-level entry physics courses. The objective of this research is to create a platform that simultaneously improves the user's awareness on the subject of optics and photonics and collects relevant analytical data on the user's knowledgebase of optics and photonics. The application will improve the user's awareness by posing knowledge-based challenges and intuitive challenges across subcategories of the main subject. The user's performance across these challenges creates the basis of the analytical data. After the analytical data is collected, it will be statistically analyzed for trends throughout the general population, hopefully revealing a sense of the cumulative knowledge base of larger statistical populations and revealing existing gaps in the applicable teaching system. The first module of this application, focusing on lenses, is already reaching the final stages. At this point, we are planning on implementing the program into a class or class-like environment for the purpose of teaching the fundamentals of optics.

NSF Undergraduate Research Program – EXTREEMS-QED

Diffusion Limited Aggregation and Saffman-Taylor Instability in Non-Newtonian Hele-Shaw Flow

Jimmie Adriazola, Adviser: Dr. Lou Kondic
Department of Mathematical Sciences
New Jersey Institute of Technology, Newark, N.J. 07102

This is an experimental, theoretical and computational study of Saffman-Taylor instability in a Hele-Shaw flow involving the injection of a less viscous fluid into a more viscous one in a thin gap between two plates. Because of the instabilities that arise in the driven interfacial boundary, pattern formation occurs. The aim of this project is to study the instability when the more viscous fluid is non-Newtonian, with viscosity that depends on shear rate. To characterize the properties of the emerging patterns, different methods are used for calculating fractal dimensions based on the data collected from experimental trials and extensive simulations of diffusion limited aggregation type. Diffusion-limited aggregation (DLA) was originally used to model the formation of dendritic particles such as dust, but has previously been modified to model the effects of surface tension in fluid flow. Further modifications to DLA for modeling of non-Newtonian Hele-Shaw flow are used in this study. The instability development is quantified in both the experiments and simulations using Fourier analysis and is compared to analytical results obtained by linear stability analysis. The main finding is that simulations of the non-Newtonian problem yield a fractal dimension different from the Newtonian case.



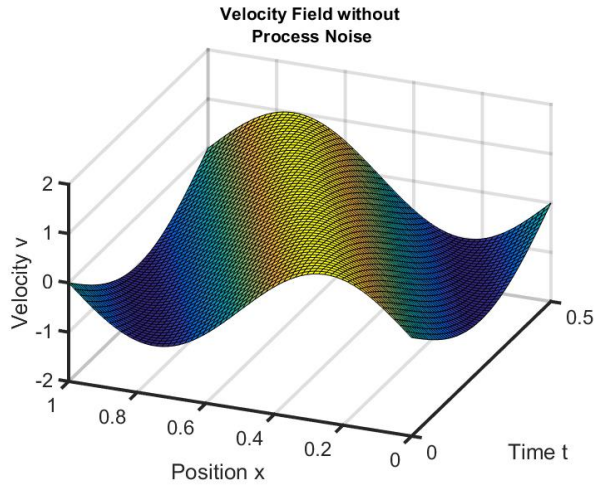
Newtonian Simulation Non-Newtonian Simulation after Image Processing

Eulerian vs. Lagrangian Data Assimilation

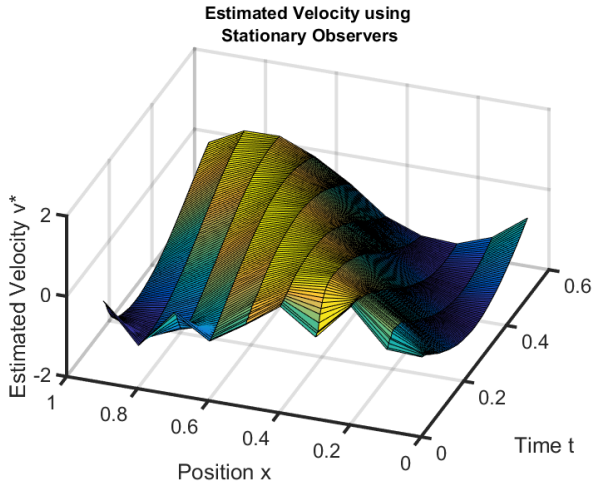
Alina Mohit-tabatabai, Tadanaga Takahashi, and Diego Rios
Adviser: Dr. Richard Moore
Department of Mathematical Sciences
New Jersey Institute of Technology, Newark N.J. 07102

Data assimilation is a process by which a physical model and observational data are combined to produce a more accurate estimate of the state of a system. It is often used when uncertainty (e.g., noise) is present in the system's evolution or in the observational data. For these types of systems, numerical methods must quantify this uncertainty in addition to estimating the mean behavior of the system. Examples of the successful application of data assimilation include predicting weather patterns and ocean currents.

We apply a specific data-assimilation technique, the extended Kalman filter, to estimate a velocity field. We demonstrate how blending a model with data allows us to infer the state of the system with better accuracy than either the model or the data alone would provide. We simulate the estimation of flow fields with different types of observers (floating versus fixed in space) and observational data (position versus velocity measurements) to analyze the effects this has on estimation skill.



Actual Solution



Solution using Data Assimilation

U.S. Army ARDEC Picatinny Arsenal Program

Constructing the Overall Brand of the Physics Additive Manufacturing Lab

Henry Drago
Collaborators: Alex Clark, Jenna Meisner, Lou Rizzo
Mentor: Sam Gatley, Adviser: Dr. John Federici
Department of Physics
New Jersey Institute of Technology, Newark, N.J. 07102

An interdisciplinary team of scientists, designers, and engineers from a variety of backgrounds, such as physics, chemistry, biology and industrial design collaborated as a research and development team on the topic of additive manufacturing including 3D and 2D printing. The team's interaction enhanced each team member's individual research to produce innovative additive-manufacturing solutions. Since the research developed would be constructed in a physical form as well as through more conventional mediums such as diagrams and equations, it would be most advantageous to display these findings in a way that presented our work both aesthetically and educationally. With the continued ideas of physical machinery, I proposed a design of an exhibition system for all of the manufactured parts. As our research grew, so did the demand for a larger exhibition space. The exhibition space works as more than just an arrangement of our research, but also a physical understanding of how our team worked and collaborated together.

The center display holds a space for a model Apache helicopter. This helicopter provides an area to display an arrangement of electronics, 3D components and sensors to better demonstrate our focus of exploration. Aside from the center space there are two pillars which separate the main shelving units. These pillars act as another vestibule of space as a way to display and encase our research. We gained knowledge from each other that we would not be able to obtain by working with people in our own fields. The exhibition space works as a way for each member of our team to come together in the additive-manufacturing lab to produce, innovate and display our designs.

The overall structure of the exhibition space allows for growth, as does the continuous research that can be further developed from our summer of collaboration. As technology advances and the accessibility and ease of use becomes a staple in every student or researcher's knowledge, the variation of this display arrangement has the opportunity to grow and change with the needs of each researcher for the future.

NJIT PHYSICS
ADD LAB
ADDITIVE MANUFACTURING LAB

Analyzing Shape Memory Effect through the Assessment of Smart Materials

Jenna Meisner, Collaborators: Alex Clark, Lou Rizzo, Henry Drago
Mentor: Sam Gatley, Adviser: Dr. John Federici
Department of Physics
New Jersey Institute of Technology, Newark, N.J. 07102

Smart materials are a type of material that reacts to external stimuli. The stimuli trigger a response in the smart material that changes its properties, such as shape or color. The materials tested were all thermally activated smart materials. Using a shape-memory effect, materials can be deformed and then return to their original shape. These smart materials can be used in practical applications such as "flat packing," where we can compress 3D objects into more easily transportable forms. After delivery to their destination, they regain their 3D shape by applying a stimulus such as heat. We tested various smart materials such as shape-memory polymers and shape memory alloys over the duration of the research and analyzed their shape-memory properties.

One type of a smart material we worked with is shape-memory alloys or metals. Nickel Titanium, also known as Nitinol, was assessed in our lab. This has a two-way shape memory effect. It can form a remembered shape when held rigid and heated to about 500^0C. After cooling to room temperature the material is bendable and can be molded into any other shape. When reheated past the transition temperature, the Nitinol wire will revert back to its remembered shape. This Nitinol shape memory wire has several applications. It can be used to ship things in a 2D or "flat" form, and then when the package arrives it can be heat treated and "pop up" to a 3D form. Then it can be compressed again once it cools to room temperature and pop back up whenever needed by heat treating to the programmed temperature. This 2D to 2D conformational change can be useful for many applications, from shipping packages to biomedical applications.

Shape-memory polymer is another smart material we worked with. It is typically made from a monomer, cross-linker and acrylates. We made a particular type of shape-memory polymer (SMP) using benzyl methacrylate as the main monomer. This SMP sets its remembered state during the curing process. In the low-temperature "cooled" state, the material is hard and not easily manipulated. This is ideal for a coating on vehicles or other objects that can have their shape set as a hard protective shell. At high temperatures, the material becomes malleable and can be reformed if held in place until cool again. The shape can be set and reset every time the material is heated to its glass transition temperature. If you do not prolong the heat treatment, the SMP demonstrates self-healing properties. This particular shape memory material could be used for a variety of biomedical applications. A thick self-healing SMP could be used for artificial bones that can be deformed and sized for your body. Then if you "break your bone," you simply heat the area and it can self-heal without weeks of immobility. We tested the benzyl methacrylate SMP to determine the efficiency of the self-healing process.

Assessment of Optical Components Incorporated into 3-D Printed Structures

Lou Rizzo, Sam Gatley, Alex Clark, Jenna Meisner, Henry Drago, Adviser; Dr. John Federici
Department of Physics
New Jersey Institute of Technology, Newark, N.J. 07102

3D printing is utilized in many areas of prototyping and research. One area of interest is the incorporation of optical components into 3D printed structures. The precision and tolerances of 3D-printed structures housing optical components were evaluated during this study with use of an Ultimaker 2 printer and Polylactic Acid (PLA) filament. Lenses and prisms were set in various 3-D printed optical instruments. These instruments consisted of telescopes and binoculars that were designed with a Computer Aided Design (C.A.D.) program. Image focus, image stability and optical alignment were analyzed.

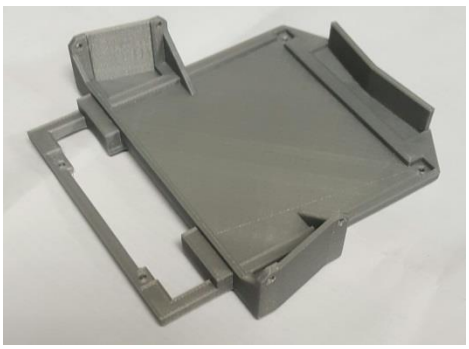
N.J. Space Grant Consortium
Summer Research Program

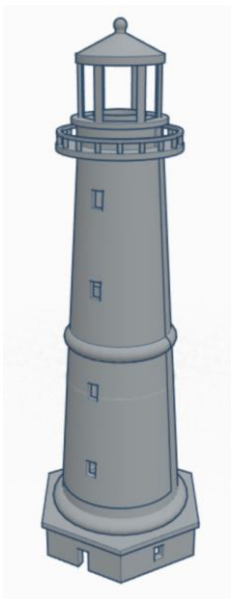
Integration and Optimization of Electronic Circuits and Devices into 3D-Printed Structures

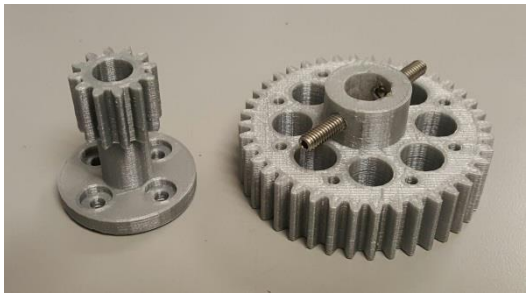
Alexander Clark[1]
Adviser: John F. Federici[2] **Mentor: Sam Gatley**[2]
Collaborators: Henry Drago[2]**, Jenna Meisner**[2]**, Lou Rizzo**[2]
[1]School of Theoretical and Applied Science, Ramapo College of New Jersey, Mahwah, N.J.
[2]Department of Physics, New Jersey Institute of Technology, Newark, N.J.

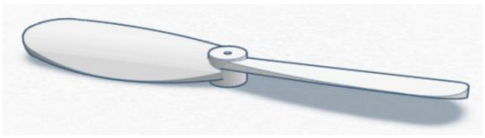
As 3D printing becomes more mainstream in the design and manufacturing industries, the possibilities for optimization and integration of printed parts is also becoming greatly visible. The goal of this project was to test different applications that require electronics to be placed within Fused Deposition Modeling (FDM) 3D-printed structures to accommodate and complete certain tasks. The different objects were printed using Polylactic acid (PLA), Acrylonitrile Butadiene Styrene (ABS), and wood-based, iron-based and bronze-based thermoplastics. The three-dimensional models were created using Computer-Aided Drafting (CAD) software. To demonstrate the abilities additive manufacturing has in combination with electronics, implementation of devices such as cameras, sensors, LEDs, Raspberry Pis, Arduinos, power converters, servos, brushless motors and more were assembled within 3D-modeled and printed structures.

A 1/87th scale functional lighthouse was designed and successfully printed to integrate stepper motors, optical lenses and high-power LEDs into a printed frame. A large portion of the summer was devoted to designing, printing and applying printed objects to a 1/6th scale Apache Helicopter model donated by the U.S. Army. An infrared night-vision camera mounted on an analog joystick-controlled gimbal was fixed to the front. Temperature and humidity sensors, as well as a mock laser beaming wireless-power transfer module were all fitted to the model to demonstrate the proficiencies of adding 3D-printed parts to a preassembled model. This form of post applied sensor packages will be used in future research to create interchangeable sensor payloads for drones and quad copters to operate and transport at low weight, power and cost.









Observing Solar Flares at Radio Wavelengths

Lindsey Gray[1], Dr. Bin Chen[2], Sijie Yu[2]

[1]School of Theoretical and Applied Science, Ramapo College of New Jersey, Mahwah, N.J.

[2]Department of Physics, New Jersey Institute of Technology, Newark, N.J.

The sun experiences solar flares, which are large energy releases from the sun's magnetic field in the form of radiation. By studying solar flares, scientists hope to understand the particle acceleration of the energy release as well as the physical mechanisms of the flare itself. The sun, at approximately 150 million kilometers away, is the closest star to Earth. Physicists can apply their findings regarding solar flares to other more distant stars. Solar flares also affect Earth by interfering with radio communications and satellite technology such as global positioning systems (GPS).

This research begins by surveying solar events that occurred between November 1, 2011 and May 22, 2016 that were observed by the Jansky Very Large Array (VLA), a radio wavelength observatory in Socorro, N.M. Simultaneously, a geostationary satellite server (GOES) observed the sun in soft X-ray wavelengths. Figure 1 shows an example graph of data collected from GOES during a flare. The Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI) is a flare observatory in space that collects hard X-ray data from the sun that would otherwise be blocked by Earth's atmosphere. The VLA, GOES and RHESSI data is combined into a summary page to provide an overview of each event. The event on November 1, 2011 was chosen to focus on due to its flare strength. For this event, a dynamic spectrum is created which displays the intensity of the flare (in frequency) as a function of time as seen in Figure 2. From this spectrum, regions of interest will be selected to make radio images. These radio images can then be compared to data taken from the Solar Dynamics Observatory (SDO), a NASA-run observatory that has been monitoring the sun since 2010. Further research in this project will include taking these comparisons and attempting to make implications with respect to the flare energy release process.

Figure 1

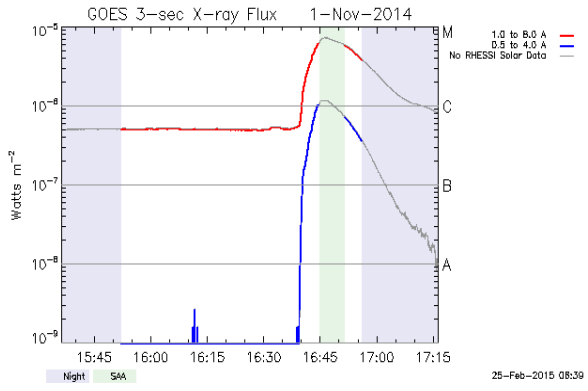


Figure 2

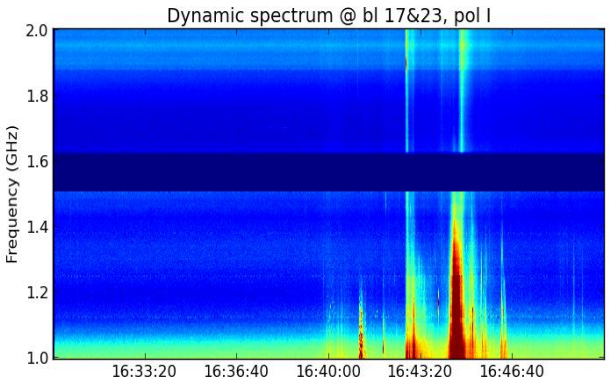


Figure 1: GOES soft x-ray data taken on November 1, 2014 from 15:30:00-17:15:00.

Figure 2: VLA dynamic spectrum taken on November 1, 2014 from 16:30:00-16:50:00.

Protein Folding Using the GROMACS Molecular Dynamics Software

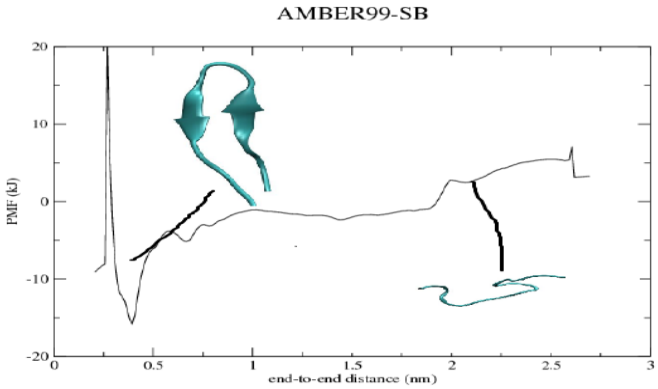
Patrick Rehain[1,2], Farbod Mahmoudinobar[1], and Cristiano L. Dias[1]

[1]Department of Physics, New Jersey Institute of Technology,, Newark, N.J. 07102

[2]Department of Engineering Physics, Ramapo College of New Jersey, Mahwah, N.J. 07430

Proteins are large molecules found in living organisms that perform specific functions determined by their three-dimensional structure. A protein starts as a simple rope or string-like structure and folds into increasingly complicated structures until it reaches its stable, functioning, native state. This native and functional state corresponds to the global minimum of the free-energy-landscape (FLS) of the protein. Diseases like Alzheimer's, Parkinson's and Type II Diabetes are the result of incorrect folding of amyloid proteins which stops them from functioning correctly. To understand the nature of these diseases, and to try and combat them, it is necessary to study the folding processes of various proteins. However, watching the folding process of a protein is no easy feat, because the entire process takes place in the range of microseconds, which is not easily accessible to experiments. This is where molecular dynamics simulations become helpful.

A molecular dynamics (MD) simulation of a protein starts with an initial configuration of all of the atoms in the protein and then models their trajectory, over a given time, by repeatedly solving Newton's Second Law for each atom in the system. Here we focus on the one-dimensional mapping of the free-energy, known as the potential-of-mean-force (PMF). PMF calculations give a description of what values of the reaction coordinate the system was preferential towards, or what values it had a local minimum of free-energy. The validity of a MD simulation is governed to the computational cost of the models and parameters chosen, as well as how well they are effectively able to simulate the real system.



My project this summer was to study the folding process of the 16-residue Beta-Hairpin structure of the GB1 protein to develop new methodologies to calculate the PMF. Specifically, I was to compare different force-field models, using an implicit solvent, with regards to the forming of the Beta-Hairpin. The study was done using the GROMACS MD software using umbrella sampling to fix the ends of the protein at specific distances from each other, and temperature replica exchange for enhanced sampling to calculate the PMF of the protein as a function of its end-to-end distance. The graph above is an example of the PMF graph for the AMBER99-SB force field. An end-to-end separation around 0.5 nm corresponds to the native hairpin structure while larger separations are associated with the unfolded structure. The data collected from this study will enable us to validate an efficient methodology to simulate small proteins.

Heritage Institute of Technology – NJIT Summer Research Program

Fracture Modeling of 3D-Printed Thermoplastics

Samprit Basu, Rajasekhar Tripuraneni, Siva Nadimpalli
Department of Mechanical and Industrial Engineering
New Jersey Institute of Technology Newark, N.J. 07102

Fused deposition modelling (FDM) is a 3D-printing technique in which a thermoplastic polymer filament heated above the glass transition temperature is extruded through a nozzle to print layer by layer of a part. While stress- and strain-based experiments were performed on these components, fracture toughness data, which is an important property of these thermoplastics, is not available. In this summer project, a fracture mechanics based methodology was adopted to study the interlayer adhesion of FDM 3D printed materials. Double cantilever beam (DCB) specimens were printed with ABS filament of diameter 1.75mm and a pre-crack of 10 mm. The DCB samples were fractured in a MTS machine, and the load displacement curves from these tests were used in finite element analysis to calculate critical stress intensity factors. The fracture process of a 3D-printed DCB was simulated using the commercial finite element package Abaqus and the effect of sample geometry on the crack tip stress state was analyzed.

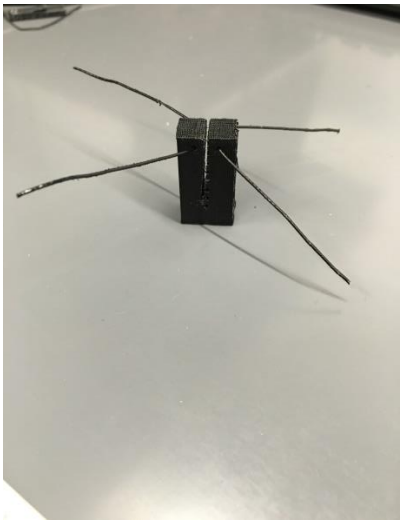


Fig 1. DCB sample

Fractured in a MTS machine

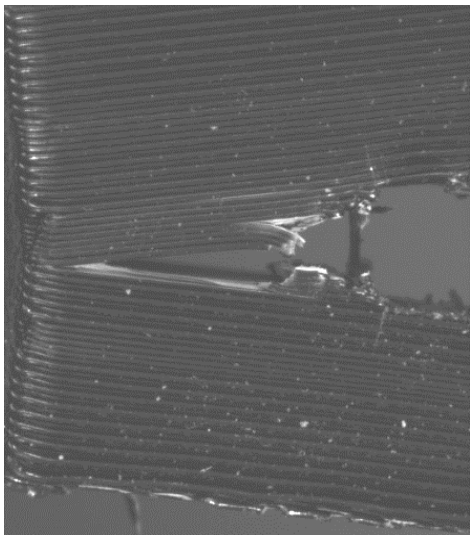


Fig 2. Crack Initiation

References:

Measuring the interlayer fracture resistance of FDM printed thermoplastics
N. Aliheidari, J. Christ, A. Ameli, Advanced Composites Laboratory, School of Mechanical and Materials Engineering, Washington State University Tri-Cities, WA
R. Tripuraneni, S. Nadimpalli, Department of Mechanical and Industrial Engineering, New Jersey Institute of Technology, Newark, N.J.

Speech-to-Text Conversion Using CMU Sphinx

Ayushi Churiwala, Adviser: Dr. Vincent Oria, Mentor: Sheetal Rajgure, Ph.D. Student
Department of Computer Science
New Jersey Institute of Technology, Newark, N.J. 07102

Speech is the essence of communication and the easiest way to express oneself. Speech-to-Text (STT) conversion is hence a very important issue to help deaf people communicate or interact conveniently. Also, the speed of typing is generally one word per second, so speaking may be the fastest mode of communication. However, speech is a complex phenomenon as it is a dynamic process without clearly distinguished parts. The same word when spoken by different people never sounds the same. Hence, the accuracy of these systems can never be 100 percent.

We are using the software CMU Sphinx for speech to text conversions for building a better video search for Ultimate Course Search Engine, a Search Engine developed by New Jersey Institute of Technology researchers. Ultimate Course Search Engine is a search engine for students and faculty wherein a person selects the type of study material he/she wants to view or learn from (books, class lectures, videos, etc.) by simply typing a keyword. We aim to convert the speech in the videos or lectures to text so that we can integrate the speech into the search process. In order to do so, we first train the system and store the parameters in the form of templates or models. Next comes the recognizing phase where the unknown input is fed into the system which then generates the result based on its previous learning (as seen in Fig. 1). Based on the outputs found using the Speech-to-Text Converter on different sample inputs, the accuracy of the system will be determined and attempts will be made to improve upon them so that it can be implemented in the search engine developed.

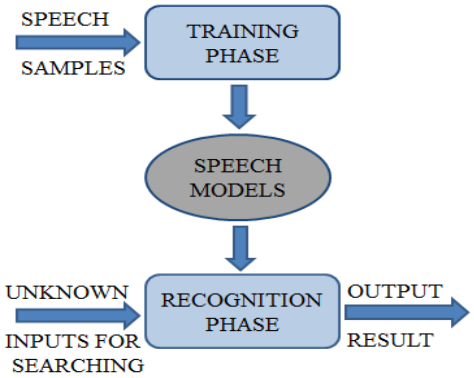


FIG 1: Basic concept used in Speech-to-Text Conversion software CMU Sphinx

References:

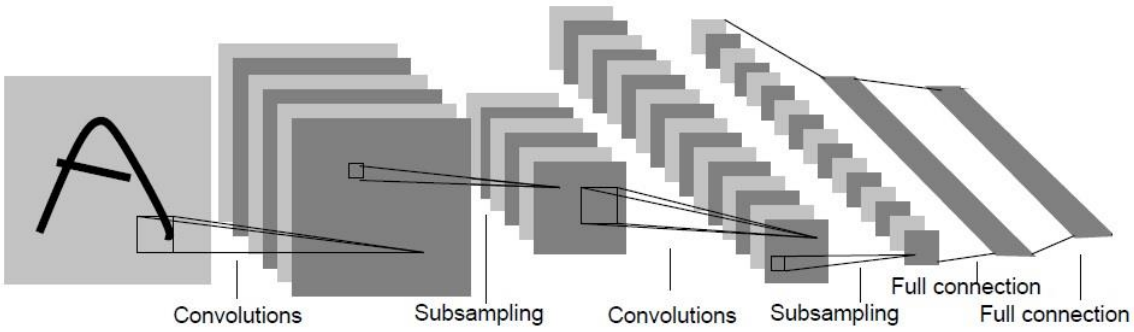
1. http://cmusphinx.sourceforge.net/

2. ***A review on speech to text conversion methods,*** **Prof. Bhope V. P,** Department of E&TC Engineering**,** Savitribai Phule University of Pune**, Miss. Prachi Khilari,** Department of E&TC Engineering**,** Savitribai Phule University of Pune.

A Literature Study of Solutions to Handwritten Digit Recognition Using Convolution Neural Networks

Arkoprovo Dey, Mentor: Shruti Kulkarni Adviser: Dr. Bipin Rajendran
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Handwritten Digit Recognition is a very popular benchmark problem in the field of Machine Learning. The work currently being done at NJIT toward solving this problem involves the use of bio-inspired third-generation Neural Networks, or Spiking Neural Networks (SNNs). Solutions to the problem have already been developed using second generation Neural Networks. However, it has been shown that SNNs can bring about a significant reduction in power consumption. The work we propose to do here is a literature study of the various approaches to the handwritten digit recognition problem using Convolution Neural Networks (CNN, a second-generation approach), mainly involving the works of eminent computer scientists Yann LeCun and Léon Bottou, which serves as a complementary work toward developing an SNN model. The CNN model, called the LeNet 5, along with its tweaks and variations will be analyzed in terms of the techniques used in implementing and training the various layers and the number of computations involved. Along with that, we will develop software code to implement the basic modules of the LeNet 5. This will help in comparing the SNN approach with the CNN approach, in terms of trade-off between computational complexity and the desired classification error.



Basic Framework of LeNet 5

References:

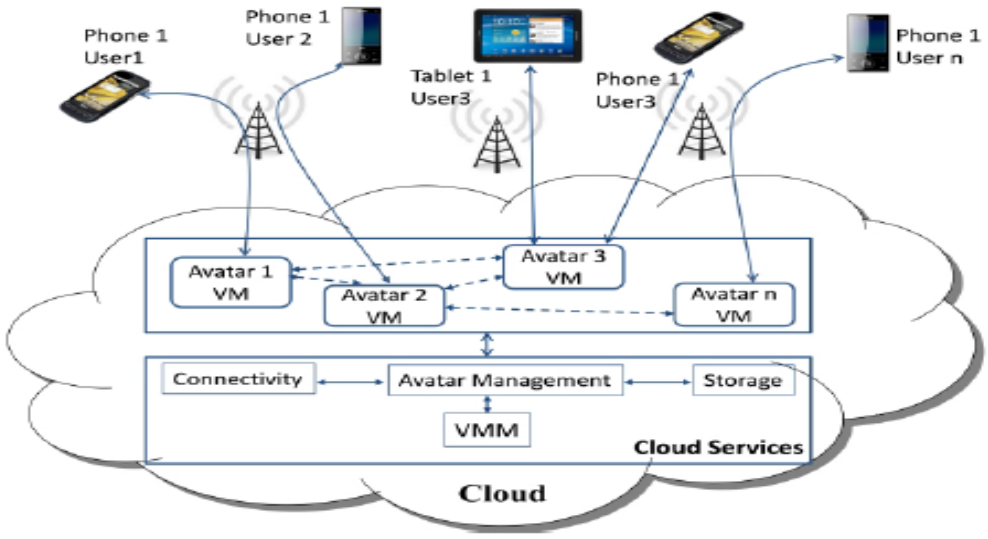
1. **Gradient Based Learning Applied to Document Recognition.** Y. LeCun, L. Bottou, Y. Bengio, P. Haffner
2. **Efficient BackProp.** Y. LeCun, L. Bottou, G. Orr, K. Muller

LunchBox: A Mobile App Enabling a Home-Cooked Food Marketplace

Akanksha Mukherjee and Susnata Mandal (UG Researchers), Adviser: Dr. Cristian Borcea, and Mentor: Pradyumna Neog (M.S. Student)
Department of Computer Science
New Jersey Institute of Technology, Newark, N.J. 07102

LunchBox is an Android-based mobile app that makes freshly made hot food available to the people who prefer to eat healthy home-cooked food, which is also less costly than restaurant-cooked food. The app is used by both vendors, i.e., home cooks who sell their food, and customers, e.g., office workers at lunch break. When a customer wants to order food, LunchBox performs a search among the offers of the vendors located in walking-distance proximity. The app considers the customer's culinary preferences and price constraints when selecting the items to show on the screen. Since LunchBox targets small businesses, the vendors may not be able to cater to all the customers in case there is a rush of customers at lunch time. For this scenario, the vendors will have a bidding option that can be activated, and only the highest bidders under a time constraint will be able to place the orders.

LunchBox uses the *Avatar* mobile cloud computing platform and its associated middleware, *Moitree*, for programming mobile distributed apps assisted by the cloud. *Avatar* leverages cloud resources to support fast, scalable, reliable and energy-efficient distributed computing over mobile devices. An avatar is a per-user, always on a software entity that resides in the cloud and acts as the surrogate of a mobile device, thus reducing the workload and the demand for wireless bandwidth at mobiles. *Moitree* allows unmodified apps to execute seamlessly over mobile/avatar pairs with the provision of offloading computation and communication. *Moitree* simplifies the development of LunchBox and provides efficient execution over the Avatar platform.



Avatar Mobile Cloud Platform

Digital Image Processing and Seam Carving

Enhancement of the Light Extraction Efficiency in AlGaN/ GaN Nanowire LEDs Using FDTD Simulations

Manisha Mondal, **Adviser:** ***Dr. Durgamadhab Misra,*** **Mentor:** ***Dr. Mehrdad Djavid***
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

AlGaN/GaN nanowire light emitting diodes (LEDs) have gained immense importance in the past decade due to their unique optical properties and potential applications in sterilization, biomedical instrumentation and high-density optical storage. The internal quantum efficiency of LEDs has reached ~80-90 percent [1][2], by proper choosing of the semiconducting material. However, the light extraction efficiency (LEE) has remained very poor (~20 percent) [2], as shown in Fig. 1. This is mainly due to the total internal reflection caused by the difference in the refractive index between the semiconductor and the surrounding medium (acting as a multilayer waveguide) [3], for which most of the light remains inside the device, thus limiting its performance. Hence for improved LEE, we present a vertical array of GaN nanowires on a Silicon substrate. Using 3-D Finite Difference Time Domain (FDTD) simulations, different parameters contributing to the enhancement of LEE have been studied in the near UV region. After several variations, the optimum conditions for the nanowire diameter, spacing and height, wavelength of light and p-GaN thickness are presented, which demonstrates a very high LEE (~60-70 percent).

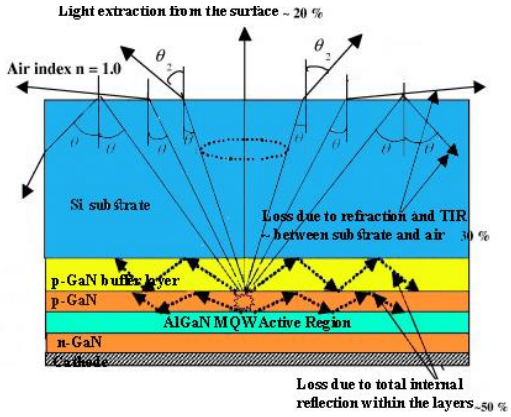


Fig.1 Schematic of total internal reflection in LEDs causing inefficiency in light extraction

References:
[1] Z. Mi et al. "Aluminum nitride nanowire light emitting diodes: Breaking the fundamental bottleneck of deep ultraviolet light sources", *Scientific Reports*, 5, (2015), 8332.

[2] **Benjamin S. Mashford et al. "**High-efficiency quantum-dot light-emitting devices with enhanced charge injection", *Nature Photonics*, 7 (2013), 407–412.

[3] **A. I. Zhmakin**, "Enhancement of light extraction from light emitting diodes" Elsevier, *Physics Reports*, 498 (2011) 189-241.

Channel Estimation for Underwater Communication

Abhijit Pal, Adviser: Dr. Ali Abdi, Mentor: Erjian Zhang, Ph.D. Student
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Sound is basically a mechanical disturbance that travels through fluids. Sound propagation underwater can be very useful for not only human hearing but also exchanging a lot of information through. We have developed technologies that enable us to communicate using sound waves underwater far more effectively than nature has enabled us. For this communication to take place underwater, there are various factors and processes which are to be kept in mind. The transmitting and receiving is done by a sound projector and a hydrophone, respectively. But the most important part of the whole transmitting and receiving phenomenon is the channel through which the sound signal will propagate. Keeping this as our primary objective, we focus on estimating the unknown channels for underwater communication. We start with the usage of linear frequency modulated (LFM) signals also known as chirp signals. These are the signals whose instantaneous frequency varies linearly with the time. The signal is generated from the windows sound card present in the computer and fed to a sound projector. The sound signal is received by the hydrophone from which we get the output responses. The process of estimating the channel comprises of using the correlation functions or convolving the output resultant at the receiver with the LFM signal used at the transmitter end. This process gives us the response of the channel through which the propagation of the signal took place. So, primarily we focus on this estimation technique and we also extend this to further study the channel responses under the presence of different types of sediments at the bottom like sand, gravel, etc., because attenuation due to their presence also plays a vital role in the channel response. After analyzing the channel responses we calculate and compare the delay spreads for different sediments present at the bottom in order to have a comparative study.

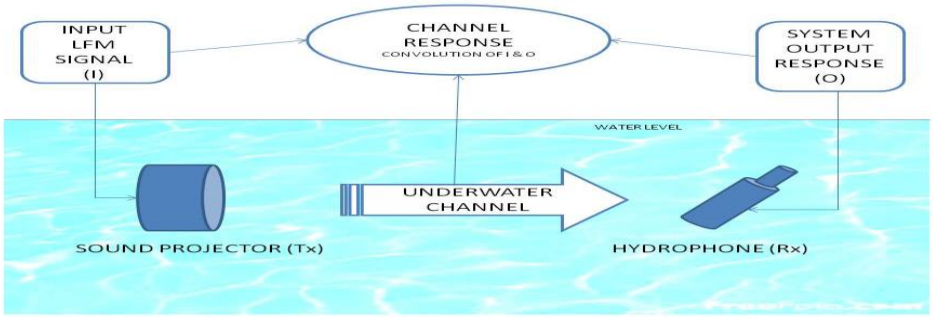


Fig: Representation of the whole experimental setup and procedure.

References:

3. **Characterization of Underwater Acoustic Communication Channels**, Abraham Boayue, Department of Electronics and Telecommunications, Norwegian University of Science and Technology.
4. S. M. Kay, **Intuitive Probability and Random Processes using Matlab**. New York: Springer, 2006.
5. B. Carlson, P. B. Crilly, and J. C. Rutledge, **Communication Systems: An Introduction to Signals and Noise in Electrical Communication**, 4th ed., New York: McGraw-Hill, 2002.
6. **Adaptive Channel Estimation For Underwater Acoustic MIMO OFDM Systems,** *Milica Stojanovic***,** Northeastern University**,** Department of Electrical and Computer Engineering, 409 DA Boston, MA 02115.

Numerical Simulations of Electric Field Driven Hierarchical Self-Assembly of Monolayers of Mixtures of Particles

Arka Raha, Adviser: Dr. Pushpendra Singh, Mentor: Edison Amah, Ph.D. Student
Department of Mechanical and Industrial Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

When an electric field is applied in the direction normal to a fluid-liquid or liquid-liquid interface, containing a mixture of particles, the particle mixture self-assembles into a molecular-like hierarchical structure arranged in a pattern. In this study, the process of self-assembly of particle mixtures on fluid-liquid interfaces when an electric field is applied in the direction normal to the interface is analyzed numerically. The force law for the dependence of the electric field induced dipole-dipole and capillary forces on the distance between the particles and their physical properties is used for conducting simulations of the self-assembly process of particle mixtures. As in experiments, the structure of a self-assembled monolayer of a particle mixture depends on factors, such as the relative sizes of the particles and their polarizabilities and the electric field intensity. If the particles sizes differ by a factor of two or more, composite particles are formed; these composite particles have a larger particle at its core and several smaller particles form a ring around it. Approximately same-sized particles which are of equal concentrations in the mixture form binary particles or chains (analogous to polymeric molecules) in which positively and negatively polarized particles alternate. Also, another observed structure of the monolayer is the formation of chains, which is due to increase in the overall capillary force between particles. In some instances, a particle chain with at least one positively and negatively polarized particle at both ends would fold to form a circular chain. In addition, for submicron and nano-sized particles, the effects of Brownian force on particles become important and thus should no longer be neglected. So, simulations are performed to analyze the extent of the effect of Brownian motion.

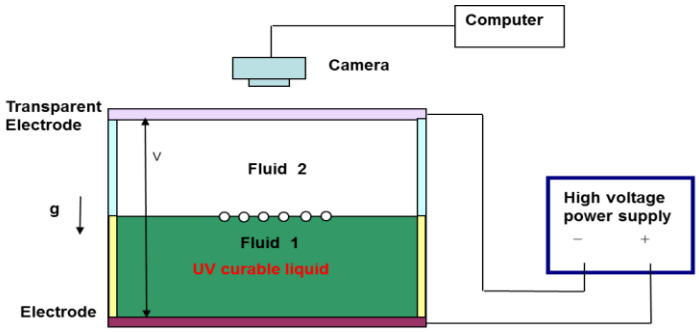


Fig: Representation of the whole experimental setup

References

1. "Molecular-like hierarchical self-assembly of monolayers of mixtures of particles," P. Singh, M. Hossain, S. K. Gurupatham, K. Shah, E. Amah, D. Ju, M. Janjua, S. Nudurupati and I. Fischer.

Accuracy of Robotic Cuts in Soft Tissue Equivalent Compliant Materials

Shaunak Sarkar, Adviser: Prof. Sanchoy K Das, Mentor: Babak Hoseini
Department of Mechanical and Industrial Engineering
New Jersey Institute of Technology, Newark N.J. 07102

The application of robotics has become widespread in the industrial sector and its influence is growing gradually in the health care sector as well. The preference of robots is mostly in case of surgery and the Da Vinci robotic system is widely used in physician assisted precision surgeries. However, there are some disadvantages as well due to which some cases of internal injuries have been detected in patients. The main difference between surgical robots and other robots is that the surgical robots have to interact with soft and delicate body tissues. These tissues are mostly compliant or nonrigid and so are subject to physical deformation under pressure. Due to this nature, a robotic arm may fail to create an incision accurately and the scalpel may deviate from the required cutting line. So, the aim is to determine how accurately cuts can be made by a robot on compliant materials. For experimentation, a table-top robot Lab Volt 5200, controlled by RoboCIM software is used. Cuts are then made on compliant materials similar to body tissues. Using design of experiments, statistical analysis of cut frequency is done.

Figure 1 : **Lab Volt 5200 robot**
(image from www.labvolt.com)

Figure 2: RoboCIM 5250 software
(image from www.atctrain.com)

Reference:

1. "An Approach for Integration of Industrial Robot with Vision System and Simulation Software" by Ahmed Sh. Khusheef, Ganesh Kothapalli and Majid Tolouei-Rad, World Academy of Science, Engineering and Technology, *International Journal of Computer, Electrical, Automation, Control and Information Engineering* Vol:5, No:10, 2011
2. http://www.labvolt-taiwan.com/product_info.php?p_id=157&level1_id=1&level2_id=3
3. https://www.labvolt.com/solutions/98-5251-00_robocim_5250_software
4. http://biomed.brown.edu/Courses/BI108/BI108_2005_Groups/04/davinci.html

An Investigation of Capacitance-Voltage Characteristics of High-K/Ge MOS Capacitors

Arijit Sengupta, Mentors: M. N. Bhuyian and Y. Ding, Adviser: Prof. D. Misra
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Germanium devices are widely investigated due to their high hole and electron mobility compared to that of silicon. Mobility above 300 $cm^2V^{-1}s^{-1}$ has been reported for Ge PMOS. On the other hand, Ge NMOS showed poor drive current and low mobility in previous studies. This poor performance is attributed to the inability to form a good Ge/high-k interface (1). They also exhibit hysteresis during the capacitance voltage (C-V) sweep because of the presence of slow trap states near the dielectric substrate interface (2).

In this work, we have investigated metal/HfZrO/Al_2O_3/Ge metal oxide semiconductor (MOS) capacitors with six different Zr/(Hf+Zr) content (0 percent, 25 percent, 33 percent, 50 percent, 75 percent and 100 percent) in the dielectrics. The dielectrics were subjected to slot-plane-antenna plasma (SPAO) treatment during the deposition process and compared with the control HfO_2 without any SPAO treatment. Capacitance voltage (C-V) and conductance voltage (G-V) characteristics were studied for all of the devices using a 4284A LCR meter and a cascade probe station. The equivalent oxide thickness (EOT), flat-band voltage, interface state density (D_{it}), C-V hysteresis and oxide trapped charge ($Q_{trapped}$) were estimated from the experimental results. Figure 1 shows the C-V hysteresis for the metal/ZrO_2(3.5 nm)/Al_2O_3(1 nm)/Ge MOS capacitor with SPAO treatment.

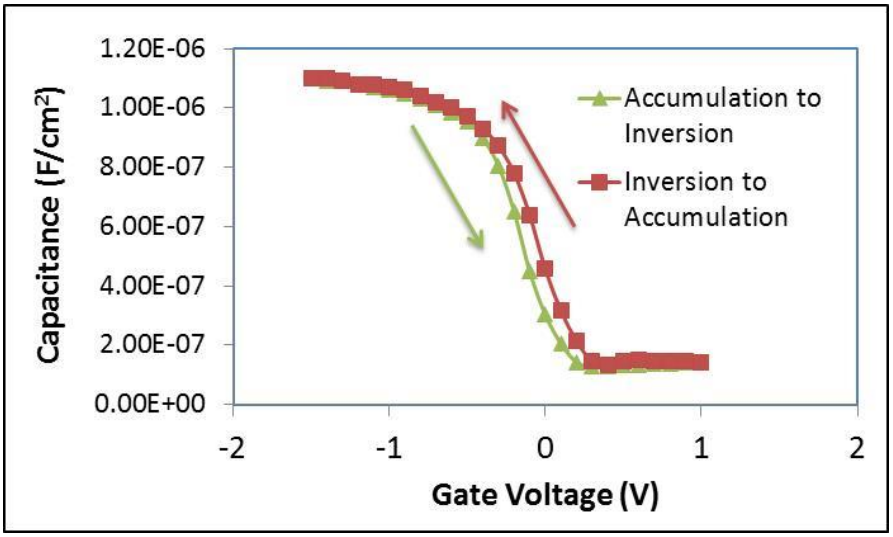


Figure 1: Capacitance voltage (C-V) hysteresis observed by performing the C-V sweep first from accumulation to inversion and then from inversion to accumulation. ZrO_2(3.5 nm)/Al_2O_3(1 nm)/Ge +SPAO is presented in Figure 1.

References:
1. Y. Ding, D. Misra, M. N. Bhuyian. *ECS Trans*, 69 (5) 313-322 (2015).
2. J. Lin, Y. Y. Gomeniuk, S. Monaghan, et al., *J. Appl. Phys*, 114, 144105 (2013).

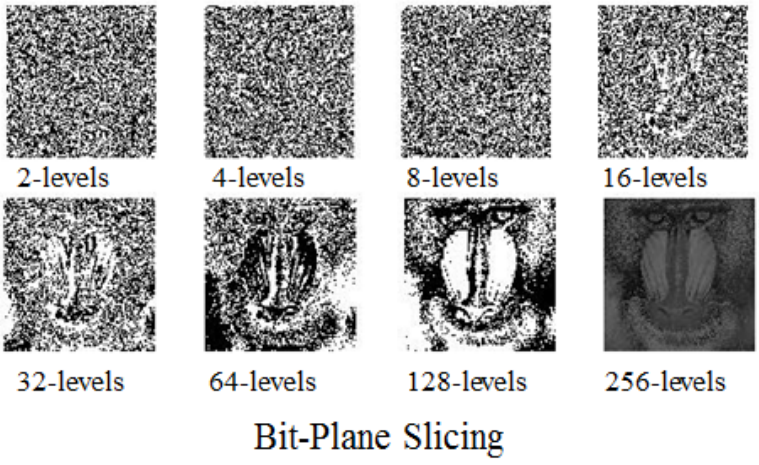
Digital Image Processing and Seam Carving

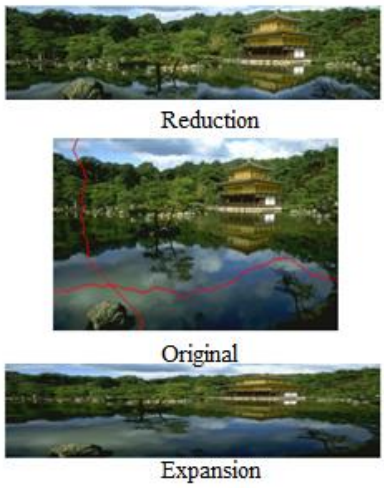
Aman Singhania, Adviser: Dr. Yun Qing Shi, Mentor: Jingyu Ye, Ph.D. Student
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Digital image processing refers to processing images using digital computers. A pixel is the smallest image element whose value describes the element's intensity. The intensity resolution refers to the smallest discernible change in intensity levels. It has been observed that as the number of intensity levels in smooth areas of a digital image is reduced, an effect called false contouring may be observed. On the other hand, reducing the number of pixels in a digital image may degrade the image quality.

Often the quality of an image may be bad due to the existence of noise, the boundaries of the objects in an image may not be clearly distinguishable, or the image might have a poor contrast. In all these cases the image is not clearly visible to the naked eye and the image enhancement becomes a necessity. This may be achieved by using histogram equalization where we improve the contrast by adjusting the image intensities to make the histogram flat.

Seam carving is an image operation used for content aware image resizing: either reduction or expansion. A seam is a connected path of low-energy pixels in an image. To expand an image, we add the suitable seams and to reduce an image we remove some selected seams. In this project, these two issues are studied and researched. Two relevant pictures are shown below.





Seam Carving-expansion and reduction

References:

1. Book-**Digital Image Processing** by *Rafael C. Gonzalez* and *Richard E. Woods*.

2. **Seam Carving for Content-Aware Image Resizing**, ***Shai Avidan,*** Mitsubishi Electric Research Labs, ***Ariel Shamir,*** the Interdisciplinary Center & MERL.

Lean Startup Accelerator Program

CNIM Scale UP

Kabir Mitra, Adviser: Dr. Mitra, and Mentor: Dr. Sagar Roy
Department of Chemistry and Environmental Science
New Jersey Institute of Technology, Newark, N.J. 07102

The objective of this project is to utilize carbon nanotubes (CNTs) to synthesize Carbon Nanotube Immobilized Membranes (CNIM) with breakthrough membrane properties for the generation of pure water from sea and brackish water via membrane distillation (MD). This fundamentally new approach will reduce the energy requirements and cost for desalination. MD can be operated at relatively low temperatures (60-90^{o}C) and can be powered low-grade heat. This enables an MD system to utilize waste heat and alternative energy sources such as solar energy. MD offers several advantages over traditional desalination techniques, including the ability to handle higher salt concentrations, less stringent pretreatment requirements, less energy consumption, significantly less fouling, and longer lifetime for the membranes. This technology it will dramatically change the competitive landscape of conventional methods such as Reverse Osmosis (RO) and thermal evaporation.

This project also focuses on ***issues related to power plants.*** Due to their high cooling-water requirements, the power plants are the largest consumers of fresh water. The global water crisis is a major problem facing power generation, and CNIM-MD offers several opportunities to help alleviate this issue. In addition to utilizing sea and brackish water, the utilization of waste heat will reduce the cooling-water requirements, and by treating the saline cooling-tower effluents, CNIM-MD will allow the towers to operate at higher cycles of concentration. The effluent from CNIM-MD is pure enough to be used as boiler feed water, with minimal additional treatment. ***The specific goal for this phase of the project is to study the scale up of membrane modules for eventual power plant applications.***

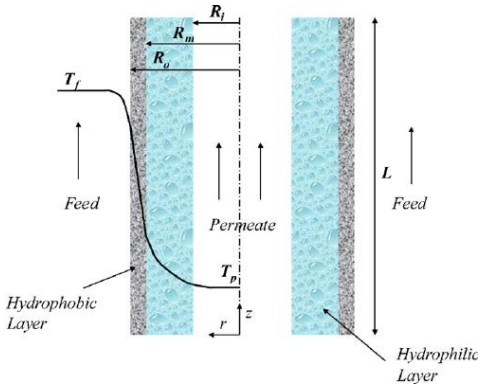


Figure 1. Membrane distillation schematic.

Brazil Scientific Mobility Program

Magnetism Applications in Power Transfer and Generation

Artur Balthazar, Eduardo Pereira, Leonardo Fontoura, Adviser: Dr. N.M. Ravindra
Department of Physics
New Jersey Institute of Technology, Newark, N.J. 07102

The gradual insertion of efficient and renewable energy generation is among the biggest challenges for engineering in the next centuries. Windmills are gaining a lot of attention for being one of the strongest renewable sources. In this project, we develop a different epicyclic gearing system for wind turbines, where the biggest advantage is the substitution of the mechanical teeth by magnets. This gear technology is called magnetic field augmented rotational system (MARS) and dispenses lubrication, resulting in less maintenance to the turbines, less noise and friction. With the design presented in this project, we expect the generator wheel to turn seven times faster than the motor wheel.

Another appliance that is being explored is the controlled magnetic levitation to generate electricity using magnetic movement. According to Faraday's law, an electromotive force (emf) can be induced by the change of the magnetic flux, so the goal is to generate power from a moving magnet towards a pickup coil plugged in a voltmeter to measure the induced voltage.

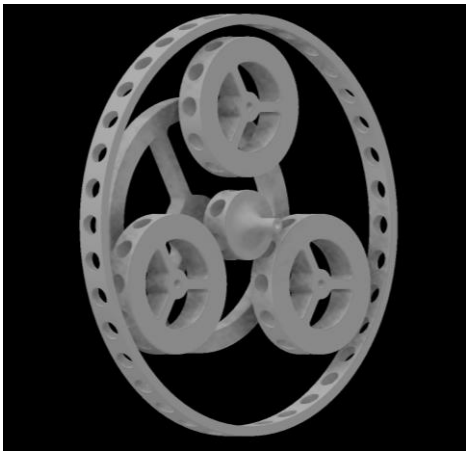


Figure 1: 3D model of the magnetic epicyclic gearing design for the project.

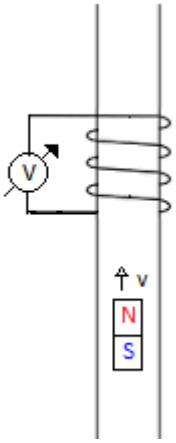


Figure 2: Magnetic sketch for electricity generation from magnetic motion.

Improvement in a Simple and Sustainable Apparatus to Measure Fines Content in Soil

Eduardo B. Carlin, Guilherme T. N. do Amaral, Tatiana de F. Centuriao
Adviser: Dr. M. Mahgoub and Dr. L. V. Pots
John A. Reif Jr. Department of Civil and Environmental Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Infrastructural projects have a high demand on geotechnical investigation and laboratorial soil experimentation to define its properties and behavior within desired conditions. These tests are time consuming and costly. One of the properties which is important to know is the content of fines. Laboratory mass-based wash test, designated ASTM D1140, is used on selected soil samples in order to estimate fines content for geotechnical investigations. Trying to save time and money, a new method was designed using the principle of estimating fines content by measuring relative volumes of the coarse-grained to fine-grained soil fractions. This innovative method uses less water and no energy is required during the test. This new method runs in approximately 15 minutes and can be made on field, bringing sustainable principles to the procedure. Cooked samples were produced and tested in order to make statistics analysis determining its reliability and accuracy. However, the device still has some problems, such as loss of sample and leakage which compromises the effectiveness of the apparatus. Improvements were proposed to avoid aforementioned adversities and increase workability and accuracy of the equipment by making the test easier to run and decreasing the time spent and loss of sample. Even with an improved device, the volume-based test still does not reach the same precision as the weight-based ASTM D1140 test, which was an expected outcome. Nonetheless, the benefits of the new apparatus adds notable enhancement to the overall procedure on fine-grains experimental testing.

Figure 1: Apparatus for the new method to measure fines

Virtual Sisters App: Providing Social Support for Women in STEM

De Jesus, R., Kulkarni, I., Leal, C. M., Poojary, A. S., Schiquetti, F. A., Spryszynski, A., Wohn, D.

Social Interaction Lab – Department of Information Systems
New Jersey Institute of Technology, Newark, N.J. 07102

Women are still underrepresented in STEM (Science, Technology, Engineering and Math) majors and for that reason have difficulty identifying mentors and peers. This can lead to them dropping out of their university or STEM program. It is therefore fundamental to determine the factors that might influence that decision. One of these factors is surely social support.

Hence, it is important to structure a social-support system that can help female STEM major students who are going through such an experience while attending university. Virtual environments, such as social-media networks, are a possible medium to obtain and express social support. These virtual interactions can have a positive impact in helping female students adjust to their STEM program environment.

This paper describes the approach chosen to develop a female-only mobile virtual-support environment. The Virtual Sisters App allows female STEM students to support each other in overcoming the challenges that may arise during their time at university. The environment prompts students to develop a sense of community where they would actively seek and provide social support. The Virtual Sisters App is meant to be used by the female community enrolled in STEM majors at New Jersey Institute of Technology (NJIT), a heavily STEM-focused university located in New Jersey.

After the initial brainstorming, researchers agreed that user-centered design would be the best approach to the task, as potential users' feedback would be crucial to help identify the most important features to be available in the application. The specific methodology chosen was the qualitative research interview.

Before researchers could go out and start to do the field work, a protocol was developed and refined through multiple iterations. Once the protocol was ready, researchers recruited potential users (female NJIT students of all ages) to be interviewed.

Researchers have interviewed 20 female NJIT students from different STEM majors and of a variety of cultural, ethnic and racial backgrounds. All the interviews were audio recorded and later transcribed. The interviewees were asked questions regarding their personal habits, interaction with colleagues, technology usage and preferences, as well as how they felt as NJIT students, if the environment was welcoming and if they would be willing to seek and/or provide social support through a mobile virtual environment.

After being analyzed by the researchers, the data will uncover important findings that will be able to deliver a more complete view of the needs of the female students in STEM majors at NJIT, providing the feedback necessary to design and develop the proposed application.

Concrete Bridge Digital Method Analysis Through Laser Scanning

Cristiano Fernandes, Douglas Freitas, Nícolas Pauli. Adviser: Mohamed Mahgoub
John A. Reif, Jr. Department of Civil and Environmental Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Sustainability is becoming an important issue in different areas of our society. In civil engineering, it is no different. Concrete is one of the most used materials in construction. A lot of materials are used for production, such as cement, sand, crushed stone, pozzolans, water and admixtures. The world supply of them are bigger than the world demand, but the production of some materials, such as cement, generates a huge amount of air pollution. For the production of one ton of cement, one ton of CO_2 will be released in the air. The goal of this research is to increase the life cycle of a concrete bridge, reducing the consumption of concrete to build a new bridge and reducing the pollution released by the cement in the air. To increase the life cycle of the bridge, our group used laser-scan equipment to scan the bridge and identify all damages, such as cracks, holes and corrosion in computer software. With all the results obtained by the equipment, it is possible to evaluate the effectiveness of the laser-scan method applied to identify concrete pathologies compared to the traditional visual approach.

Figure 3 Concrete bridge model created by laser scan as method to identify concrete pathologies

Use of Red Clay to Remove Heavy Metals from Contaminated Water

Vitor Russyere Sousa Barros and Jay N. Meegoda

The consumption of water containing heavy metals is a big problem for the human body. It is known that heavy metals like Cadmium, Arsenic and Chromium, for example, can lead to a series of problems to thuman health. In Sri Lanka the heavy metals in the water are causing Chronicle Kidney Disease (CKD), which is a big health problem because it will make the kidneys malfunction, leading to death because the body will not filtrate the blood.

The **red clay (a)** is a type of clay in which there is the presence of higher fluxing oxides, like K_20, Na_20 and Fe_20 with clay minerals. The advantages of using clay minerals as the alternative adsorbents for the removal of heavy metals are high ion sorption/exchange capacity, low permeability, swelling ability, chemical and mechanical stability, and moderate specific surface area. Studies to test which type of clay is better for heavy metal adsorption and what are the conditions to make this process more efficient are important to understand how each type of clay reacts with the heavy metals.

In order to remove the heavy metals in the water using a low-cost filter made of red clay, it is desirable to study chemical, mineralogical and textural properties of the red clay. The tests for the Atterberg Limits (Liquid Limit and Plastic Limit) were performed to understand the properties of the red clay. Then **different mixtures of red clay (b)** were made, such as red clay with sawdust and red clay with diferent sizes of sand. Then disks were made using a **cylindrical glass (c)**, then dried into an oven and then the disks were put into a high temperature kiln and burned. The thickness and diameter of the **burned disks (d)** were measured three times and the average was taken.

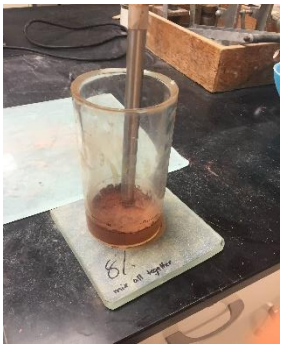
The Permeability of the disks was performed using **Triaxial Permeameter (e)** and calculations of the coefficient of permeability were done using Darcy's Law. After the permeability tests, a **chromium test (f)** was made using a solution of 5 ppm of chromium which pass through the disk, and samples were taken at two hours and four hours after the test was started. The solution collected after the filtration was tested using Atomic Absorption Spectroscopy in order to measure the heavy metal concentration in the filtered water sample.

Key words: Contaminated Water; Heavy metals; CKD; Red Clay; Filter.

a)

b)

c)



d)

e)

f)

Colloidal Silver to Remove Pathogens

Ana Clara Carvalho, Wen Zhang and Jay Meegoda
John A. Reif, Jr. Department of Civil and Environmental Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

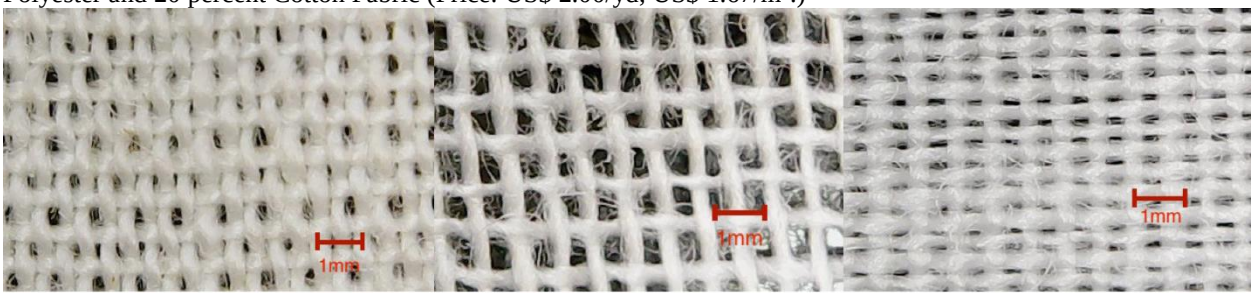
The access to clean water is a really important issue in countries where most of the people don't have it. The bacterial contamination of drinking water brings a lot of water-borne diseases, such as cholera, giardiasis, gastroenteritis and many others.

In an effort to meet the essential needs of the poor, it is necessary to create a cheap and easy-to-use and distribute portable filter that can eliminate the pathogens from the water. Colloidal Silver is a powerful natural anti-bacterial and anti-fungal agent, proved to be effective against infections, colds, influenza, fermentation and parasitic infestations.

The proposed device developed for this study consists in a cloth filter, made with different fabrics, impregnated with a silver solution. All the fabrics are made of or contain cotton in its composition, and cotton is known because of its absorption ability. The fabrics will be impregnated with different concentrations of colloidal silver and the samples will be assessed to know how much silver remains on cloth after several uses and also if there is any increase in silver concentration in the water after filtered.

(a) (b) (c)

Figure 1 - (a) Sample #1 – 100 percent Cotton Fabric (Price: US$2.99/yd, US$ 3.33/m^2.); (b) Sample #2 – 100 percent Cotton Fabric (Price: US$ 2.99/yd, US$ 2.50/m^2.); (c) Sample #3 – Fabric made of 80 percent Polyester and 20 percent Cotton Fabric (Price: US$ 2.00/yd, US$ 1.67/m^2.)



(a) (b) (c)

Figure 2 - Microscope pictures. (a) Sample #1 – 100 percent Cotton Fabric; (b) Sample #2 – 100 percent Cotton Fabric; (c) Sample #3 – Fabric made of 80 percent Polyester and 20 percent Cotton Fabric.

Making High-Throughput Microfluidic Experimentation Possible through the Use of Computer Vision

Cleber Oliveira Damasceno, Saint Clair Barbosa Bernardes, Silvino Gustavo
Adviser: Professor Roman Voronov
Department of Chemistry and Environmental Science
Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark N.J. 07102

The goal of our project is to create a machine learning model of stem-cell behavior (in other words we want to use artificial intelligence to predict how cells build living tissue), with the ultimate goal of controlling the behavior. In order to achieve this, it is necessary that the detection of the cells and devices in these images are retained. By finding these elements, called devices, the machine can analyze and understand the blood clot forming process.

However, it is unviable for a person to identify and examine the behavior of the cells in the device with the naked eye, given that the dimension of the images being used can reach hundreds to thousands of pixels. In order to automate this detection process, several tools using the principles of machine vision were developed using MATLAB, such as a graphical user interface for cell data gathering used for the detection software training, identification of the devices using image processing principles and cross correlation and feature-selection techniques, pre-processing of the images, stabilization and segmentation algorithms, among others.

Having these tools, we hope to significantly decrease the overhead involved with the cells and the devices detection.

An Innovative Method to Determine the Suitable of Soils for Clay Pot Filters

Álisson Giaretta and Jay Meegoda
John A. Reif, Jr. Department of Civil and Environmental Engineering
New Jersey Institute of Technology, Newark, N,J. 07102

Clay pots are used to provide clean water for people in developing nations. Clay pots are usually made of locally available clays. The composition of the soil is very important in order to develop suitable clay pots. There are completing criterions; First, there should be sufficient clay content so that it can be molded and fired to make virtrified clay. However, there should be sufficient voids for the clean water to flow out. However, with high clay content the water flow rate is low. Hence, in order to find the optimum design for the pots, we are exploring the suitability of geotechnical tests such as Liquid Limit Test and Plastic Limit Test to serve as predictors. Several soils with different compositions of clay, silt and sand were tested to develop a simple criterion. First Liquid Limit and Plastic Limit Tests were performed. Then a three in diameter and 0.25" thick disks were made and placed in an oven at 800^{o}C to virtrify the soil. Then a permeability test was performed to find the suitability. Based on the preliminary data, if the soil Liquid Limit is around 50 percent and Plasticity Index is around 20 percent, one could make suitable clay filters. This information will be used as background to instruct people from Sri Lanka to choose the right soils to make the filters.

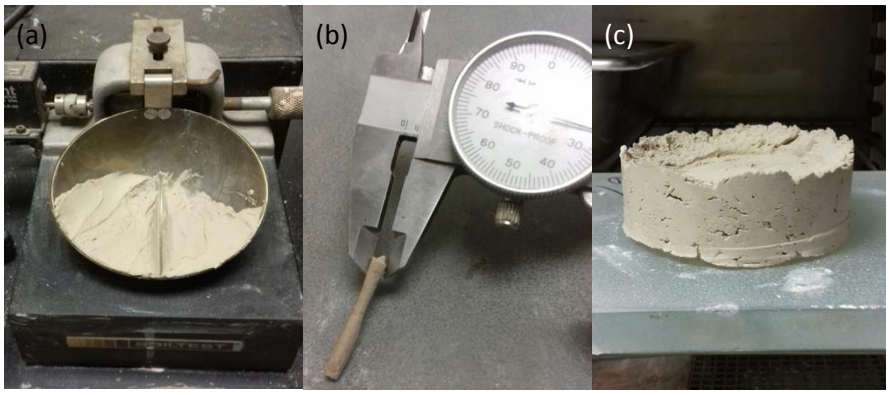
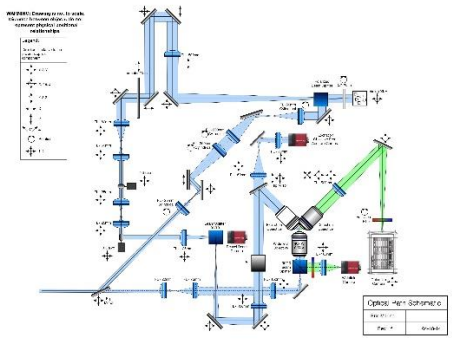


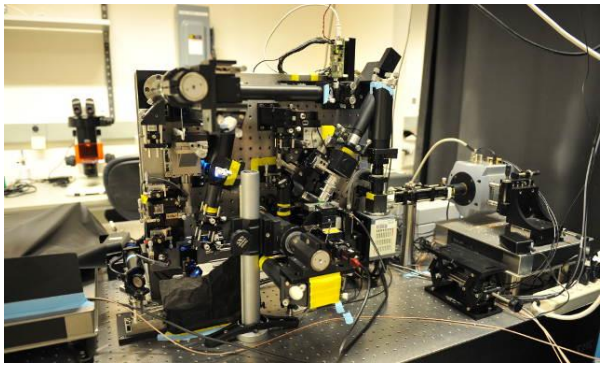
Figure 4 - (a) Liquid Limit Test (b) Plastic Limit Test (c) Disk For Permeability Test

Lattice Light-Sheet Microscopy

Karine Alves de Freitas Leite, Tulio Seike Nascimento, Adviser: Dr. Roman Voronov
Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

This research focuses on building a Lattice light-sheet microscopy. This microscopy is a modified version of the light sheet fluorescence microscopy developed at the Howard Hughes Medical Institute's Janelia Research Campus by Eric Betzig, who won the 2014 Nobel Prize in Chemistry. The major difference from the previous version is that it decreases damage to cells since the phototoxicity in other hand the data acquisition speed is increased. It is useful for in-vivo cellular localization and super resolution 3D images. Using a confined excitation band kept nearly all illuminated cells in focus. The reduction of large, out-of-focus spots allow precise tracking of individual cells at a high molecular density, a capability unattainable through previous microscopy methods. Consequently, lattice light sheet is being used for a number of dynamic cellular interactions. Here at NJIT, it is going to be used in stem cell studies and how it regenerates damaged tissues. During the summer program, the students were responsible for constructing cables, learning/ordering/powering up the hardware/computer boards, how the software communicates with the microscope hardware, aligning the optics and developing pieces for the microscopy.





References

[1] Chen, B.-C. et al. "Lattice light-sheet microscopy: Imaging molecules to embryos at high spatiotemporal resolution." *Science* 346, 1257998 (2014).

[2] Gao L, Shao L, Higgins CD, Poulton JS, Peifer M, Davidson MW, Wu X, Goldstein B, Betzig E. "Noninvasive imaging beyond the diffraction limit of 3D dynamics in thickly fluorescent specimens." *Cell* 2012;151:1370–1385.

Smart Structural and Sustainability Analysis for Rehabilitation of Steel Structures

Alef A. Lima, Igor Y. P. Nishimura, Caique Ogata C. da Rocha, Advisers: Dr. Mohamed A. Mahgoub, Dr. Laramie V. Potts

John A. Reif, Jr. Department of Civil and Environmental Engineering

New Jersey Institute of Technology, Newark, N.J. 07102

Steel is highly present in cities and is known as a durable material for construction, while still being also vastly used in other areas of the industry and mechanical engineering. Iron ore (approximately 98 percent), carbon and small parts of other elements compose steel, which means the steel production is dependent of iron ore production. In the last decades, the production of steel and iron ore have grown, especially in the 21st century. However, this quick growth is a threat to the existing reserves of iron ore. It leads to a need for a maintenance and rehabilitation of current structures and other devices. The material flow analysis method was used in this research in order to obtain an estimate of iron ore and finished steel production and consumption worldwide. It is necessary to find pathologies in structures in order to repair them and maintain their functionality. This paper shows that both the visual method with optical human observation and the digital method with structural surveying via laser scan are suitable for different situations. In the next years, steel demand is going to be greater than its supply. Considering the results of the material flow analysis, at the current rate the world's iron-ore reserves will be depleted in the next 80 years. For this reason, we can conclude that constant maintenance of steel structures, as well as improvements to the steel recycling industry must be achieved in order to maintain the iron-ore reserves without compromising the potential of construction.

Fig.1 NJIT's steel structure scanned for the research.

Fig. 2 Leica MS60 Laser Scanne.

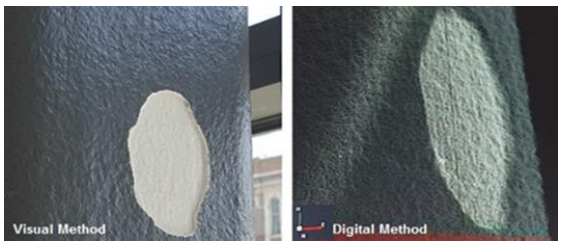


Fig. 3 The optical human observation of failures in a steel structure Avs. the digital method observation of failures on a steel structure.

Automated Microfluidics

Guilherme Parana, Adviser: Dr. Roman Voronov
Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Microfluidics is the science and technology of manipulating and controlling fluids in networks and channels with lowest dimensions from tens to hundreds of micrometers [2]. The need for microfluidics automation came up because it has been successfully used for culture experiments up to four weeks on a variety of cells. The devices will test different culture conditions and their ability to drive cell growth and proliferation in an automated form, with no need of human interference during the process, and also with high-throughput experimentation purpose [1]. The main goal of this research is to develop the electrical installation for the microfluidics control inside the chip. This chip was designed to screen the effects of different mixtures of reagents on the behavior of cells over long-term culture for tissue engineering. The automation process was done using a programmable logic controller (PLC) made by WAGO Corporation; between the different types of control methods, it seemed to be the best choice because it does not require any circuit assembly and is very reliable. It also allows the automation of different parts of the process, adding different I/O modules into the controller. Thus, the user can control different types of sensors and transducers at the same time. At the end of the project, the WAGO controller will automate three parts of the process. The most important part is the pneumatic solenoid control valves which are responsible for controlling all the on-chip valves. The controller will also acquire data from pressure sensors to measure real-time flow rates in the piping system with the purpose to ensure the exact chemical concentration inside the chip, and also automate the chip temperature using an Indium Tin Oxide (ITO) coated glass as the heating unit. All the automation processes were programmed using MATLAB and are controlled by a computer using a Graphical User Interface (GUI).

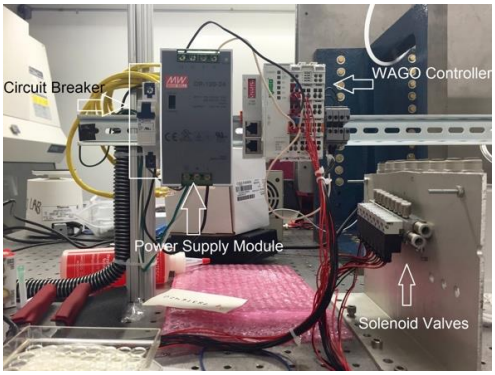


Figure 1 - Programmable Logic Controller electrical installation.

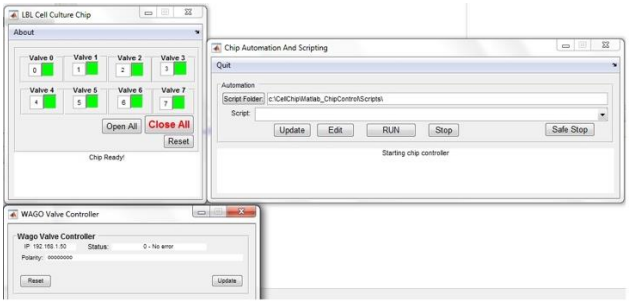


Figure 2- MATLAB GUI for the valves control.

References:

[1] Chen, C; Gómez-Sjöberg, R; Leyrat, A; Pirone, D; Quake, S. Versatile, Fully Automated, Microfluidic Cell Culture System. Analytical Chemistry 2007, 79, 8557-8563.

[2] Microfluidic Definition by Fluigent, Fluigent Microfluidics Made Easy, Web.

Inexpensive Water Filter Remove Heavy Metals for Using Bio-Char

Priscila A. Eburneo Tanioka and Jay N. Meegoda

One of the causes for heavy-metal accumulation in the human body could be explained by consumption of contaminated water. It's known that heavy- metal poisoning can lead to CKD (Chronic Kidney Disease) development over the years, which is a major public health issue in Sri Lanka. An attempt was made to develop a low-cost filter using biochar in order to remove heavy metals from contaminated water. Biochar is charcoal used as a soil amendment. Like most charcoal, biochar is made from biomass via pyrolysis. An experimental filter was produced using accessible materials, for instance biochar, sand, gravel, paper filter and waste plastic soda bottles. For experiments in the laboratory, a plastic bottle with 16.9 oz. cut at the bottom and with an orifice in the lid was filled with a layer of biochar, followed by sand and a third layer of gravel (Figure 1). Also, a paper filter was added between the lid and the bottle before closing it. Paper filter, sand and pea gravel allow the uniform flow conditions. Tests were performed using a concentrated solution of heavy metals in water. The solution collected after the filtration was tested using Atomic Absorption Spectroscopy in order to measure the heavy -metal concentration in the filtered water sample. Test results show promising results.

Key words: Contaminated water; Heavy metals; CKD; Biochar; Filter

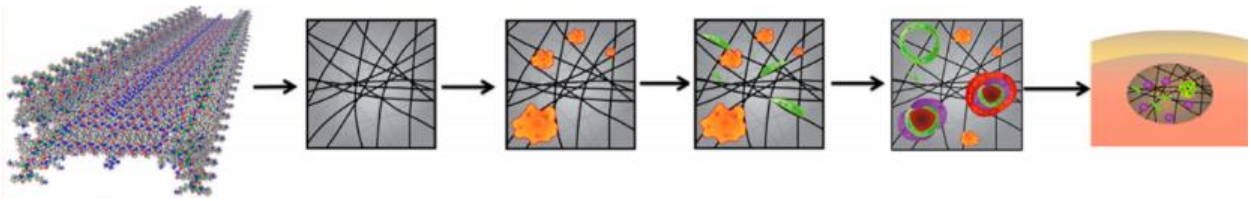
Figure 1: *Inexpensive water filter made of biochar for removing heavy metals.*

Biomedical Engineering

The Characterization of Angiogenic Peptide Hydrogels for Myocardial Regeneration

Anthony Chirayath, Adviser: Professor Vivek Kumar, and Mentor: Dr. Peter Nguyen
Department of Biomedical Engineering
New Jersey Institute of Technology, Newark, N.J. 07102

Traditional scaffold-based tissue regeneration strategies have many limitations due to the inherent design flaws associated with the use of larger fibrous artificial scaffolds. This is particularly true with approaches targeting the regeneration of myocardium for the treatment of myocardial infarction. The nature and design of these scaffolds lead to many challenges when attempting to use them for implantation, including a lack of host cellular infiltration, unwanted immunogenicity, surface degradation prior to integration, and the whole host of issues associated with the surgery for implantation. In order to bypass many of these limitations, we have designed a self-assembling peptide with an angiogenic mimic, which forms an injectable nanofibrous hydrogel with proangiogenic properties. In order to assess the tissue regeneration potential of these scaffolds with stem cell derived cardiomyocytes, several characterization studies will be conducted to quantify cell proliferation and measure cell viability throughout the hydrogel. In addition, we will be looking at the ability of the peptide hydrogel to promote the synchronous beating of cardiomyocytes. These results will confirm the advantages of self-assembling peptide hydrogels over traditional scaffold-based tissue-regeneration strategies for myocardial regeneration.



International Council for Small Business Academy

Characterization and Promotion of the Digital Entrepreneur

Miriam Helmy and Rola Shehata, Adviser: Dr. Cesar Bandera
Martin Tuchman School of Management
New Jersey Institute of Technology, Newark, N.J. 07102

Ever since the invention of the Internet, markets are witnessing an increase in the number of new ventures whose products or services are entirely digital and have no physical substance. Reasons for this trend include the feasibility of software solutions that previously required dedicated hardware (e.g., cloud services, health monitors and music authoring) and the virtualization of companies (e.g., online storefronts, social media marketing and digital currency). The prevalence of such digital startups is particularly high at educational institutions, as illustrated by the growing popularity of hackathons, accelerators centered on mobile app products, and newsworthy gazelles with campus origins.

In contrast, entrepreneurship education curriculum and business incubation policies have remained relatively unchanged over the last decade (an exception may be those adopting the lean startup methodology). There is little consensus on what distinguishes the "digital entrepreneurs" who launch these digital startups from the more traditional entrepreneurs who launch startups with physical products or services. Moreover, there is no dedicated effort to track the progress or economic impact of digital entrepreneurship.

Our research focuses on two questions:

1. What characteristics distinguish a digital startup from a nondigital startup?
2. Do digital entrepreneurs exhibit characteristics different from the founders of non-digital startups?

So far, we have been able to conduct a survey and collect around 40 interviews. We have transcribed them and are now in the process of coding the data using Atlas.TI.

BRIQ Meals

Trentino Pezzano, John Fahim, Matt Reda, Miriam Helmy
Adviser: Dr. Cesar Bandera
Martin Tuchman School of Management
New Jersey Institute of Technology, Newark, N.J. 07102

We all have had our doubts with college food systems that are put in place. This is why we created BRIQ Meals, a food-to-consumer based iOS, Android and Web-application. The system is an online ordering system that stems from the urge of allowing more edible food at colleges. Campus Dining, after several surveying efforts has been known to disappoint, and we have brought together our best efforts in order to provide a flexible meal plan for college students by working with restaurants surrounding college towns. We are going to simply have an off-campus meal program in place of a normal on-campus meal program.

In order to grasp attention, we had sought out statistics from several college students across a variety of campuses and have figured out that implementation is going to require the access of a working online interface along with the support of a local university to represent and endorse the company as it first gets its feet off the ground. In valiant efforts, we hope to bring a more flexible plan to students by working in accordance with the many diverse restaurants surrounding college campuses.