NJIT
New Jersey Institute of Technology

BOOK OF ABSTRACTS

Eighth International Undergraduate Summer Research Symposium

Thursday, July 30, 2015

Book of Abstracts
Eighth NJIT International Undergraduate Summer Research Symposium

Thursday, July 30, 2015

Symposium Coordinator: Ms. Angela Retino
McNair Coordinator: Ms. Zara Williams

Sponsors

Brian Kiernan and family, Capital One Bank, Peggy McHale, NASA, National Science Foundation, Needham Foundation, McNair Program, NJIT Office of Research and Development, Pfeiffer Foundation, PSEG Foundation, and the U.S. Department of Education

Office of Research and Development
New Jersey Institute of Technology

Copyright © 2015 by New Jersey Institute of Technology (NJIT). All rights reserved.

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

Joel S. Bloom
President

July 30, 2015

I am very pleased to welcome you at the Eighth NJIT International Undergraduate Summer Research Symposium. It is gratifying to see the continuously growing enthusiasm for undergraduate research and innovation that resonates the NJIT strategic plan and vision.

With an overall research enterprise of over $110 million expenditure per year and growing, NJIT has a strong strategic emphasis on Undergraduate Research and Innovation (URI) with several externally and internally funded undergraduate research, design and innovation programs. The URI enterprise includes Provost Summer Research Fellowships, Ronald A McNair Post-Baccalaureate Achievement Program, three National Science Foundation (NSF) funded Research Experience for Undergraduates (REU) programs in Neural Engineering, Nanotechnology and Quantitative Simulations, Faculty NSF REU Supplement Grants as well as privately funded Newark Innovation Acceleration Challenge and TechQuest Innovation Competition programs. This summer, there are more than 118 undergraduate students working on different research projects funded through different programs from NJIT and partner institutions.

I congratulate the summer research students, and their faculty advisors for impressive success in research, and productivity that is evident from the abstracts and posters presented at the International Summer Research Symposium. It is exciting that the Book of Abstracts of Eighth NJIT International Undergraduate Summer Research Symposium is available through NJIT URI website as an initiative started by Dr. Atam Dhawan, Vice Provost for Research and Executive Director of Undergraduate Research and Innovation to document the wonderful research work being done at NJIT. I thank staff members and program directors for putting together this excellent event.

I am confident that Undergraduate Research and Innovation programs at NJIT will continue to grow significantly providing our undergraduate students an exceptional academic and research experience. It is an integral part of our strategic plan to educate future leaders in the global society. Thank you all for your contributions in supporting the undergraduate research and innovation programs.

Sincerely,

Joel S. Bloom
President

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 30, 2015

A message from the Provost:

Welcome to the NJIT Eighth International Undergraduate Summer Research Symposium. I would like to congratulate all undergraduate summer research students, their faculty advisors, and program directors for the impressive research work exhibited here. The symposium clearly demonstrates the excellence in interdisciplinary research and innovation by undergraduate students honing their expertise in preparation for taking important leadership roles in science and technology. As it is critically important for all of our students to develop such leadership 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 advisors, and program directors for organizing this impressive international symposium. Through the Undergraduate Research and Innovation (URI) initiative established by Dr. Atam Dhawan, this year's summer research program has been significantly expanded and has involved more than 118 students from NJIT and partner institutions through different programs.

The online publication of the Book of Abstracts of the Eighth NJIT 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 enabling them to become leaders in the 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 30, 2015

I would like to extend warm welcome to all students and faculty advisors participating in the 2015 Eighth International Summer Research Symposium. Congratulations to all NJIT undergraduate students, international students, high school students, faculty advisors and mentors for their impressive research work that spans over core and interdisciplinary areas including science, technology engineering and mathematics (STEM) as well as arts and architecture.

The spectrum of research projects pursued this summer clearly focuses on discovery of new knowledge along with application research addressing the needs and challenges of our global society for high potential impact. Opportunities to work during the summer on research projects bring a special focus as students are not stressed out with heavy course work. Through such opportunities, students get hands on working closely with fellow students and faculty advisors to gain valuable research experience that enhances their future career prospects whether they go to graduate or professional school, or join industry. The posters presented in the Symposium emphasize the fact that when our students concentrate on scientific and application research, they produce outstanding results with leading edge of innovation.

I am very pleased to present the "Book of Abstracts of Eighth NJIT International Summer Research Symposium" that contains 98 abstracts submitted by symposium participants. We expect that the Book of Abstract will be used as a resource long after the symposium as an online publication. You can find it at the Undergraduate Research and Innovation (URI) website http://centers.njit.edu/uri/programs/index.php.

Organizing such a symposium requires tremendous efforts and time. I am very grateful to President Dr. Joel Bloom, and Provost and Executive Vice President Dr. Fadi Deek for their synergistic vision and kind support to undergraduate research and innovation. Special thanks to Symposium Coordinators, Ms. Angela Retino, from the Undergraduate Research and Innovation (URI) program, and Ms. Zara Williams, from the McNair program, and staff members from the Office of Communication and Web Services who helped in web publication of the Book of Abstracts.

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

Sincerely,

With best regards;

Atam P. Dhawan, Ph.D.
Vice Provost for Research and Development 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

Ronald E. McNair
Postbaccalaureate Achievement Program

July 30, 2015

Welcome to New Jersey Institute of Technology's Eighth International Summer Research Symposium. It is indeed an honor and a privilege to be part of the 2015 International Undergraduate Summer Research Symposium and join with all the other individuals that are a part of the event.

The 2015 Research Symposium is the 15th summer symposium showcasing the research efforts of undergraduate students from the NJIT Ronald E. McNair Program. From its modest NJIT beginnings it has grown to today's event, which includes over 120 presentations by students from the United States 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 these students, the quality of the 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

Eighth NJIT International Undergraduate Summer Research Symposium

Thursday, July 30, 2015

Table of Contents

NSF UNDERGRADUATE RESEARCH PROGRAM – EXTREEMS-QED

NSF UNDERGRAD NANOTECHNOLOGY SUMMER RESEARCH PROGRAM

TECHQUEST INNOVATION

PSEG FELLOW

NJ SPACE GRANT CORSORTIUM SUMMER RESEARCH PROGRAM

HERITAGE INSTITUTE OF TECHNOLOGY-NJIT SUMMER RESEARCH

LEAN STARTUP ACCELERATOR PROGRAM

BRAZIL SCIENTIFIC MOBILITY PROGRAM

CIVIL ENGINEERING SUMMER RESEARCH PROGRAM

Provost Undergraduate Summer Research Program

Iterative Methods for Acoustic Scattering Problems

Jimmie Adriazola, Advisor: Dr. Yassine Boubendir
Department of Mathematical Sciences
New Jersey Institute of Technology, Newark NJ 07102

Abstract: This project's aim seeks to study the acceleration of numerical algorithms used to solve the Helmholtz equation with Dirichlet boundary conditions. The Helmholtz equation arises naturally in physical problems modeled by partial differential equations in space and time as a time-independent wave equation when applying the technique of separation of variables. Using Dirichlet boundary conditions on an infinite domain helps in modelling an outgoing scattered wave after incidence without transmission through the reflecting media. In this work, we are interested in robust numerical methods based on integral equations to solve the Helmholtz equation. It is known that this technique leads to large and dense linear systems in particular in the high-frequency regime, therefore, it is difficult to solve even when using High Performance Computing. We are investigating here some iterative methods based on Domain Decomposition Algorithms to solve the so-called single layer potential. The main idea consists of splitting the boundary of the obstacle into many sub-boundaries and solving the integral equation separately on each of these surfaces. This procedure is performed at each iteration, where some of the data are exchanged between these surfaces in order to recover the original solution. This employs a transfer-matrix method to solve for the density function as a vector in a matrix equation by LU factorization. In using this technique, we hope to see accelerating convergence of the approximations to the density function in the near future.

Helmholtz Equation

$$\Delta u + k^2 u = 0$$

Dirichlet Boundary Conditions

$$u(R, \theta) = f(R)$$

$$\lim_{r \to \infty}(|u(r, \theta)|) < \infty$$

Single Layer Potential in terms of Green's function and density $\rho(\tau)$

$$u(x) = \int_{\partial\Omega} G(t, \tau)\rho(\tau)d\tau = -e^{-ikrcos\theta}$$

Towards a Standard Open Source Simulator for Visible Light Communication

Walter Berreta, James Basuino, Ryan Ackerman, Akshita Gupta, Atreya Misra, Advisor: Dr. A Khreishah
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: The radio frequency (RF) spectrum is the most common form of communication when accessing the Internet for mobile devices. However, RF has disadvantages, such as the limited amount of the RF spectrum, and harmful effects of radiation to the human body. This calls for further research in systems that can complement RF. Visible Light Communications (VLC) is a growing topic specially now in the age of technology. The goal of this project is to develop a module add-on to an already well known simulator for a VLC system. The simulator accurately models the devices, links, and applications, before physically testing the system. In addition, the simulator is open source and free for anyone to use that may want to implement their own VLC system. Also, the simulator allows us to implement heterogeneous networks with both RF (Wi-fi) and VLC. We have incorporated a VLC error/interference model and channel model modules into a broadly utilized network simulator (ns-3). Ns-3 is a free discrete-event software network simulator targeted for researchers and students. The advantage of ns-3 is that it is in constant development and free for the community to further develop the software. Therefore, building these modules will allow other research groups interested in RF/VLC to use this software add-on with the already familiar network simulator.

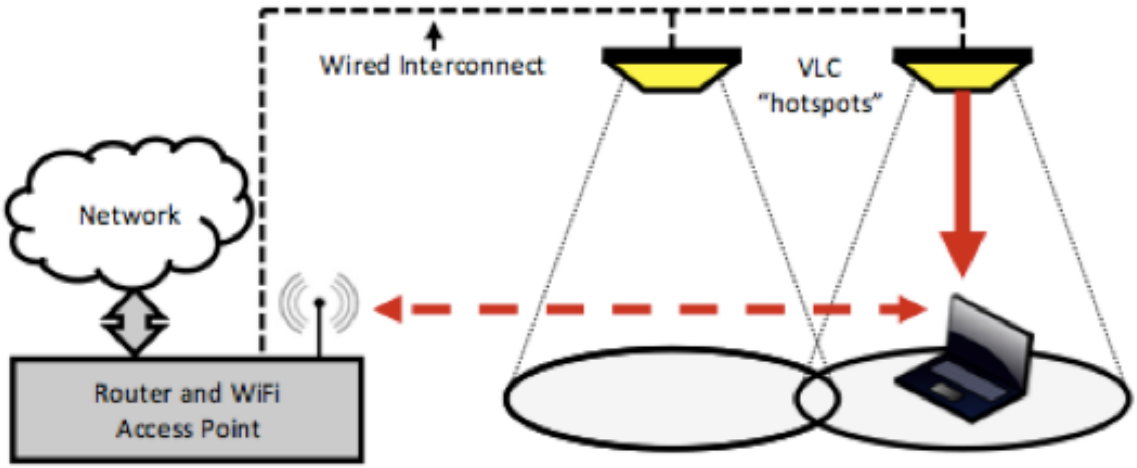
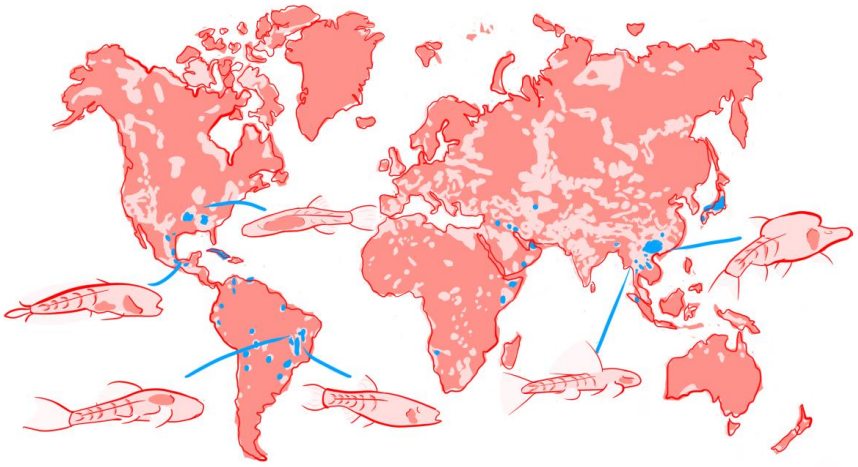


Figure 1: A conceptual heterogeneous wireless communication system where traditional WiFi is supplemented with asymmetric VLC channels.

Cavefish Morphological Evolution

Alex Bradbury-Wallad[1] and Daphne Soares[2]
[1]School of Architecture and Design
[2]Department of Biological Sciences
New Jersey Institute of Technology, Newark NJ 07102

Caves and other subterranean habitats represent one of the most challenging environments on the planet. Other than salamanders, teleost fishes are the only vertebrates that have successfully colonized and have lives completely restricted to caves. Despite being known to science for over 150 years, only recently have cavefishes become model systems for evolutionary studies. The physical characteristics of any habitat constrain the evolution of sensory structures. The association between habitat and sensory morphology has been examined in many species of surface fish. Morphological sensory diversity is high in fishes and is partly explained by a higher number of accessible sensory modalities in aquatic environments, due to the physical properties of water. It is generally agreed that relative size of peripheral organs scales positively with that of the related brain regions, and that both are a measure of the relative importance of a particular sensory modality in the species. Most surface fishes rely on vision and have a corresponding large optic tectum. Cavefishes on the other hand, have evolved to rely on other sensory modalities for behavioral decisions and giving rise to distinct brain morphologies. We used design techniques to compare cavefish brains and their closest living surface relatives. We also created an animation for the website Ted ED that explains how cavefishes evolve and why they are especially well suited for the study of evolution.



Virtual Reality Vision Therapy

John Vito d'Antonio-Bertagnolli (BME) [1]***, Robert Gioia (IT)*** [1]

Advisors: Tara Alvarez (BME) [1]***, Marc Sequeira (IT)***[1]***, Mitchell Scheiman (Optometry)***[2]

[1]Department of Biomedical Engineering and Department of Information Technology
New Jersey Institute of Technology, Newark NJ 07102

[2]Salus University Pennsylvania College of Optometry, Elkins Park, PA 19027

Convergence insufficiency (CI), prevalent in 4-8% of the population, is a binocular vision disorder, characterized by a reduced near point of convergence (Fig. 1), and a tendency for the eyes to drift outward (exophoria). Symptoms include blurry or double vision, headaches, eye strain, and difficulty sustaining attention when engaged in reading and other near work. Office-based vision therapy is effective for 75% of patients; however, it can potentially be cost prohibitive and / or time restrictive. Alternative home-based therapy methods are only as effective as placebo therapies, often due to lack of patient compliance, especially in the 8-18 year old age group. This project seeks to develop a novel method of vision therapy, specifically targeted at patients ages 8-18years old suffering from CI.

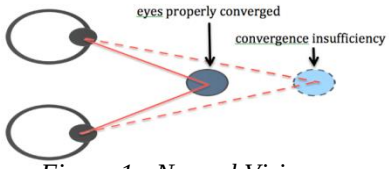


Figure 1 - Normal Vision vs. Convergence Insufficiency

The mechanics of most vision therapy procedures rely on practicing repetitive motion such as converging and diverging one's eyes under controlled conditions. Thus, the main mechanism of this project is repetitive eye motion involving convergence/divergence in different positions of gaze. Stimulating and engaging the patient to make this repetitive motion was the main objective of the project. Thus, in this project a game was developed, targeting the 8-18 year old age range A unique feature of this game is that accuracy of eye alignment is objectively monitored, and progress depends on accurate eye movements. This is a feature that is not available in any other currently available vision therapy procedure. Currently, a therapist or a parent has to work with a patient to determine if the procedure is being performed correctly. The objective eye movement monitoring feature incorporated into the design of this game will insure that the patient is performing the technique properly, if not, the child will not be able to progress through the game.

An Oculus Rift DK2, a head-mounted display, was chosen as the gaming platform. Eye tracking was accomplished with a pair of infrared-sensitive cameras integrated into the Oculus. A pair of Raspberry Pi microcomputers detect eye motion using a proprietary eye-tracking software, developed in C++ and OpenCV, a real-time video processing library. Currently, using this hardware and software, the device is capable of real-time eye tracking at 30 frames per second. An infrared light source illuminates the eye in the dark environment of the Oculus. This grayscale image is thresholded to a binary image. A value of gray is chosen. Any darker shades are kept (black) and any lighter shades are removed (white). Then, a green cross is overlaid on the centroid of the original image (Fig. 2). The pupil, the hole in the eye through which light is absorbed, does not reflect light, and is thus the darkest spot on the binary image, making it very easy to track. The centroid tracking information is then sent to a nearby laptop via a UDP socket, where it is used as the input for a game, detailed in the abstract "*Software Platform for a Virtual Reality Game for Vision Therapy for Children with Traumatic Brain Injury*" by Robert Gioia. The mechanic of the game is eye motion involving repetitive requirements to accurately converge and diverge, which encourages player interaction, and compliance with the therapy program.

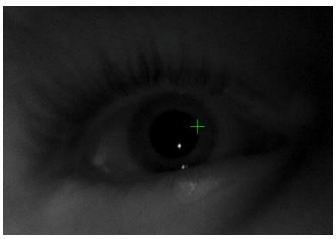


Figure 2 – Centroid-based Pupil Tracking

Modeling Subconcussive and Cumulative Subconcussive Insults Using a Digitally Controlled Fluid Percussion Injury Device

Ashley Fitzsimmons, Mathew Long, Viji Santhakumar and Bryan Pfister
Department of Biomedical Engineering
New Jersey Institute of Technology, Newark, NJ 07102
Department of Pharmacology, Physiology and Neuroscience
Rutgers Health and Biomedical Sciences, Newark, NJ 07102

Abstract: Mild traumatic brain injury, often referred to as a concussion, is typically the main focus of research on brain injury of athletes and military personnel. However, in the absence of medically diagnosed concussion, autopsies have revealed tauopathy found in neurodegenerative disease Chronic Traumatic Encephalopathy (CTE). The possibility of brain injury without a history of concussion suggests subconcussive insults may affect the brain more than previously thought. Thus, athletes and military personnel may be injuring themselves in a way that knowledge of diagnosing, treating or preventing needs improvement. Our hypothesis is repetitive subthreshold insults to the head can cumulate into injury to the brain associated with developing cognitive problems. In order to research this, a subconcussive threshold needs to be determined as defined by an injury that is just below the level that produces acute behavioral measures and neuronal degeneration. To establish a subconcussive threshold, a voice-coil fluid percussion injury device was used, reducing the peak amplitude of the pressure wave to a level at which no significant difference was observed in acute behavioral markers or neuronal degeneration between injured and uninjured rats.

Wistar rats (21-25 days old) were subjected to lateral fluid percussion injury (FPI) at peak pressures 14±1.0 psi (Group 1) 10±1.0 psi (Group 2) or received sham injury. Behavioral measures including apnea, righting time, toe-pinch reflex and seizures were assessed immediately after injury. Righting times did not differ between groups with different injury peak pressure (one-way ANOVA, $F(2,37) = 0.550$, $p=0.582$) Group 1: 148±24.65, Group 2: 122.1±25.95, n=13 each, Sham: 117.3± 16.4 n= 14. Seven of the 13 group 1 rats exhibited apnea (3.75±0.46s, n=7), but none of group 2 or sham rats did (n=5 each). Based on the presence of apnea Group 1, subconcussive insult was modeled using a magnitude of 10 psi.

Once the threshold for subconcussion was determined, we started to investigate the effects of 1 to 5 repetitive subconcussive insults on subjects at 5 min intervals. Although Fluoro-Jade C staining indicated there was no hemorrhage or dentate hilar neuronal degeneration after single injury, rats with repetitive showed evidence of hemorrhage in the fissure despite the absence of acute behavioral deficits or hilar neuronal degeneration.

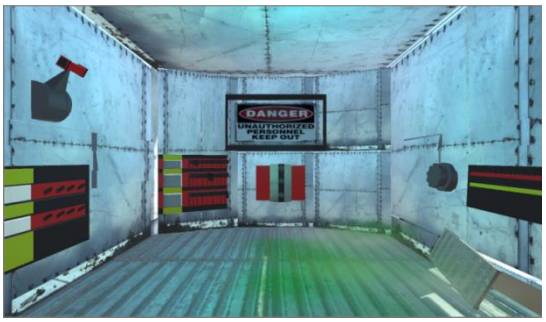
Additional subconcussive insults ranging from ten to fifteen repetitions will also be evaluated in the future. In further investigating the effect of these cumulative insults, activated microglia will be assessed for anti-CD68 antibody [ED-1], blood-brain barrier permeability will be assessed by anti-rat antibody IgG and further behavioral studies will be conducted.

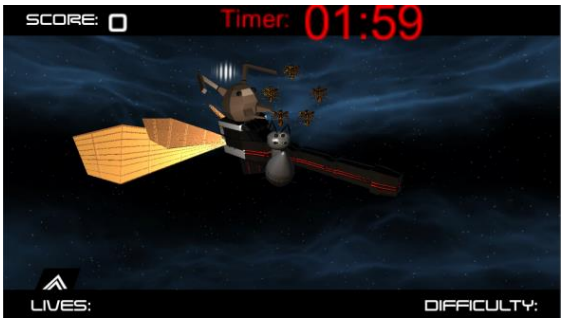
SOFTWARE PLATFORM FOR A VIRTUAL REALITY GAME FOR VISION THERAPY FOR CHILDREN WITH TRAUMATIC BRAIN INJURY

By Rob Gioia (IT), John Vito d'Antonio-Bertagnolli (BME),
Advisors: Tara Alvarez (BME), Marc Sequeira (IT), Mitchell Scheiman

Many forms of rehabilitation utilize a repetitive pattern that improves function but can easily result in patient boredom. Vision therapy is composed of repetitive eye movement procedures that can be administered to patients of all ages with various types of vision dysfunction. One recognized problem in the field of vision therapy is poor patient compliance with home-based vision therapy because current therapy procedures lack the sophistication, graphics, quality, and excitement of currently available videogames. The use of virtual reality gaming as a platform for therapeutic intervention has the potential to significantly reduce visual symptoms via improved patient compliance. The purpose of this project is to design a virtual reality game using the Oculus Rift DK2 that incorporates techniques used clinically in a fun, creative and stimulating environment. The system uses object-oriented architecture which utilizes a variety of visual parameters in a flexible architecture that will allow for a modular, object-oriented design, with the potential for the creation of a variety of games. 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 such as convergence insufficiency, strabismus, and nystagmus. Future research will include validating the system to measure both eye movements and accommodation. The 3D virtual reality game for vision therapy will be tested in the clinic to determine whether vision function improves and visual symptoms are reduced.

The official game demo for this project developed over the ten week program is a 3D Space Shooter game, screen captures seen below, where the patient's eye position controls the weapon firing system in the game. When the player's gaze remains fixed on an enemy for a certain length of time with an appropriate level of convergence (specified in the difficulty settings by the clinician or patient) the current active weapon will be fired and the enemy will be destroyed. There are currently six playable levels in the game, many of which are locked at the start of the game. As the player advances through the levels, these initially inaccessible levels slowly become accessible for the player to enjoy. Other locations in the game include a shop where the player can purchase new weapons and power ups for in-game use, a level where the player can explore their space ship's interior from a first person point of view, and a puzzle which unlocks a new weapon for the player to obtain upon completion.





Meth-Induced Cerebral Hemorrhages as the cause for Expedite Aging caused by Cerebral Amyloid Angiopathy and Neuropathy

Nandini Isaac, Dr. James Haorah
Department of Biomedical Engineering
New Jersey Institute of Technology, Newark NJ, 07102

Abstract:

Methamphetamine the most addictive psycho-stimulant drug in the United States; it affects the lives of more than 19% of the nation (4% of that percentage is from meth users in the Newark, New York, Pennsylvania region). It isn't realistic to stop to use of meth because there is little/nothing to be done about preventing the use or overdose of meth. Meth induces mini-hemorrhages in the brain, causing neurons to degenerate and brain matter to decrease. Cerebral hemorrhage stroke is a condition where an artery in the brain breaks causing the blood to leak into the surrounding spaces of the brain. Cerebral Amyloid Angiopathy is as an age-associated disease caused by amyloid deposition in cerebral and meningeal vessel walls lined with endothelial cells. CAA is strongly associated with micro- and macro-hemorrhages, dementia, disrupting cerebral blood flow, altering blood-brain barrier permeability, and inflammation and metabolic activities that disrupt the neurovascular integrity. We have determined that the use of methamphetamine causes Cerebral Amyloid Angiopathy (CAA) causing cerebral hemorrhage strokes leading to expedite aging in meth users. Protein fragments called beta-amyloid peptide fragments cluster into plaques that cause cell-to-cell signaling to be blocked at the synapses. When these amyloid fragments cluster, they become insoluble and cause the artery to harden leading to atherosclerosis, ultimately leading to an ischemic stroke. In addition to beta-amyloid plaques, the presence of Tau-phosphorylated protein is a significant indicator of the degeneration of neurons in the perivascular region, known as neuropathy. Three antibodies are used to detect for the presence of neuropathy: anti-smooth muscle antibody, anti-Tau antibody and anti-endothelial cell antibody. In Figure 3, neuropathy is detected in the perivascular region of a blood vessel, specifically in the internal capillaries of the brain. This research project is novel because it is the first of its kind to demonstrate the success of laboratory findings and use the results of the research to develop therapeutic treatments in the future for people affected by meth-induced hemorrhagic strokes caused by neuropathy and CAA.

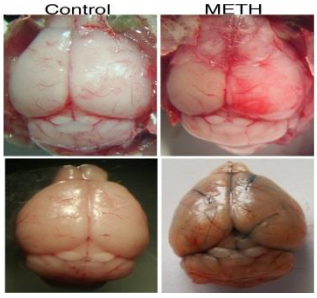


Figure 1: Picture of Hemorrhage and BBB permeability of Evans Blue into the brain of METH administered mice. Cerebral Hemorrhage is indicated by leaking of blood into surrounding spaces due to disruption of BBB.

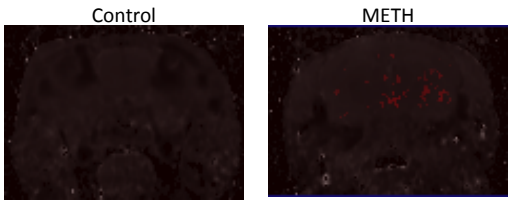


Figure 2: MRI Brain Imaging of leaky BBB. 10mg/kh/day in mice causes muscle atrophy and twitching at week 5 and death week 6.

Figure 3: Neuropathy detected by the use of anti- Tau phosphorylated actin antibody

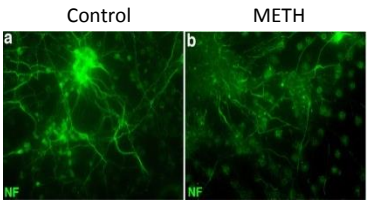


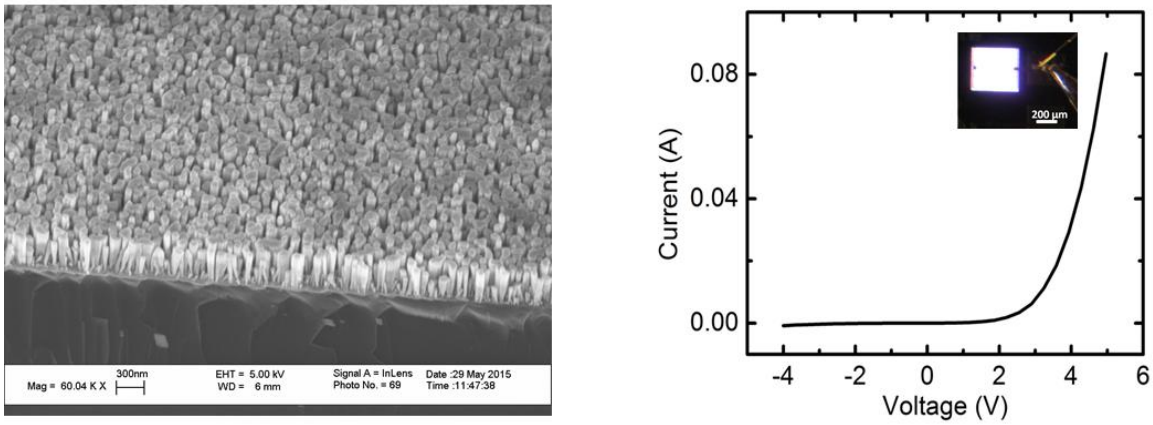
Figure 4: Effect of Methamphetamine on Interneurons, using neuro-filament staining (NF)

Molecular Beam Epitaxial Growth of High Quality III-Nitride Nanowires for Phosphor-Free Solid-State Lighting Applications

Ashish John, Md. Nasiruddin Bhuyian, and Hieu P. T. Nguyen

Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark NJ 07102

Abstract: Light emitting diodes (LEDs), with the use of III-nitride nanowire heterostructures, have been intensively investigated. Compared to their planar counterparts, nanowires exhibit drastically reduced dislocation densities and polarization fields, thereby promising superior performance LEDs for lighting applications. However, the performance of nanowire LEDs is limited due to the poor hole transport, the electron overflow, and the large surface non-radiative recombination. In this regard, we have investigated the design, epitaxial growth, fabrication, and fundamental characterizations of high efficiency III-nitride nanowire LED heterostructures monolithically grown on Si substrates by molecular beam epitaxy, wherein the emission characteristics are controlled by the dot properties in a single epitaxial step. Full-color nanowire LEDs with emissions in the visible wavelength range were fabricated. Moreover, by integrating multiple emission colors including red, green, and blue inside a single GaN nanowire, we have achieved high efficiency, truly white light emission from nanoscale LED devices without using phosphor-converter. With the use of p-type modulation doping, electron blocking layer, and core-shell heterostructures to eliminate the aforementioned limiting factors, the performance of phosphor-free white LEDs was dramatically enhanced with record output power of ~5.2mW and unprecedentedly high color rendering index of > 95. Such high performance nanowire LED devices are ideally suited for future smart lighting applications. Applications and experimental results will be discussed in the poster.



(a) (b)

Figure 1: (a) Scanning electron microscopy image of a typical InGaN/GaN nanowire LED sample. (b) Current-voltage characteristics of a phosphor-free InGaN/GaN nanowire LED. The optical image of such white LED is shown in the inset.

A Robotic Super-Resolution Microscope for Single Cell Analysis

Brandon Jones[1], Marcus Taylor[2], Kolawole Campbell[3], Felipe Lauerti[4]
Advisor: Prof. Roman Voronov,
Mentor: Long Quang Pham (Ph.D student)
[1]Department of Physics
[2]Otto H. York Department of Chemical, Biological & Pharmaceutical Engineering
[3]Helen and John C. Hartmann Department of Electrical & Computer Engineering
[4]IIE Brazilian Scientific Mobility Program

The goal of this project is to construct a customized lattice light sheet microscope that will take high-resolution images of single cells. The advantages of the recently discovered microscopy technique allows the capture of 3D images at super resolution (beyond the diffraction limit of light), with negligible photo-toxicity/fluorophore bleaching, and at high acquisition speeds. We are assembling the microscope following the set up by 2014 Nobel Laureate Eric Betzig and his team, while customizing it to meet our needs and using 3D printed parts to save on costs (Jones). We are also automating the microscope by writing custom programs using Matlab (Campbell) and Labview (Lauerti). Which will enable us to perform long term experiments without having to attend to the microscope. In conjunction with this configuration, a customizable self-regulating cell culture chamber is being designed (Taylor) in order to image cell cultures live on the microscope while maintaining the proper environment for their incubation. For our first test system, we plan to use this setup to investigate effects of acoustic standing waves on stem cell migration. The anticipated impact of this study is in the field of non-intrusive control of growth patterns for tissue engineering.

RS Flip-Flop Circuit Dynamics Revisited via Theory and Experiment

Ian Jordan, Advisor: Dr. Denis Blackmore, and Mentor: Aminur Rahman, PhD Student
Department of Mathematical Sciences
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: Logical RS flip-flop circuits are investigated using dynamical systems theory, specifically starting with a simple bilinear (minimal) component model map of the form

$$F(x,y) = (x+y-xy)^{-1}\big(y(1-x), x(1-y)\big),$$

based on fundamental principles [3], and actual circuits. Although this discrete planar dynamical system model produced some of the expected properties, the chaotic regimes found typically in simulations of physical realizations of RS flip-flop circuits were not reproduced. However, physical realizations of a chaotic logical circuit must involve small perturbations with large or nonexistent derivatives. Therefore, perturbed forms of the minimal are analyzed in detail. It is proved that perturbed bilinear models can exhibit chaotic regimes, sometimes associated with chaotic strange attractors, as well as some of the bifurcation features present in physical realizations and other models. Validation of the approach developed is provided by some comparisons with (mainly simulated) dynamical results obtained from more traditional investigations and some differential equation models of physical realizations of the circuit.

Following the analysis on the theoretical model, a physical circuit representing the system was constructed. This circuit is based on the RS flip-flop with chaotic inputs developed by Cafagna and Grassi [1]. The circuit consists of the typical elements seen in common RS flip-flops, using two voltage control mechanisms to limit the output voltage. Chaotic elements added to the system were devised using Chua's circuit [2]; a simple nonlinear circuit that exhibits unstable highly oscillatory behavior. The chaos demonstrated by Chua's circuit is mainly due to the construction of a nonlinear resistor that follows three separate linear piecewise defined functions. This component was constructed out of two IC-Dual JFET input operational amplifiers (NTE858M), an op-amp ideal for chaotic and nonlinear dynamics due to its low input noise voltage, low harmonic distortion, and wide gain bandwidth. Following the construction of the physical model, the outputs of both the RS flip-flop and Chua's circuit were modeled in the form of three-dimensional continuous dynamical systems. The same form of analysis done on the theoretical model was then applied to the results from the experimental model, and compared. Although no practical application currently exists for this system, future research will be done to try to manipulate the output allowing for a potential form of encryption, using the chaotic RS flip-flop as an analog means to form a random number generator. This concept will be heavily based on both the interference of noise within the physical model as well as the error bounds of the components with respect to temperature and physical damage.

References

[1] D. Cafagna and G. Grassi, Chaos-based SR flip-flop via Chua's circuit, *Int. J. Bifurcation and Chaos* **16** (2006), 1521-1526.

[2] L. Chua, Chua's circuit: Ten years later, *IEICE Trans. Fundamentals* **E77-A** (1994), 1811-1821.

[3] A. Rahman and D. Blackmore, RS flip-flop circuits revisited, (in preparation).

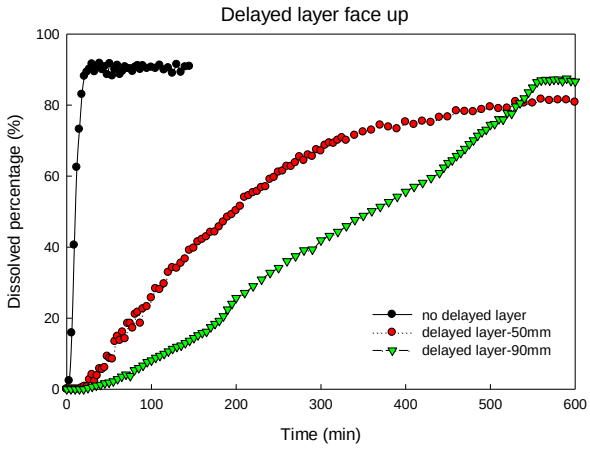
Controlled Drug Release from Multilayers Film for Fenofibrate Delivery

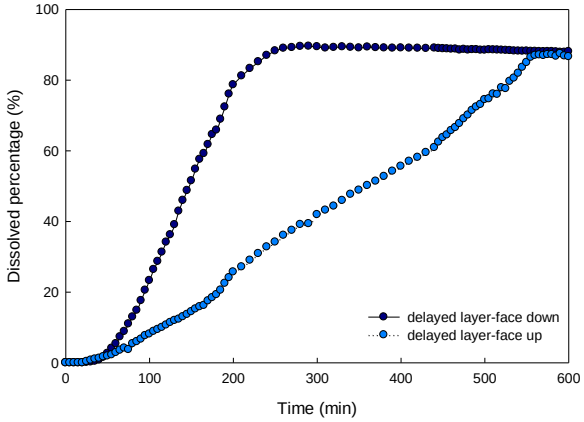
Afrida N. Kabir, Lu Zhang, Rajesh N. Dave

New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract

In this work, we provided a novel stripfilm format for the delayed release delivery of API. The delayed release system was accomplished through a multilayers film. The film has two protective layers over the drug, namely hydroxypropyl methylcellulose (HPMC-E15LV) plus additives and glycerin. According to the molecular weight factor, Guar Gum, Pectin, HPMC-E4M and Xanthan Gum were chosen to form the delayed layer with HPMC-E15LV. The middle layer with the drug was a mixture of HPMC-E15LV and glycerin. The lag time for the drug can be ranged from minutes to hours depending on the protective layer thickness and formulation. After the lag time, the drug starts to release from the middle layer. Therefore, the delayed release system can be used in target therapy. Fenofibrate is chosen as the sample BCS class II drug. In this summer project, we also studied effects of dissolution method on dissolution profiles. For comparison of dissolution test method, two USP IV dissolution tests were performed with delayed layer face up and face down in the dissolution cell. Texture analysis, Viscometer and USP IV were using to evaluate the multilayer film performance. The results show that thickness of delayed layer significantly affect lag time, and delayed layer face up also sustained the release time of stripfilm. The addition of additives helps to enhance the viscosity of polymer precursor and prolong the release time.





Understanding neuronal activity in the brains of weakly electric fish

Monica Khattak and Eric S. Fortune
Department of Biological Sciences
New Jersey Institute of Technology, Newark NJ 07102

Abstract: A fundamental goal of neuroscience is understanding how brains control the behavior of organisms. In vertebrate animals, neurons can have thousands of synapses, each communicating with the postsynaptic cell through the release of neurotransmitter molecules. The spatial arrangement of synapses on the postsynaptic neuron determines the relative strengths and internal temporal organization of information flow within neurons. This flow of information can be studied in the brains of model organisms, like the weakly electric fish *Apteronotus leptorhyncus.* These fish emit an electric field (electric organ discharge or EOD for short), which surrounds their body and is used in electrolocation and electrocommunication. The EOD is recognized by sensory receptors located along the fish's body, which then project to the electrosensory lateral line lobe (ELL) via sensory afferents. The midbrain region of this organism contains laminated structures, the optic tectum and torus semicircularis, which preserve a topographic relationship between the electrosensory and visual world. These midbrain structures communicate with the telencephalon, however the map organization preserved by the ELL and torus no longer exists in the telencephalon. Therefore the torus is a key neuronal area for studying how these fish sense their environment. Through a blind-patch technique we were able to record the neurophysiology of neurons responding to visual stimuli (tectal neurons) and neurons responding to directional object movement (neurons in the lower levels of the torus).

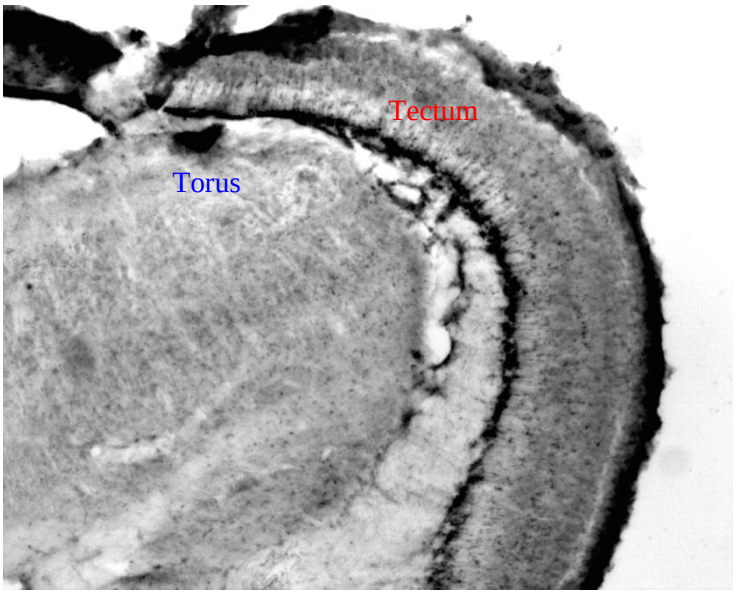


Figure 1 Sagittal section of a weakly electric fish brain, the torus and tectum are labeled.

Solving Bottlenecks in Educational Workflow Software

Angelica M. Llerena, Advisor: Dr. Michael Bieber

Department of Information Systems

New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract:

The Collaborative Learning Through Assessment (CLASS) actively engages and provides learning opportunities for students in all stages of the problem lifecycle: creating the problems according to the instructions, grading solutions from fellow students with written justifications, and optionally disputing grades, in which case students grade their own solutions. The CLASS process can be modeled as a large workflow system, which allocates and manages the series of tasks by all the students involved in each individual problem. This workflow system requires several vital algorithms that execute automatically to make it work effectively. Previously only some of these had been developed in the CLASS prototype in a very preliminary, inefficient manner, and others had not been developed yet. These bottlenecks severely limited CLASS efficiency and the ability to support many types of course activities. This project's outcome is the design and implementation of much needed workflow algorithms, which also contributes to educational workflow research. The objective of these algorithms is to make the workflow system function effectively and in an efficient manner.

A literature search and interviews with instructors that have used the system in previous semesters have been done. The allocation algorithm was redesigned to randomly allocate students to tasks for different problem lifecycle structures. A reallocation algorithm was designed to allocate students from a volunteer pool to tasks that are late. A grade consolidation algorithm was designed to collect all facets of a student's grade from different tasks and workflows for an assignment. The project's deliverables include interview summaries, test results, the algorithms themselves and programming code implementation (in PHP).

Studying Microtubule Dynamic Instability

Mohamed Miraoui, Omar Singer, Advisor: Dr. Camelia Prodan
Department of Physics
New Jersey Institute of Technology, Newark, NJ 07102 USA

The drug currently used in chemotherapy to treat cancer, Taxol, has been found to stabilize the microtubules of cancerous cells. Our research is concerned with studying the vibrational modes of microtubules along with other properties. The theory is that these properties will lead to a better understanding of how Taxol works. To better model this theory, we seeked to build a macroscopic structure, representing a microtubule on a larger scale. The structure consists of brass balls connected with springs and longitudinal rods. By vibrating the model at different frequencies and observing the structural movements, we are working to map out the phonon spectrum (a graphical representation of the vibrational modes). In addition to creating this model, we need to isolate a microtubule on a microscopic level by use of a microchannel (Figure 1). The reason being that if not isolated, microtubules tend to stick together in large clusters and data acquisition is increasingly difficult. Once isolated we will use what we understand from the macroscale model to help us study the vibrational modes of the actual microtubule. If the vibrational modes of microtubules were obtained and the theory proven, pharmaceutical companies would be able to personalize their drugs for cancerous cells, similar to how antibiotics are synthesized.

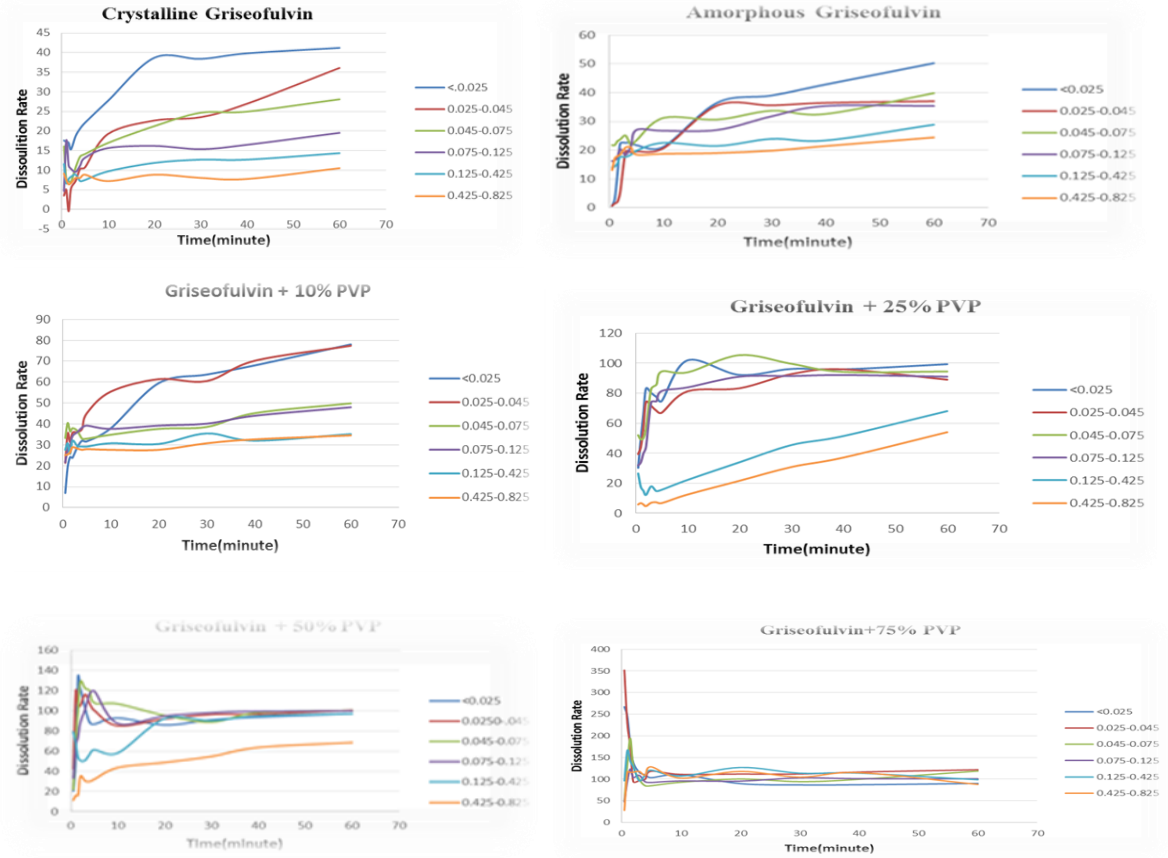
Figure 1- (left) A cross sectional view of the PDMS polymer (type of plastic) as it hardens on the mold. (middle) A cross sectional view of the completed channel. (right) A top view of what the completed microchannel would look like. The PDMS polymer cures with a thin channel running along it.

Impact of polymer loading and particle size of amorphous solid dispersions on the dissolution behavior of Griseofulvin

Mehnaz Moon, Advisor: Dr. Rajesh Dave, Mentor: Kai Zheng, PhD student

Abstract:

Amorphous solids (AS) and amorphous solid dispersions (ASD) of active pharmaceutical ingredients (APIs) offer a formulation route capable of improving the poor water solubility of many APIs. Amorphous APIs can be administrated, in combination with a small particle size, to result in rapid dissolution which may improve the bioavailability. The amount of polymer relative to the API in solid dispersions has a significant impact on the dissolution behavior and the dissolution appears to be controlled by the physicochemical properties of the polymer. The purpose of this current research is to determine the relationship between the dissolution rate of solid dispersions with respect to polymer loading and particle size. In this study, we find that smaller particle size and high polymer content of the ASD increase dissolution rate as expected. Interesting dissolution behavior consisting of a fast initial dissolution rate occurring in the first 5 min of dissolution followed by a secondary period of a slow dissolution rate was observed. Super saturation was observed with 50% PVP and 75% PVP. It was also observed that the dissolution rate changed rapidly with the increasing amount of polymer loading. In order to obtain fast dissolution of amorphous formulations while avoiding high polymer contents, fine particle sizes should be produced.

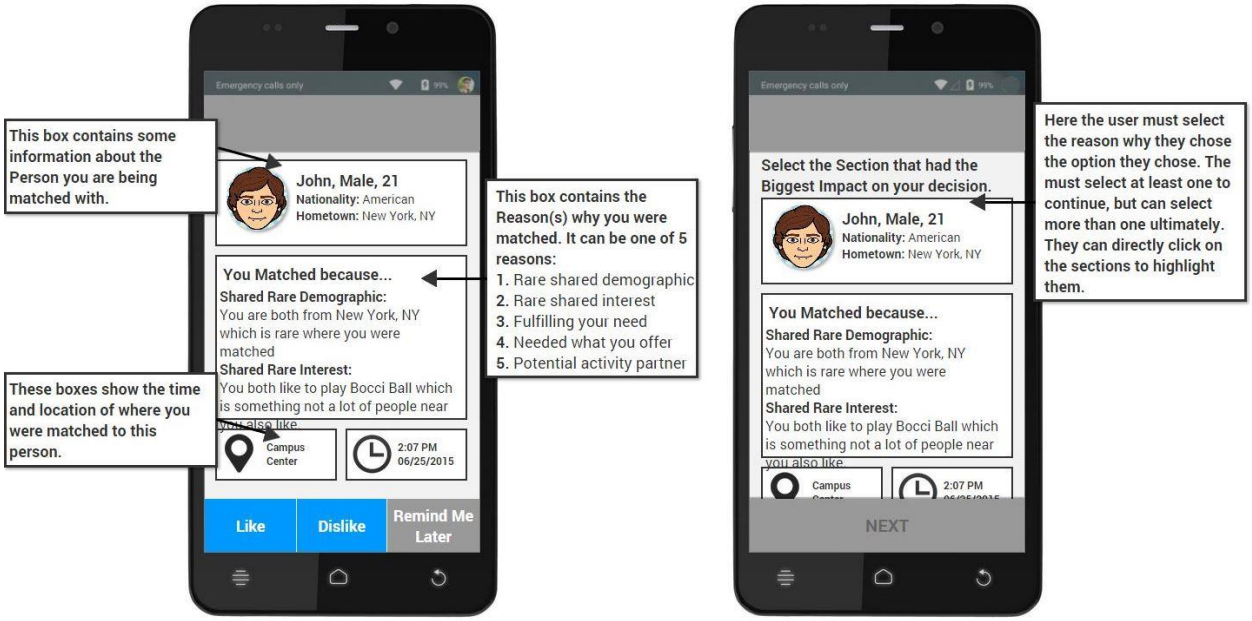


Informing Users about Opportunities for Valuable Social Encounters

Lukas Noll, Advisor: Dr. Q Jones, Mentors: Julia Mayer, PhD Candidate and Rich Schuler, PhD Candidate
Department of Information Systems
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: Everyday, we miss opportunities to meet new people that are in our vicinity. As useful and capable as our smartphones are today in connecting us to the world, they still rarely help us to connect to the people right next to us for valuable face-to-face interaction. Context-aware social matching offers many unique and interesting opportunities for advancing the way we think about human interactions and explore new ways to connect people. As part of this project I investigated how to display relevant information about matches to users so that they can assess if the relevance of their matches are good or not. I also worked on the development of an interface to collect feedback about what users specifically like or dislike about the matches presented to them over time. Over the summer, I used scenario based design to come up with ideas for how an application would be able to present matches to other people. These scenarios made it possible to hypothesize how potential users would react to a presented social match, and how different levels of unavailability affect that, whether it be a time or a mental constraint. Using an iterative design process in combination with scenarios made it possible to specify what type of actions people would want to take, and how that in turn impacts on our research software design. Below is a recent sample of our iterative scenario based design prototype.

Sample Prototype of A Match Screen based off of Scenario Based Design Research



3D Printed Microfluidic Device for Dynamic Investigation of the Blood Brain Barrier

Hathija Noor, Victoria Harbour, Monica Torralba, Faculty Advisor: Dr. Sagnik Basuray
Department of Chemical Engineering,
New Jersey Institute of Technology

The "Blood Brain Barrier" (BBB), surrounding the capillaries in the Central Nervous System, is a tissue composed of endothelial cells joined to each other by tight junctions. It serves to impede the passage of any impurities from the blood to the brain and is essential to brain homeostasis, disruption of which can result in a myriad of brain disorders like Alzheimer's, Multiple Sclerosis, and Parkinson's disease. Current in-vitro models of the BBB include a seeded Transwell ® Membrane under static conditions, where the apical and basal side fluids do not exhibit dynamic flow and apply shear stress on the membrane. Being a simplified model of the tissue, it does not adequately model the tissue as it is in-vivo, where there is dynamic flow of both basal (cerebrospinal fluid) and apical (blood) fluids. Consequently, we have designed a microfluidics device, the μTRANS chip, to model the BBB under dynamic conditions, allowing us to study not only the tissue structure of the BBB but also the cellular level dynamics of it under different environmental conditions. Our initial results, revolving around the construction of the device, its characterization, and the biochemical/mechanical modulations of the tissue will be presented. In terms of construction, the device was built using a seeded Transwell ® membrane (consisting of a layer of human brain endothelial cells on the apical side and a layer of astrocytes on the basal side) inserted between two glass slides. Each of the glass slides served as a distinct chamber, containing two 3D printed micro-channels, interconnected by smaller micro-channels. The smaller channels were designed to allow for fluid exchange between the larger micro-channels. Gold electrodes were also built into the device to analyze the permeability of the BBB using electrochemical impedance spectroscopy (EIS). The channels, glass substrate layers, and Transwell ® Membrane were all placed into a 3D printed vacuum chamber as the final step in construction, in order to maintain contact between the different layers of the device during experimental modulations. We believe that our ability to study the BBB in a dynamic environment allows us to not only accurately model the tissue under physiological conditions but to control its characteristics using biochemical and mechanical means.

Effects of Dry Coating with Nanoparticles on Drug Release Rate of Tablets Made with Ibuprofen

Sohui Park, Advisor: Dr. Rajesh N. Dave Mentor: Anna Owasit
Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark NJ 07102

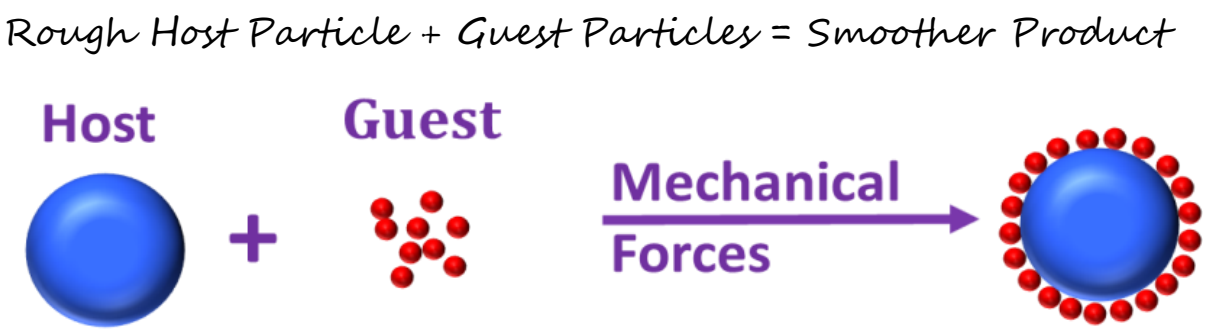
Abstract: Most drugs exist in the oral dosage forms of capsules, tablets, or liquids since taking drugs by mouth is the most convenient and the safest route for the drugs to be introduced into the body. In recent years, considerable attention has been focused on the development of new drug delivery systems, which are capable of improving or sustaining the rate of drug delivery. Controlling the drug delivery is crucial because drugs work the most effectively when they reach their target sites, which can be in the stomach, the lungs or other parts of the body. While some drugs must dissolve quickly because their target sites are close to the mouth, some need to dissolve slowly enough to reach their target sites. In the pharmaceutical industry, numerous drug molecules exhibit poor bioavailability originating from their low water-solubility and ensuing slow drug dissolution in the gastrointestinal fluids of the human body. One approach to alleviate this issue is to increase the specific surface area of the poorly-water soluble drugs via reduction of particle size. According to the Noyes–Whitney equation, an increase in the specific surface area results in a proportional increase in dissolution rate. However, as the particle size goes down, the milled particles tend to agglomerate, producing poor flowability and delayed dissolution rate. In this study, a simultaneous milling and coating method through a fluid energy mill (FEM) will be applied to improve the flowability as well as the drug dissolution rate. Ibuprofen is selected as the model drug while hydrophilic silica A200 is selected as the guest material. Different milled drugs will be produced by controlling the solid feeding rate and the grinding pressure. Overall, this study provides a surface modification of drug powder by dry coating and USP Dissolution Apparatus that produces an environment that closely resembles the gastrointestinal tract.

Investigating the influence of the dry coating process on pharmaceutical powder compatibility

Hardik V Patel, Liang Chen, and Rajesh Dave
Department of chemical, biological, and pharmaceutical engineering
New Jersey Institute of Technology, Newark NJ 07102

Abstract:

Dry coating is a new technology in which host particles are coated with a small amount of guest particles (Nano-size silica like Aerosil 200 and Aerosil R972P are used in this work). These guest particles are placed on the surface of the spherical host particles to improve flowability. It is important to know the characteristics of different excipients, which works as a drug delivery vehicle for the APIs (Active Pharmaceutical Ingredient). It has been demonstrated that the excipient Avicel, microcrystalline cellulose (with different particle sizes such as Avicel 101, 102, and 105) coated with either hydrophilic silica (A200) or hydrophobic silica (R972P) can significantly improve flowability. However, the dry coating process reduces the tensile strength of the excipient. It is also observed that the hydrophobic silica reduces tensile strength of the excipient much lower than what the hydrophilic silica is capable of. The results show that the smaller particle size of the excipient tents to have higher tensile strength because of the high molecular level interaction and the level of surface contact. Most of the APIs used in the industry have very low tensile strength. For that reason, it is crucial to keep the tensile strength of the overall drug high enough to produce good quality tablets. In this work, LabRAM is used to dry coat drug excipient with guest particles. FT4 is used to investigate the flowability of the host particles before and after the dry coating process. The tablets are produced using the Carver tablet press with a series of different compaction forces (0.5 metric tons, 1.0 metric tons, 1.5 metric tons, 2 metric tons). In the same manner, the compatibility is tested using the TA-XT2 texture analyzer.



Creating Unique Patient Images in Order to Improve Prescription Readability and to Reduce Medication Errors By Using Image Hashing Algorithms

Parth Patel, Advisor: Dr. James Geller, and Mentor: Matthew Polsky
Department of Computer Science
New Jersey Institute of Technology, Newark NJ 07102

Abstract: In the United States, patients of age 65 or older are prescribed on average 27.9 prescriptions per capita annually, the largest consumer demographic at this time. This also, in turn, makes them the largest population of casualties to Adverse Drug Events and related side effects. By associating a unique image identifier to each of the patients' medication labels, those who are visually impaired will have an easily recognizable identifier with which to associate their medication. This will decrease the chance of a medication error, bringing the number of Adverse Drug Events down significantly.

By utilizing resources such as "open license hashing algorithms", we were able to create a functioning prototype to achieve the proposed solution. The algorithm first encrypts the data provided (in our case this will be the patient's name, date of birth, drug name and dosage). This encrypted data will be passed to an image generator that creates a single, unique image which is pooled from many images in order to accurately represent the patient's prescription information.

After a few iterations of rigorous prototype testing, we can conclude that the design and software will be effective in aiding patients to reduce errors at home where the confusion is most prevalent. This functionality and ease of readability also benefits the pharmacy technicians who are still capable of making these errors before the patient receives the medication. This adds yet another preventative fail-safe.

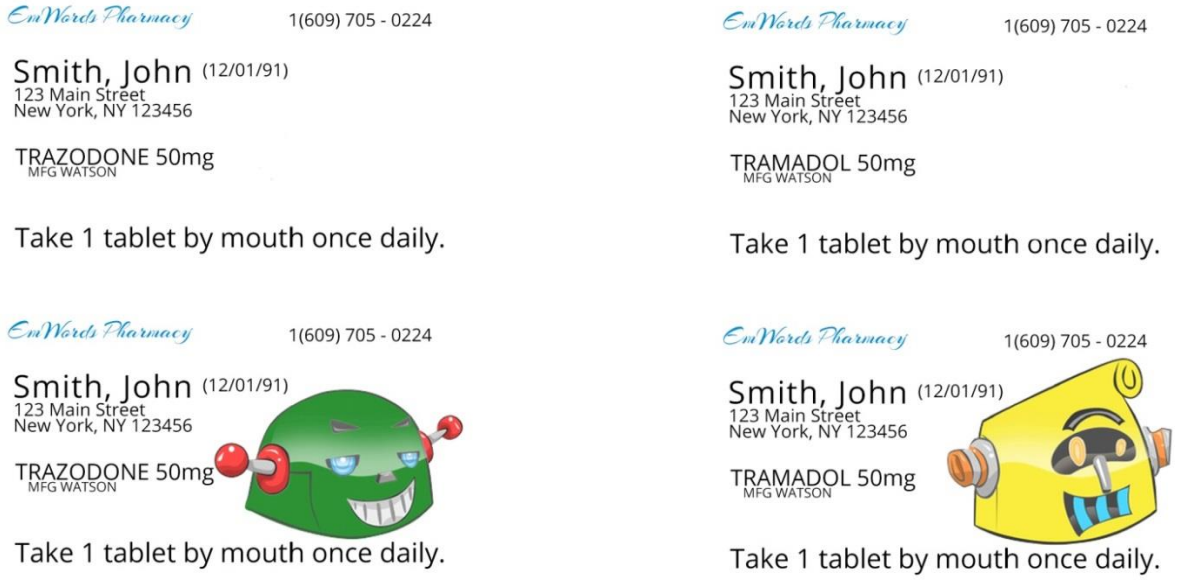


Figure 1: Pharmacy label without identifiers vs pharmacy label with identifiers.

Thermochemical Study of a Reaction Pathway in the Propenal (Acrolein) Oxidation Reaction: in Search of Chain Branching Reactions in Combustion Systems

Justin Pinca and Joseph W. Bozzelli
Department of Chemical, Biological, and Pharmaceutical Engineering and Department of Chemistry and Environmental Science, New Jersey Institute of Technology, Newark NJ 07102

Abstract: The goal of this project is to determine a reaction pathway of the combustion of propenal, commonly named acrolein. Propenal is usually created when burning petroleum fuels, plastics, fats, or cigarette smoke and are often found in combustion conditions [1]. The propenal structure consists of a vinyl group or olefin bonded to an aldehyde; recently Yommee et al [2] have shown the vinylic carbon site radicals and a vinyl aldehyde in cyclopentadienone lead to significant chain branching upon oxidation. Understanding the combustion of propenal and vinyl-aldehyde oxidations with branching paths should be beneficial for ignition in non-spark ignition engines, which are currently shown to have lower emissions. The pathway studied is of the formation and oxidation of a radical on the secondary carbon of propenal, CH_2=C•CHO, its reaction intermediates, transition states, and final products. Then geometries of each of the species were optimized through MOPAC. The B3LYP/6-31G(d,p) DFT method was then used to further optimize and determine accurate enthalpies for reactants, transition state structures and intermediates. Isodesmic work reactions were used to determine the Enthalpies of formation for all species in the reaction paths. Entropy and heat capacity, S^o (T) and C_P^o(T) (50 K ≤ T ≤ 5000 K) respectively, were determined using geometric parameters, internal rotor potentials, and frequencies from the B3LYP/6-31G(d,p) calculations. Bond dissociation energies and reaction path energies to important intermediates were determined. Transition state structures were estimated and further optimized and calculated using the DFT methods to determine transition state energy – reaction barriers.

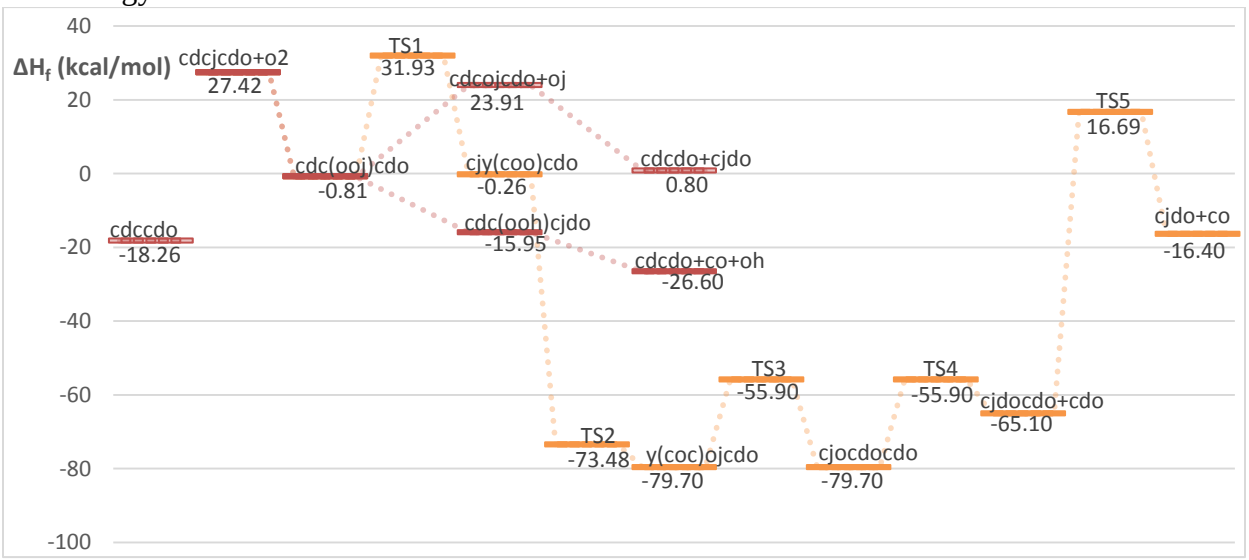


Fig. 1: Energy diagram of studied pathway of propenal, calculations continue to improve Enthalpies.

References
[1] Stevens, J.F.a b d , Maier, C.S.c. *Acrolein: Sources, metabolism, and biomolecular interactions relevant to human health and disease* (2008) Molecular Nutrition and Food Research, 52 (1), pp. 7-25.
[2] Suriyakit Yommee, PhD thesis NJIT 2015.

Interruption of Bioenergetics Communication in Neuroimmune Cells

Ashley Ramjattan, James Haorah

Department of Biomedical Engineering

New Jersey Institute of Technology, Newark NJ, 07102

Abstract:

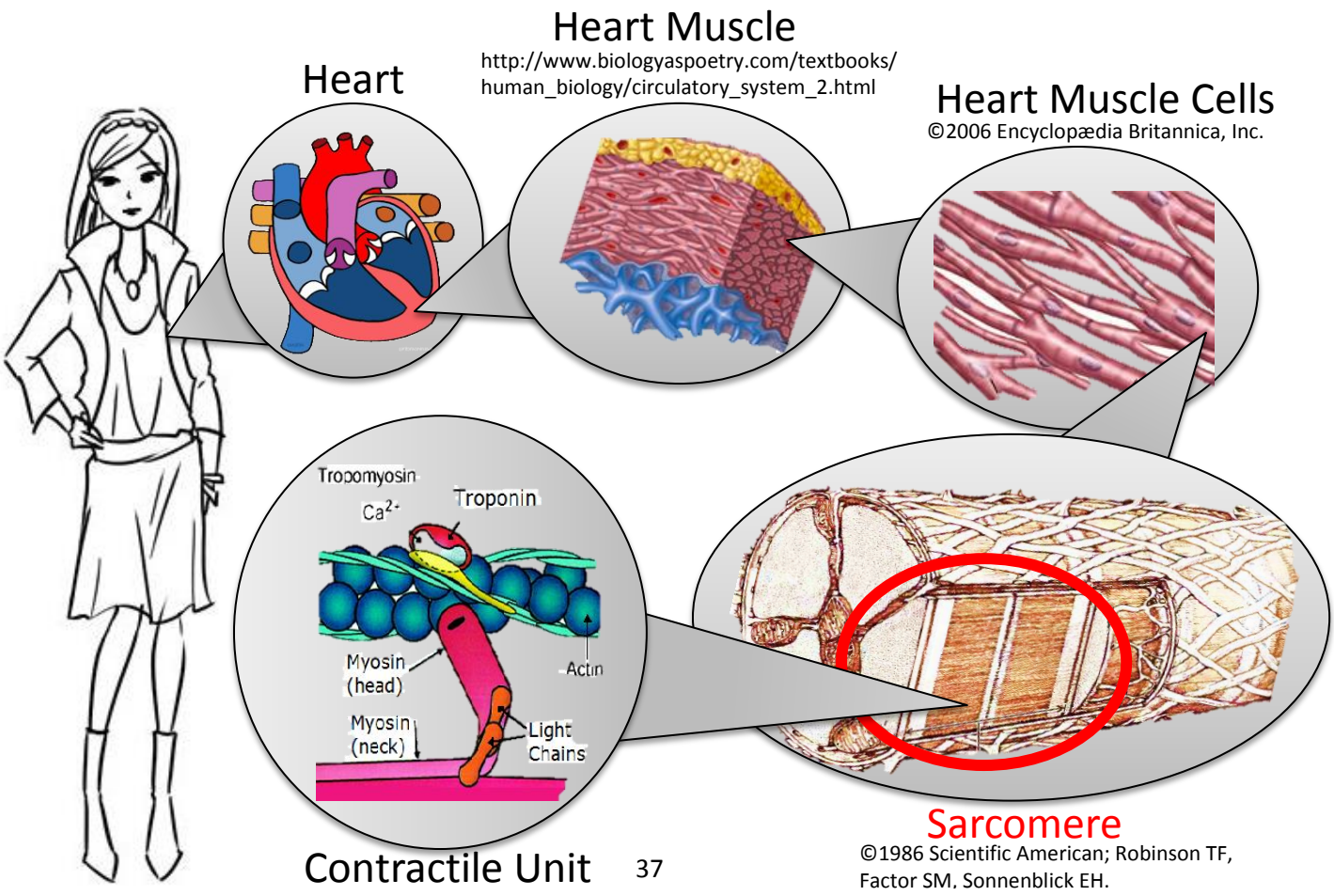
There is 20 million people who consume alcohol on a daily basis. There are epidemiological studies that show a correlation between chronic alcohol use and neurological diseases such as stroke and fetal alcohol syndrome. The two neurological diseases in chronic alcohol use is Wernicke-Korsakoff syndrome and Fetal Alcohol Syndrome which results in neuronal degeneration and neurocognitive defects. In chronic alcohol usage, the level of ATP decreases, which is recognized in neurological diseases. Alcohol abuse causes oxidative damage to mitochondria and cellular proteins. Alcohol inhibits glucose transport across the blood brain barrier, leading to BBB dysfunction and neurodegeneration. The blood brain barrier is the interface between the blood and the brain. The BBB consists of tight junction proteins that control ions and molecules that circulates into the brain from the blood. Tight junction proteins such as occludin, claudins and zonula occuludens (Z0-1-3) connect the brain endothelial cells to form a tight monolayer ensure permeability across the BBB. The mechanism of the dysfunction of BBB remains unknown. The aim of the project is to examine the mechanism that affect the glucose delivery at the endothelial-astrocytes end-feet during chronic alcohol exposure. Our studies show that alcohol induced oxidative injury of the BBB causes decrease in glucose transport into the brain, neurovascular inflammation, and neuronal degeneration.

We Don't Skip a Beat:

Creating a Compact Model to Predict How Changes in Sarcomere Length Affect Probability for Force Generation

Alison Schroeder, Advisor: Dr. William C. Hunter
Department of Biomedical Engineering, New Jersey Institute of Technology, Newark NJ 07102

The sarcomere is the fundamental building block of cardiac muscle and, therefore, a compact model of cardiac sarcomere dynamics is useful when developing integrated models of whole ventricular function. This is particularly useful in critical clinical situations when there are different regions of heart muscle that work at different sarcomere lengths and are activated at different times. Within a sarcomere there are an abundance of molecular contractile units each composed of six interacting proteins. Our model separates slower from faster chemical reactions occurring between these six proteins; the representation of faster processes can then be reduced to their equivalent equilibrium relationships. Important fast reactions act cooperatively, and this can be analyzed using statistical thermodynamics. To establish a rational set of parameters for the model, we compared the results of running our model to previously published data, and then we adjusted the parameters so that our output matched the data reasonably well. These comparisons were all done for a fixed sarcomere length (SL = 2μm). It is hypothesized that changes in SL would alter only one parameter in the model. The effect of altering SL in the model was compared to previously measured data on the force generation at different SLs.

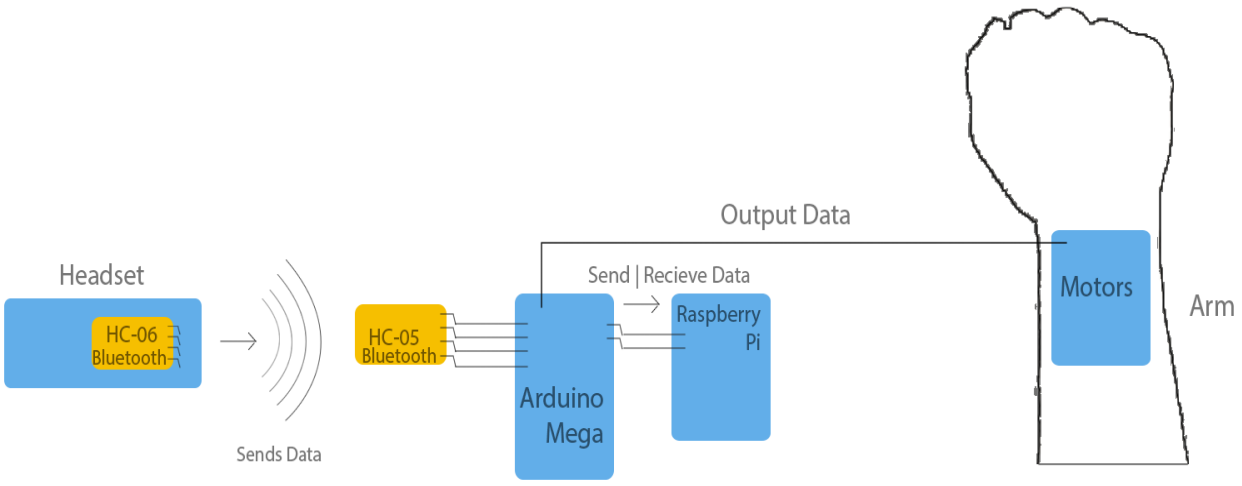


Economically Viable Electroencephalographic Robotic Arm

David Sheynkman and Francis Uzzolina Advisor: Dr. Richard Foulds
Department of Biomedical Engineering
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: Today's prosthetic arms are very limited in what they are able to do. Most prosthetics today are purely aesthetic and provide little to no functionality as compared to a real arm. There are still many basic tasks that people cannot perform with these prosthetic arms. Even in the world of research, most robotic prosthetics can only accomplish basic tasks, such as picking up a cup, and are intensely specialized to work for a specific person. On top of this, these prosthetics cost anywhere from $80,000 to millions of dollars. This project was designed to be a much cheaper prosthetic that would be able to provide more mobility than the research prosthetics of today. The main focus was to create a user controlled prosthetic arm that could not only pick up objects, but also interact with them. One example of such an interaction would be using a pen to write.

The user will be able to control the arm by using an electroencephalogram (EEG) headset. The headset will communicate with the arm using two Bluetooth chips, one connected to the headset and another to a microcontroller and micro-computer installation in the arm. The EEG uses electrodes to detect electrical activity in the human brain. The data from the headset creates a set of instructions to send to the motors in the arm via the microcontroller's analog outputs. This is done by translating the brain activity into motor control. The basic idea behind this system is the human ability to learn. The system uses the brain's feedback system to let the user learn at their own pace. The process is similar to how children learn to control their own bodies. The person sees a specific output in the arm, and that strengthens that neural connection. Over time, this connection grows stronger and stronger until it is like second nature. Not only will this give the person both very precise control over the arm, but will also allow anyone to use the arm. The size of the arm is similar to that of a human arm, but it is important to note that the structural design of the robot arm will be different.



The Impact of Multiple Sense Stimulus in Goal Oriented VR Simulations

Nathaniel Soto

Advisor: Augustus Wendell

Digital Design Department

Provost Summer Research Program

New Jersey Institute of Technology, Newark NJ 07102

Although Virtual Reality technology has existed for decades, it has garnered a significant amount of traction and attention in recent years. Ranging from the development of efficient and high quality head mounted displays, to large corporations investing in emerging VR technology, Virtual Reality is poised to become a significant market in the entertainment industry. However, the use for Virtual Reality wouldn't be exclusive to the entertainment industry. It has already being applied in the fields of psychology and medicine to treat PTSD and teach medical students through simulations. As such, the potential uses of Virtual Reality are broad and extensive, emphasizing the need for research and advancement within the field.

The technological advancements in the field of VR, have for the most part been focused on visual stimuli. For this research, I created a number of simulations which gaged the immersion of the player while also engaging auditory and interactive stimuli. These simulations explored how to achieve immersion by also engaging the player with objective based stimuli. These include immersing the player strategically, by providing multiple ways to complete an objective; and narratively, by giving the players a reason as to why they're completing a certain goal. I created three simulations with varying differences, all taking place within an airport. Within each simulation, the player begins at three different locations and has an objective to complete every time. Each simulation has modifications that affected their visual and auditory immersion. One version of the simulation has players start in a parking lot and are instructed to pick someone up at the baggage claim area. However, their visual fidelity downgraded, and they are left to rely exclusively on auditory stimulus and cues with no wayfinding. Another has them arriving at the airport and instructing them to take a taxi home. However, it is the inverse of the aforementioned simulation, and there is no audio presence within the simulation, and they must rely exclusively on wayfinding. The third simulation has the player go through the check in and security process, and the neither the audial or visual fidelity are compromised. Each simulation was run through in a controlled environment and the players provided significant data regarding their levels of immersion through a survey conducted after each simulation.

Improved Dissolution Performance of Drug Nanocomposites with Various Dispersants

Indiana Suriel (UG researcher), Meng Li (PhD mentor), Prof. Ecevit Bilgili (Adviser)
Department of Chemical, Biological and Pharmaceutical Engineering,
New Jersey Institute of Technology, Newark, NJ 07102

Abstract: Bioavailability of a poorly soluble drug can be improved by preparing a drug nanosuspension and subsequently drying it into nanocomposite microparticles. Unfortunately, drug nanoparticles aggregate during milling and drying, causing incomplete recovery and relatively slow dissolution. The aim of this study is to investigate the impact of various classes of dispersants on drug dissolution from drug nanocomposites, with the ultimate goal of enhancing the bioavailability of poorly water-soluble drugs via high drug nanoparticle loaded, surfactant-free nanocomposites. Precursor suspensions of itraconazole (ITZ, model drug) nanoparticles in the presence of various dispersants were prepared via wet stirred media milling and spray dried to form the nanocomposites. Hydroxypropyl cellulose (HPC, polymer) alone and with sodium dodecyl sulfate (SDS, surfactant) was used as base-line stabilizers/dispersants during milling. Three swellable crosslinked polymers known as superdisintegrants, croscarmellose sodium (CCS), sodium starch glycolate (SSG), and crospovidone (CP) as well as two conventional soluble matrix formers, sucrose and mannitol, were used in addition to HPC. Laser diffraction, scanning electron microscopy, powder X-ray diffraction, UV spectroscopy, and dissolution tests were used for the characterization. The results indicate that the enhanced wettability imparted by SDS was critical to the full recovery of drug nanoparticles and their dissolution, whereas HPC had relatively small positive effect (Fig. 1). Use of co-milled superdisintegrants led to drastic enhancement of the drug dissolution with SSG performing close to SDS, thus demonstrating the feasibility of spray drying to prepare high drug-loaded, surfactant-free nanocomposites (Fig.1). The positive impact of the superdisintegrants positively correlated with their swelling capacity (SSG > CCS >CP), signifying a swelling-induced erosion/disintegration mechanism for fast drug release from the nanocomposite particles.

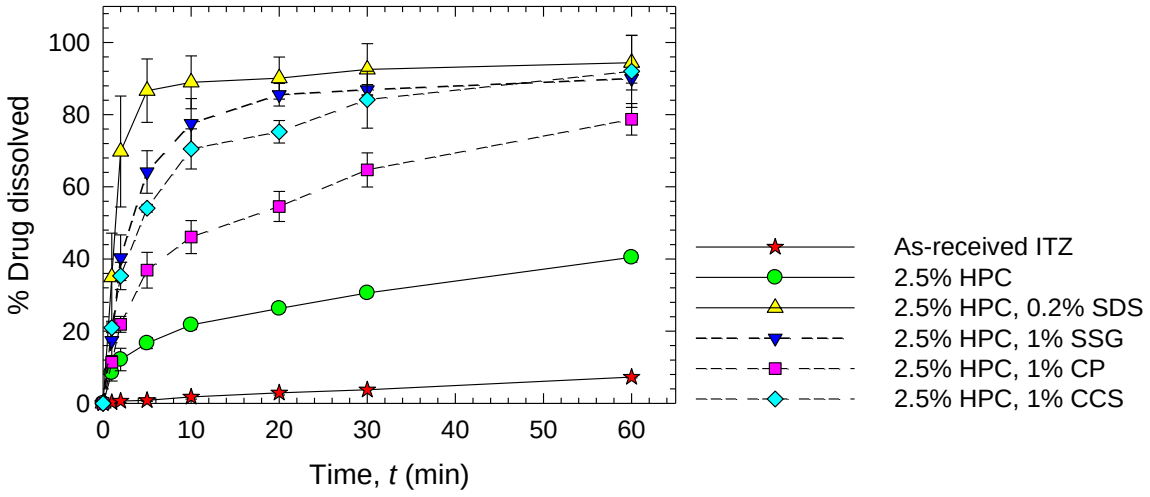


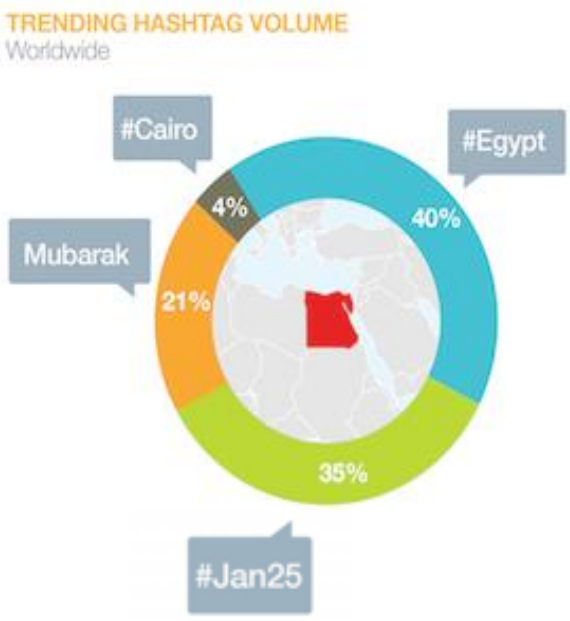
Fig. 1 Time-wise evolution of ITZ release from as-received drug powder and spray-dried nanocomposites with various formulations (USP II dissolution apparatus, aqueous SDS buffer, 37 ^{o}C).

Understanding Differences in Reporting on Major World Events; A Comparison between *The Washington Post* and *Twitter*

Michael Tadros,
Advisor and Mentor: Dr. Theresa A. Hunt
Department of Humanities
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: The goal of this project is to explore any differences between the articles of an established News Media outlet (*The Washington Post*) with posts on a Social Media outlet (*Twitter*) during a Major World Event (The Egyptian Revolution of 2011).

I followed some methods of a qualitative study done by A. J. Morales in 2014 to come up with my hypothesis that the information communicated through Twitter on a specific date by locals that were present during The Egyptian Revolution of 2011, would be different than the information that The Washington Post reported on the same day. The day of the revolution that I choose to study, January 28, 2011, was the first interaction between the corrupt government and the people. This day, dubbed "Day of Anger", was the turning point of the revolution as proven by Yasmine El Rashidi's book The Battle for Egypt in 2011. By creating a literature review of the eight Washington Post articles and performing a content analysis to the Twitter posts on January 28th 2011, I can notice some differences in the way reporting is done. This is where I can answer my research question and see if the information presented by the corporate American News Paper, does differ with the locals' social media posts. Further studies can examine more differences in the way reporting is done on social media compared to established news outlets.



Understanding the Roles of Various Dispersants on the Physical Stability of Drug Nanosuspensions

Jay Vekaria (UG researcher), Meng Li (PhD mentor), Prof. Ecevit Bilgili (Adviser)
Department of Chemical, Biological and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark, NJ 07102

Abstract: Particles of poorly water-soluble drugs are milled into nanoparticles to enhance their bioavailability. Unfortunately, their suspensions tend to form aggregates and exhibit physical instability, which can be mitigated via stabilizers such as polymers and/or surfactants. Considering that the drug suspensions are typically dried and incorporated into pharmaceutical solid dosage forms, severe aggregation of drug nanoparticles can lead to poor dissolution and bioavailability; hence, must be mitigated. The aim of this work is to prepare stable nanosuspensions of a poorly water-soluble drug, itraconazole (ITZ), and to explore the impact of various dispersants on the physical stability. Besides the common stabilizers such as hydroxy-propylcellulose (HPC, a non-ionic cellulosic polymer) and sodium dodecyl sulfate (SDS, an anionic surfactant), three superdisintegrants, i.e., sodium starch glycolate (SSG), croscarmellose sodium (CCS), and crospovidone (CP) were used in the suspensions. We co-milled each superdisintegrant and ITZ in the presence of dissolved HPC in a wet stirred media mill. To compare with co-milled suspension, ITZ was milled for 65 min in the presence of HPC and/or SDS without the superdisintegrants. Laser diffraction, scanning electron microscopy, and viscometry were used to characterize the milled suspensions. Table 1 shows that as superdisintegrants were shortly co-milled (15 min) as compared with ITZ (65 min), the presence of unbroken swollen particles led to relatively high median size d_{50} and/or 90% passing size d_{90}. Hence, to mask the impact of swollen particles in the analysis of ITZ particles, area-based size distributions were generated, and they showed the presence of ITZ particles smaller than 500 nm in all suspensions. Smallest particles were obtained upon use of HPC–SDS, whereas HPC alone and along with 15 min co-milled superdisintegrants could not eliminate, but reduced aggregation. The superdintegrants did not affect ITZ particle sizes drastically. The nanosuspensions can be used as precursor materials in the formation of solid drug nanocomposites via drying, which can enhance drug dissolution owing to presence of nanoparticles and reduced extent of aggregation.

Table 1 Statistics of the particle size distributions of the 65 min milled suspensions

Run No	Formulation[a] (% w/w)	Volume-based particle size statistics (μm)		Area-based particle size statistics (μm)	
		d_{50}, SD	d_{90}, SD	d_{50}, SD	d_{90}, SD
1	ITZ, 2.5 HPC	0.290, 0.003	1.543, 0.003	0.232, 0.003	0.420, 0.008
2	ITZ, 2.5 HPC, 0.2 SDS	0.168, 0.001	0.242, 0.000	0.154, 0.001	0.226, 0.000
3	ITZ, 2.5 HPC, 1 SSG[b]	0.342, 0.004	28.26, 0.361	0.242,0.002	0.418, 0.003
4	ITZ, 2.5 HPC, 1 CP[b]	8.840, 0.088	44.61, 1.917	0.183, 0.052	0.470, 0.015
5	ITZ, 2.5 HPC, 1 CCS[b]	0.477, 0.042	44.38, 4.651	0.221, 0.001	0.413, 0.002

[a]As-received ITZ particle size statistics: d_{50} = 14.5 μm, d_{90} = 42.6 μm (volume-based) and d_{50} = 6.60 μm, d_{90} = 20.6 μm (area-based).
[b]SSG, CP, and CCS were added during the last 15 min of ITZ milling and co-milled with ITZ

Ronald E. McNair Postbaccalaureate Achievement Program

Modifying the Simple Method to Test the Fines of Soil

Ariel Aranda, Dr. Mohamed Mahgoub
Department of Engineering Technology
New Jersey Institute of Technology, Newark, NJ 07012

Abstract: In 2009, a study was conducted to develop a simpler method to test the fines content of the soil. The mold test serves as a secondary testing procedure and revealed that it can be used to confirm the first values acquired from the ASTM D-1140 test. However, the new testing method is not recommended to replace standard testing methods. Application of the mold test shows an improvement in soil testing that can eliminate a percentage of error that is usually caused by sole visualization of the soil in order to determine its fines. Unfortunately, the apparatus used during the mold test presented complications that affected the results acquired from the test. During this experiment, modifications have been implemented to both the upper and lower portions of the apparatus. Certain complications experienced while conducting the experiment involved the apparatus being pressurized, thus making it difficult to remove the upper component. Also, large particles of the samples tested became stuck on the No.200 sieve. A handle was installed to apply a torque on the upper portion of the apparatus for rapid removal of the cup. In addition, the bottom of the apparatus was enhanced by incorporating two different sieve sizes, while retaining the original No.200 sieve size and a strainer was implemented to prevent the sieve from sagging. The purpose of this experiment was to modify the apparatus used during the mold test with the goal of reducing the number of steps already established for a desired test time of fifteen minutes or less and acquire a percentage error of 5 percent or less when compared to the ASTM D-1140 results. Implementing the apparatus within the pre-construction process assists in accelerating construction projects of various infrastructures as well as reducing the cost of transporting and conducting experiments on soil samples. Future research will be conducted on continuing to improve the apparatus with the purpose of reducing the amount of materials required to conduct the test.

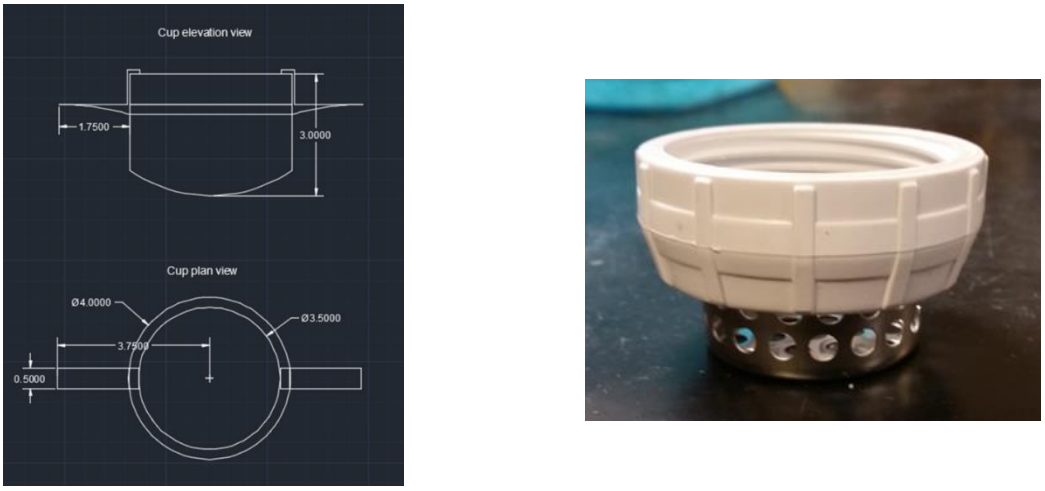


Figure: Modifications for upper portion of apparatus (left picture) and lower portion of apparatus (right picture)

Rapid Technology to Rehabilitate and Extend the Service Life of Hudson River Tunnel without Closing for Extended Durations

Walter Cevallos, Advisor: Dr. Jay Meegoda

Department of Civil and Environmental Engineering

New Jersey Institute of Technology, Newark NJ 07102

Abstract: The Hudson River tunnel was significantly damaged by the storm surge created by super storm Sandy and subsequent seawater intrusion. Salts have infiltrated the bench walls, track structure, and portions of the concrete linings and continue to have detrimental effects. Chloride attack is compromising and will continue to compromise the integrity and strength of the concrete shell of the tunnel. Based on the damage assessments, the tunnel is to be shut down for at least one year for complete rehabilitation. However, this tunnel is one of the only two tunnels crossing the Hudson River. Closing of this tunnel for one year would create significant disruptions to NJ including collapse of real estate market. Hence it is imperative to find and implement technologies that can be used to repair the tunnel during non-commuter hours to avoid such disruptions to the region. This research explores the technologies that could be adopted to repair the Hudson River tunnel during non-commuter hours such that one year of tunnel closing for repair can be avoided. The research involves investigation of rapid methods to assess the condition of the concrete shell and then to explore rapid construction methods for rehabilitation. Further this research also explores and proposes advanced materials for construction of new tunnels so that they are durable or inert to salt intrusion from hurricane Sandy type events.

Analyzing Dynamic Instability of Paclitaxel Stabilized Microtubules

Deliris Diaz, Advisor: Dr. Camelia Prodan
Department of Physics
New Jersey Institute of Technology, Newark NJ 07102

Abstract: Currently, chemotherapy has been proven to be one of the only methods of treating cancer. Although it has a low success rate, it has proven results in eliminating cancer cells. However, overtime, chemotherapy renders to be ineffective due to the increased side effects in addition to the cells becoming accustomed to the radiation of the cancer drugs which ultimately leads to the return of cancer cells. Chemotherapy aims to target a specific aspect of the cytoskeleton called microtubules. Microtubules are long protofilaments containing two proteins, alpha and beta tubulin, that can grow up to 100 μm in length and exist in all the cells that are the body. Chemotherapy targets microtubules for its ability to stop the reproduction of cells however is unable currently to specifically target cancer cells. This is due to the lack of research done in understanding how chemotherapy, in a molecular level, interacts with microtubules.

Microtubules are known for having a unique characteristic which makes cancer research a challenging task. In their growth process, or commonly referred as polymerization, given their energy source of Guanosine Triphosphate (GTP) that binds to the α and β tubulin, microtubules undergo dynamic instability in which the microtubule falls apart and grows back to its original length. The primary goal of this research project is to study the dynamic instability of paclitaxel stabilized Microtubules with the measure of time in seconds versus the length of the microtubule motion. Following the standard protocol to grow the dynamic instability microtubules, this research aims to lead to a better alternative for cancer research through analyzing the interaction of microtubules and paclitaxel.

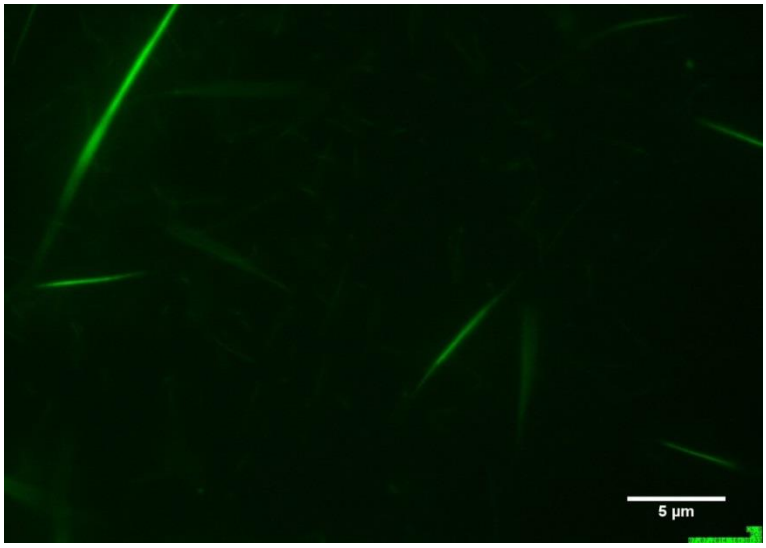


Figure 1: Microscope Image of a green HiLyte fluorescence 100x diluted (99 μl of PEM Taxol and 1μL of 5mg/ml incubated Microtubules) 2 μL sample.

A PORTAL TO ARCHIVE AND DISPLAY MECHANISM ANIMATIONS

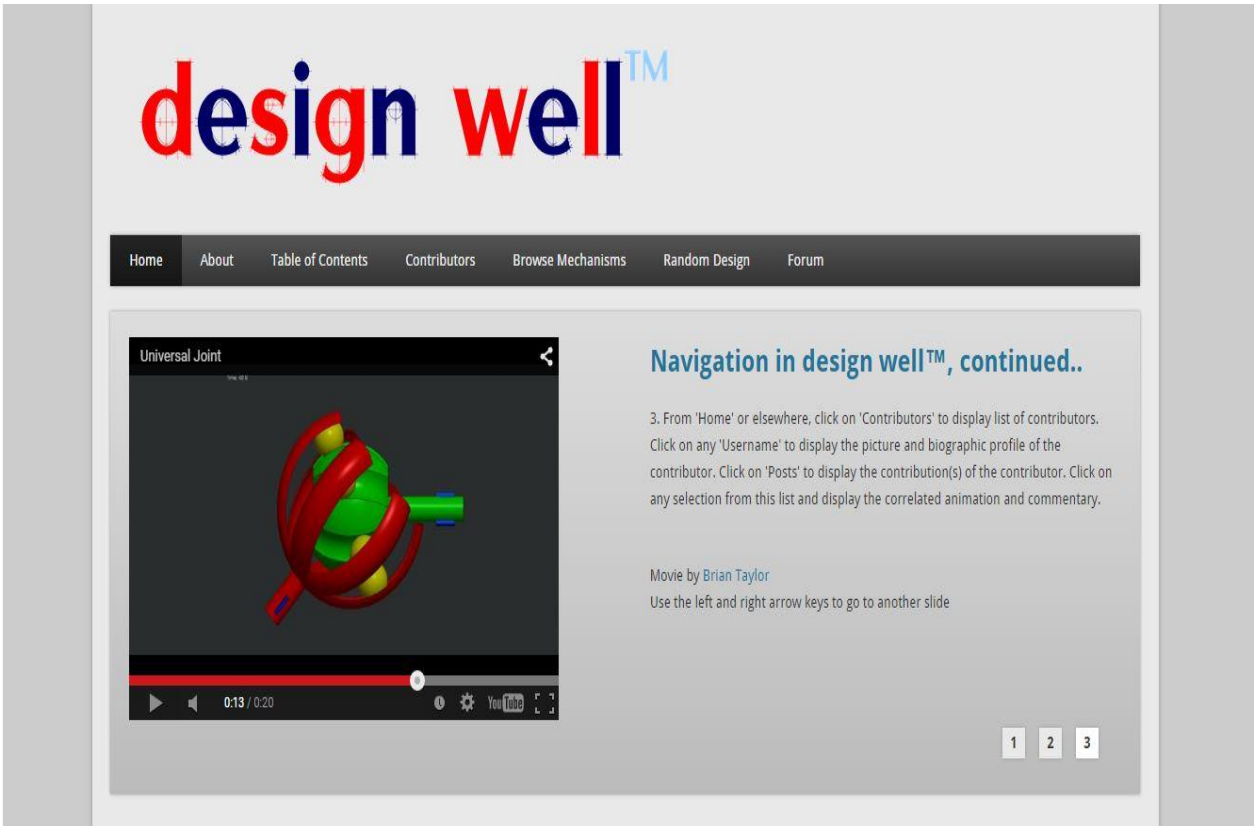
www.designwell.me

Miguel Garcia, Advisor: Professor B. S. Mani

Department of Mechanical and Industrial Engineering

New Jersey Institute of technology, Newark, NJ 070103

A group of ME students built a portal to archive and display numerous mechanism animations using a searchable database in July 2012. This portal eventually became desigenwell.me. It was designed to archive numerous mechanism animations. The animations demonstrate the intended motions of the mechanisms. A brief biographical sketch and photograph of the mechanism developer of the various mechanisms are also included. The mechanisms are modeled using a 3D solid modeling software, Creo Parametric 2.0. The searchable database was built using Drupal. The mechanism animations are classified and archived under the name of the inventor, an NJIT student. The ideas presented in the portal will serve as a resource for product designers and idea-seeking entrepreneurs. The Portal will serve as a source of knowledge and inspiration to the interested high school students and motivate them in the area of Mechanical Engineering. The NJIT student developer will thus be able to present their work and publish them to a word wide audience.



Advantages of a Scaffold Using Zein and K-Carrageenan for Application in Tooth Regeneration

Pamela Grace Herrera Yapu, Advisor: George Collins, and Advisor: Bruno Mantilla

Department of Biomedical Engineering

New Jersey Institute of Technology, Newark NJ 07102

Abstract: A prevailing problem for many adults is the loss of permanent teeth due to diseases such as periodontitis and cavities, if left untreated. According to the American Academy of Implant Dentistry (AAID), more than 30 million Americans are missing teeth. While there is an increase in the number of new techniques for zirconium-ceramic and mini dental implants, these methods cannot truly replace the original tooth. When the tooth is extracted the alveolar bone gets reabsorbed, which causes the jaw to lose height. Bone is a specialized connective tissue characterized by a mineralized extracellular matrix (ECM) that provides support and structure for the cells. This matrix consists mainly of collagen and hydroxyapatite crystals, which glycosaminoglycans (GAGs), provide the subtract for the attachment of the bone cell. The mineral part of bone, which is made of hydroxyapatite and calcium carbonate, is responsible for giving bones their strength and rigidity.

In order to mimic the bone I will attempt to fabricate a scaffold with the features of the bone. Scaffolds can provide support, structure and flexibility similarly as the ECM would under normal conditions. Zein and k-carrageenan are particularly suitable as scaffold materials along with hydroxyapatite due to their similarities to the ECM. Zein is a biodegradable protein that is highly soluble in water and ethanol, as well as microbial resistant. Hydroxyapatite, which gives bone its rigidity, has been successfully tested for electrospinning. On the other hand, k-carrageenan is a linear sulfated polysaccharide that resembles GAGs in their un-branched polysaccharide chemical structure and sulfate groups. Furthermore, κ-carrageenan has chemical resemblance to the chondroitin/dermatan sulfates responsible for structural integrity, as well as gel-forming properties. Scaffolds using these materials can be produced through electrospinning.

In this study I will attempt to fabricate scaffolds made with hydroxyapatite, Zein and k-carrageenan as the structural materials for applications geared toward tooth regeneration. Mainly, we aim to stop the reabsorption of the alveolar bone by creating a scaffold that mimics the ECM structure. We will replicate established processes for the electrospinning of hydroxyapatite, Zein, and k-carrageenan, while also concentrating on the three most important requirements of a good scaffold: support, structure and flexibility. Pending the results of this study, future research can expand on the regenerative property of the bone towards the entire tooth. Moving forward this research will help solidify the necessary understanding for the use of these materials in dental growth tissue and tooth regeneration.

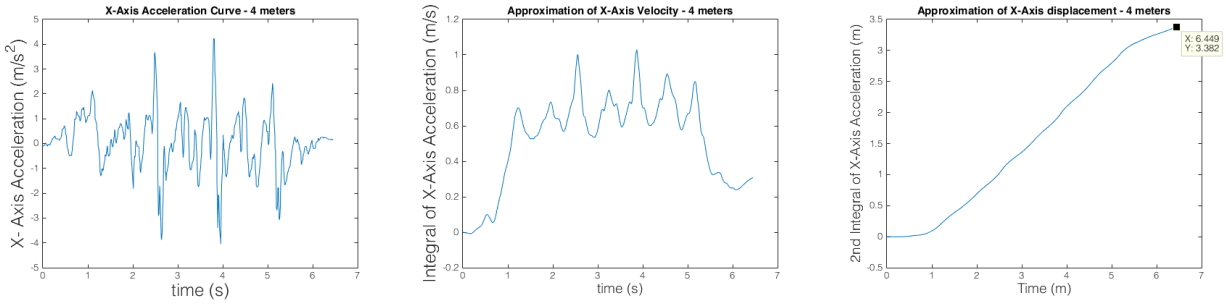
Accurate Measurement of Walking Speed of Patients Suffering from Parkinson's Disease

Matthew Lopez, Dr. Roberto Rojas-Cessa
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark NJ 07102

Abstract: The overall goal of this project is the design of a device which would be capable of measuring the walking speed of people suffering from Parkinson's disease (PD). This device would enable neurologists to collect data from patients' home instead of a clinical setting.

The final design of this device will use inertia sensors (tri-axis accelerometer and possibly gyroscope) to track the movement of patients. The use of accelerometers to track walking speed has been studied extensively, often by tracking step frequency and length using a sensor attached to the lower leg. This method of tracking poses a number of issues for our uses: PD patients display shaking of limbs which would require extensive filtering of acceleration data, the lower leg changes angle during a step, and the device must be securely affixed to the leg which could cause issues with comfort for the wearer. Alternate locations for the device were also proposed: directly on the foot and on the hip. Data collection from the hip seems to afford some benefits: the hip is close to the wearer's center of mass (COM) allowing for more direct tracking of the body's acceleration, the hip would not be subject to tremors to the extent that a patient's legs would, and lastly attaching the device to the hip would allow for the device to be secure while still being comfortable for the patient to wear. To test the validity of this sensor placement, the sensor was attached to the right hip and the test subject walked along a straight path. Three distances were used: 4 meters, 8 meters, and 12 meters. Initial collection of data was done using an Android smart phone (LG G2) which uses an LSM330 inertia sensor. Data was collected at 120Hz. For initial analysis only the x-axis (forward and backwards movement) acceleration was studied. The data points were then fitted to a curve. The curve was defined as a piecewise linear function. The curve was then integrated from time defining the start of the walk to the end of the walk providing an approximation of the subject's forward velocity. Integrating the subject's velocity provided an approximation of the subject's displacement, or distance walked. Although this methodology loses accuracy over longer distances, the low mobility of the patients may allow for the hip to be a viable location of the device.

Distance Walked	Distance Measured	Percentage Error
4 meters	3.382 meters	+15.45%
8 meters	9.104 meters	-13.8%
2 meters	8.114 meters	+32.38%



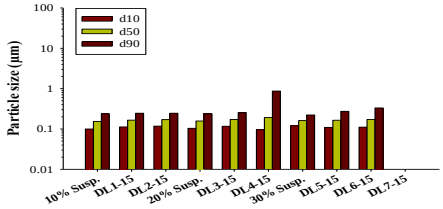
From Left to Right: Acceleration, Velocity, and Displacement

Stability of Drug Loaded Polymer Strip Films

Jacqueline Moreno, Advisors: Ecevit Bilgili and Rajesh N. Dave, Mentor: Scott Krull

Department of Chemical, Biological, and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark NJ 07102

Abstract: Strip films are a growing drug delivery method for poorly water-soluble drugs due to their larger surface area, allowing for rapid re-dispersion, recovery of particles, and enhancement of drug dissolution. The project focuses on the capability of strip films maintaining nanoparticles stable after being isolated for six months in a 40°C and 75% relative humidity chamber. The poorly water-soluble drug being considered in this study is griseofulvin (GF); an antifungal drug used to treat skin and nail infections. Glycerin and hydroxypropyl methyl cellulose (HPMC), a non-ionic polymer with different molecular weights (E15 and E4M), were used to make the polymer solution that would help stabilize the nanoparticles to minimize particle aggregation**.** The drug loading in the films were adjusted by varying drug loading in nanosuspension and polymer-to-nanosuspension mixing ratio. After six months of storage, drug dissolution rates and particle redispersion were determined using USP IV apparatus and a laser diffraction particle size analyzer respectively. It was observed that after six months of storage GF nanoparticles were successfully recovered from the E15 and E4M films after redispersion in water. The redispersion results for the fresh E15 films and six months' storage are shown in Figure 1. The dissolution results showed that the E15 and E4M films took about the same time to dissolve as they did when they were freshly made. However, there was inconsistency of 100% release in the 6 months dissolution profiles for both films that were likely result of assay issue. The dissolution graph for the E15 films are displayed in Figure 3. These results show that the films were able to keep the nanoparticles stable after being stored for a long period of time.



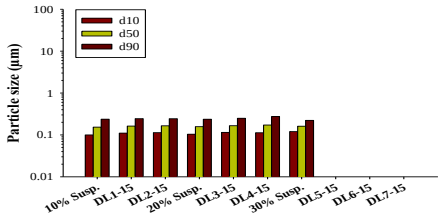


Figure 1: Paritcle sizes of fresh E15 films **Figure 2:** Partcle sizes of 6 month E15 films

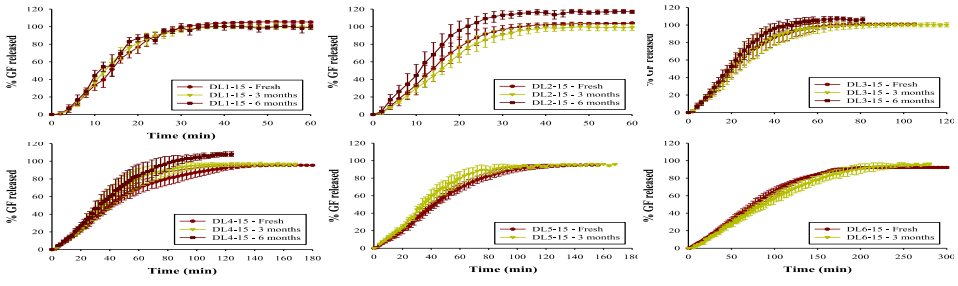


Figure 3: Dissolution rates of fresh, 3 months, and 6 months films

Compact Food Composter Utilizing Anaerobic and Aerobic Digestion

Carlos Morillo, Advisor: Dr. Jay Meegoda
Department of Civil and Environmental Engineering
New Jersey Institute of Technology, Newark NJ 07102

Abstract: Food wastes encompass a large portion of landfills and take several months to decompose. By reducing the amount of food traffic being sent to landfills, the size of landfills can decrease, as can the production of greenhouse gases. We are proposing an innovative food composter, which consists of an anaerobic digester to recover the energy content of the food waste and an aerobic composter to recover the nutritional content. In doing so, the methane released by organic substances will be diverted from landfills, while vitalizing potentially poor soils.

This study focuses on the chemical degradation of food waste via a combined anaerobic and aerobic pathway. Our ultimate objective would be to incorporate this design into a 6' x 6' x 4' device for use within restaurants. Restaurants equipped with the device will be able to divert their kitchen wastes from landfills. To accomplish this task, the time of decomposition should be as short as 20-30 days. To decrease the time needed for food to decompose in an anaerobic digester, we will test several types of decomposing methods. One proposed method includes the Bokashi method, a low-maintenance composting process. The Bokashi method anaerobically ferments organic food waste. Furthermore, the Bokashi method allows food waste to be quickly and consistently fermented and become recyclable. Once the food waste is fermented, it can be added to the aerobic digester, where it will be rapidly converted into compost. To test the rate of anaerobic degradation, we will develop a special bio-digester. The amount of degradation will be monitored by the generation of methane and acid generation. As we proceed with our experiment, we will attempt to expedite the rate of decomposition by modifying parameters, such as the pH and temperature.

An Automated Microfluidic Device for Single Cell Analysis Manufactured Using Affordable DIY UV Lithography

Olivia K. Saez, Advisor: Prof. R. Voronov
Department of Chemical, Biological, and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: Often called "Lab-on-a-chip," microfluidic devices have significantly increased due to their miniature size and ability to facilitate cell analyses. Due to the growing research in medicine and other emerging research areas, the demand for these devices has equally risen. By optimizing the use of microfluidics, we can explore the behavior of stem cells (hMSCs). We will develop a fully automated hMSC culture in a (polydimethylsiloxane) PDMS microfluidic device, allowing cell differentiation to occur for examination. Unlike regular microfluidics, a fully automated cell culture device allows unattended processing, which can be imaged by a time-lapse camera. The devices are fabricated by a two-part system: UV light source and photomask. A custom-built UV lithography light source (parts < $1500) was reproduced. The UV light source offers a low-cost alternative to making microfluidic devices, compared to a mask aligner costing $65,000. The UV light source utilizes nine high-powered 365 nm peak light-emitting diodes (LEDs), spread evenly in a 3 x 3 array, which allows collimation of the light source and results in uniform-sized microchannels. The photolithography light source projects an image from the photomask onto a wafer to create the microchannels by filtering out the negatives and producing a positive photoresist. AutoCAD is used to design the microfluidics image placed on the photomask. After fabrication, microfluidics have applications that can be utilized to further understand cell behavior for in vitro analysis.

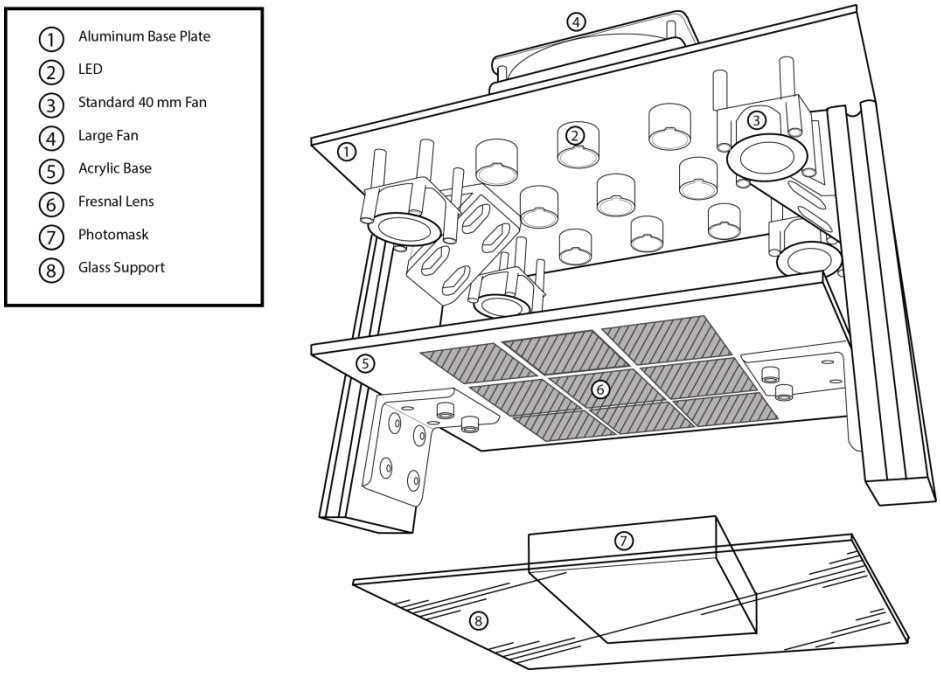


Figure 1: UV Light Source Setup with Photomask Holder

Scheduling Electric Vehicles (EVs) at Charging Stations

Shahan Uzzaman, Advisor: Dr. Edwin Hou
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, New Jersey 07102

Abstract: Due to their limited ranges, electric vehicles (EVs) need to be periodically charged during their long-distance travels on a highway. Compared to the fossil-fuel powered vehicles, the charging of a single EV takes much more time (up to 30mins versus 2mins). As the number of EVs increases, charging stations and service infrastructure need to be put in place. The waiting time for EVs to get charged at service stations could be a significant problem unless an appropriate scheduling coordination is in place so that individual EVs make correct decisions about their choice of charging locations. This research will mainly focus on developing algorithm for scheduling EVs. We will first develop mathematical models and then scheduling algorithm to optimize the operation of the charging network. Analytical designs and performance improvement will be simulated using MATLAB.

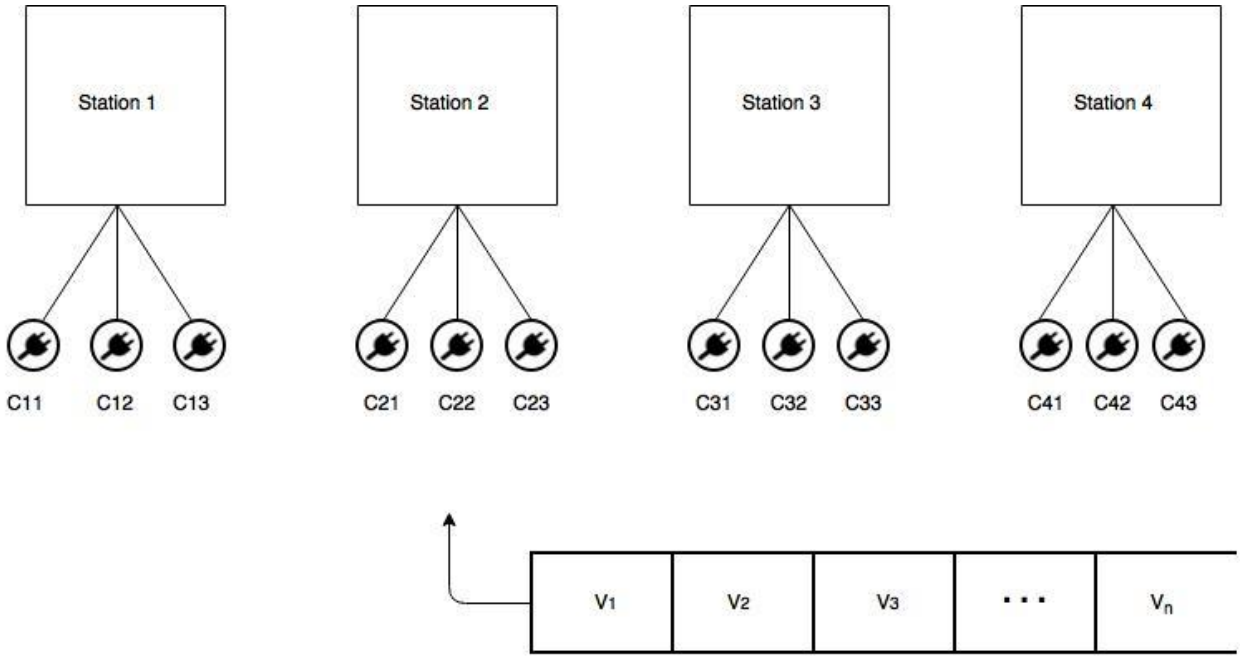


Figure: An infrastructure with charging plugs (C) and vehicles in the queue (V)

Dynamical System Analysis of a One-dimensional Walking Droplet Model

Leila Wooten, Bloomfield College, Advisor: Professor Denis Blackmore
Department of Mathematical Sciences
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: A reduced one-dimensional discrete dynamical system model of the walking droplet phenomenon is investigated using the theory of nonlinear dynamics and computational methods. Special attention is paid to such features as the stability of fixed points, bifurcations and chaotic dynamics, and how these are related to a two-dimensional model that exhibits many properties observed in walking droplet experiments. Liquid droplets bouncing on a vibrating fluid surface exhibit wave-particle behavior associated with quantum physics. For example, the droplets are propelled by the waves they generate as a result of their interaction with the oscillating fluid surface; in fact, they seem to walk across the fluid surface, and have therefore been called "walking droplets"[1,2]. Recently, Gilet [1] developed a two-dimensional discrete dynamical model for the walking droplet problem that predicts several aspects of the phenomenon with surprising accuracy. The model is based on iterates of the planar map $F:\mathbb{R}^2 \to \mathbb{R}^2$ defined as

(1) $$F(x,y) := \left(x - Cy\psi'(x), \mu(y+\psi(x))\right),$$

where $0<\mu<1$ and $0<C\le 1$ are (constant) parameters, and x, y and ψ are, respectively, the position, amplitude and an eigenmode of the walking droplet wave. The dynamics of this map is determined by its iterates $(x_{n+1}, y_{n+1}) = F(x_n, y_n)$.

We investigate a reduced one-dimensional model corresponding to constant amplitude dynamics for (1) defined as

(2) $$f(x) := x - \frac{C\mu}{1-\mu}\psi(x)\psi'(x) = x - \frac{\lambda}{2}\frac{d}{dx}\left(\psi(x)\right)^2, \text{ where } \lambda := \frac{C\mu}{1-\mu}.$$

This map and the associated one-dimensional discrete dynamical system (difference equation)

(3) $$x_{n+1} = f(x_n)$$

is analyzed for various λ and ψ such as $\psi(x)=\sin x$ and $\psi(x)=\pi^{-1/2}\left(\cos\beta\sin 3x+\sin\beta\sin 5x\right)$ for $\beta = \pi/3$ and $\pi/6$. The dynamics found, as expected from investigations [1, 2] of the dynamics of the two-dimensional system (1), include period-doubling cascades to chaotic dynamics with increasing λ, three-cycle chaos and fractal chaotic invariant sets, among other regimes. These results are obtained using both analytical and simulation techniques, and are illustrated with numerous examples.

References:

[1] T. Gilet, Dynamics and statistics of wave-particle interaction in a confined geometry, Phys. Rev. E **90** (2014) (0529170).

[2] A. Rahman and D. Blackmore, Neimark—Sacker bifurcation and evidence of chaos in a discrete dynamical model of walkers. (preprint)

NSF Research Experience Undergraduate Supplement

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

Maira Valencia, Advisor: Dr. Kevin D. Belfield

Department of Chemistry and Environmental Science

College of Science and Liberal Arts

New Jersey Institute of Technology Newark, NJ 07102

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. 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. The $\alpha_V\beta_3$ integrin is the integrin most strongly involved in the regulation of angiogenesis and the most discussed in this review. 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. 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.

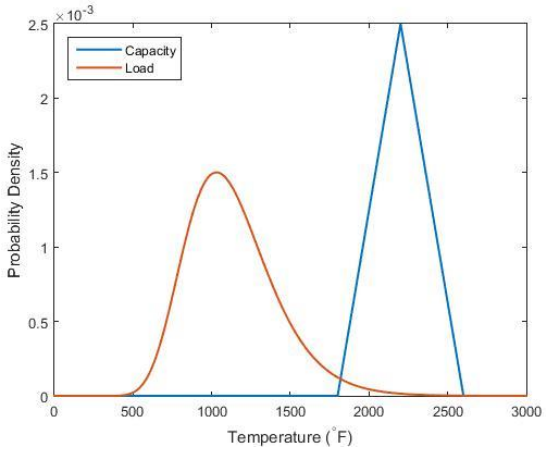
NSF Undergraduate Research Program – EXTREEMS-QED

Efficient Monte Carlo Methods for Estimating Risk of Nuclear Power Plants

Andres Alban, Hardik Darji, Atsuki Imamura, Marvin K. Nakayama
Department of Mathematical Science, Department of Computer Science
New Jersey Institute of Technology, Newark, NJ 07102 USA

Nuclear power plants (NPPs) have a risk of failure (e.g., damage to the core) during an event, such as a loss-of-coolant accident. The failure can result in the release of radioactive materials dangerous for humans and the environment. For example, the tsunami that struck the Fukushima Daiichi NPP in 2011 caused a partial meltdown of the core. Currently, nuclear engineers estimate risk through Monte Carlo simulations that compare a random load (L) to a *fixed* capacity (C) during a hypothesized event. The system fails when load exceeds capacity. They use computer codes that solve systems of differential equations to generate these random load observations. The computer codes require a long time to generate observations and therefore more efficient simulation methods are necessary for better accuracy. Recent changes in NPPs, e.g., extended licenses, have motivated a more nuanced analysis of risk. To achieve this, the Nuclear Energy Agency developed the risk-informed safety margin characterization (RISMC) framework. One of the significant changes of this approach is to consider the capacity C as a random variable to account for component aging and material variability. [1]

The goal of this project is to increase the statistical efficiency of Monte Carlo simulations for the RISMC problem by applying variance reduction techniques (VRTs), such as stratified sampling and conditional Monte Carlo. Previous work on this problem [1] considered a single criterion, where the load represents the temperature of the core. However, the Nuclear Regulatory Commission specifies three criteria, which also includes the amount of oxidation in the core. We consider different modeling approaches for the multi-criteria problem and devise new VRTs for its efficient simulation. To evaluate the performance of the proposed techniques, different models with an analytic solution were investigated. Stratified sampling combined with conditional Monte Carlo guarantees a reduction in variance [2], and it was found that the reduction can reach one order of magnitude for some models.



References

[1] R. R. Sherry, J. R. Gabor, and S. M. Hess. Pilot application of risk informed safety margin characterization to a total loss of feedwater event. Reliability Engineering and System Safety, 117:65-72, 2013.

[2] Nakayama, M. K., D. Grabaskas. “Conditional Monte Carlo for Efficient Simulation for Risk-Informed Safety Margin Characterization of Nuclear Power Plants, 2015

Data-driven Biophysical Modeling of Neuronal Dynamics

Joseph Ballardo, Jonathan Dougherty, Nilanjan Haldar
Department of Mathematical Sciences
New Jersey Institute of Technology, Newark, NJ 07102

Advisors: Casey O. Diekman and Horacio G. Rotstein

Circadian (daily) rhythms are observed in the behavior and physiology of a wide range of organisms and are controlled by internal biological clocks. In mammals, these rhythms are generated by the suprachiasmatic nucleus (SCN), a network of neurons located in the hypothalamus. As in other neuronal systems, biophysical models of SCN neurons are typically developed by assuming the presence of a set of ionic currents (e.g., potassium, calcium, sodium) and fitting the model parameters using experimentally measured current time courses. However, for many types of neurons such experimental data is not obtainable and measurements of voltage time courses are available instead. Fitting model parameters from voltage data is challenging because one does not have access to all state variables in the model (e.g., gating variables governing the dynamics of the participating ionic currents), but only the voltage. In this work we will perform a parameter search using a parallel multi-objective evolutionary algorithm to obtain the so-called pseudo-optimal set of solutions from voltage data. Such solutions correspond to a set of activity attributes (e.g., frequency, amplitude) recorded from these neurons.

We focus on two types of SCN neurons that exhibit differing electrophysiological properties (e.g. firing threshold, action potential width, and degree of afterhyperpolarization). In addition, the activity patterns of both cell types vary throughout the day-night cycle. We are developing biophysical models from voltage traces recorded from these two cell types to understand the ionic currents underlying their different activity patterns and the roles these currents play in circadian timekeeping.

Building Better Factor Models for Mathematical Finance

Josef Mohrenweiser, William Ruys, Michael Rivera, and David Horntrop
Department of Mathematical Sciences
New Jersey Institute of Technology, Newark, NJ 07102 USA

William Morokoff
Standard and Poor's, New York, NY 10041 USA

Abstract: When a lender loans money to a borrower they inherit a certain degree of risk — that the borrower will default and be unable to pay back the loan. For this reason, banks charge a risk premium to borrowers in order to cover losses they expect to incur and are legally mandated to keep a cash reserve to protect against these losses. As such, it is important for banks to have an accurate estimation of how significant they expect their losses to be. When a lender has a portfolio of these borrowers (assets), each with different inherent attributes, calculating these losses is non-trivial.

In this study, we examine methods for modeling this loss distribution for a portfolio of correlated assets beginning with a single factor model. Using Monte Carlo simulation, a distribution of losses for uniform assets is obtained and then compared against an analytical solution in order to gauge accuracy. To improve the accuracy of our results, we investigate the effects of various variance reduction techniques, including antithetic variates, control variates, and importance sampling for different economic parameters present in the model.

After constructing and testing this simplified factor model, we create a more complicated model with non-uniform assets. Parameters, such as correlation with the single factor and probability of default, are varied amongst the assets and the effect on the loss distribution is measured. Following this, we apply these methods to a multi-factor model, where assets are correlated to multiple common factors. Unlike the single factor model, this is a non-tractable problem, and thus more naturally lends itself to Monte Carlo simulation. We demonstrate the construction of these factor models and show the improvements obtained with the application of variance reduction.

The Homology of Thompson's Group T

Sabrina Lato, Angelo Taranto, Fernando Betancourt, and Dr. Daniel Farley
Department of Mathematics
Miami University, Oxford OH 45056

Presented by Angelo Taranto
Advisor: Dr. Roy Goodman
New Jersey Institute of Technology, Newark NJ 07102

Abstract

Thompson's group T was introduced by Richard Thompson in 1965 as an infinite group with a finite presentation. The closely connected Thompson's group F is often represented by certain piecewise linear homeomorphisms of the unit interval satisfying some properties. We consider it slightly more transparently as transformations of binary trees which preserve the order of marked branch points up to cyclic permutation.

Homology is a topologist's tool used to distinguish between topological spaces, but can also be computed for purely algebraic groups such as F and T as described in *Cohomology of Groups* by Ken Brown. In short, homology is the least restrictive way of distinguishing topological spaces, and often the most computable. Homotopy is much less computable but distinguishes more spaces, and homeomorphisms are the most discerning of all distinguishing tools.

The rational homology of Thompson's group T was first calculated by Sergiescu and Ghys in 1987 using very complicated tools. We will show a different approach to the calculation using a more understandable tool known as discrete Morse theory. This theory uses a discrete gradient vector field on the chain complex to create a more manageable Morse complex. We construct such a discrete gradient vector field on certain sub-complexes on which T acts, and use this filtration of sub-complexes to create finite chain groups with which to calculate the homology.

NSF Undergraduate Nanotechnology Summer Research Program

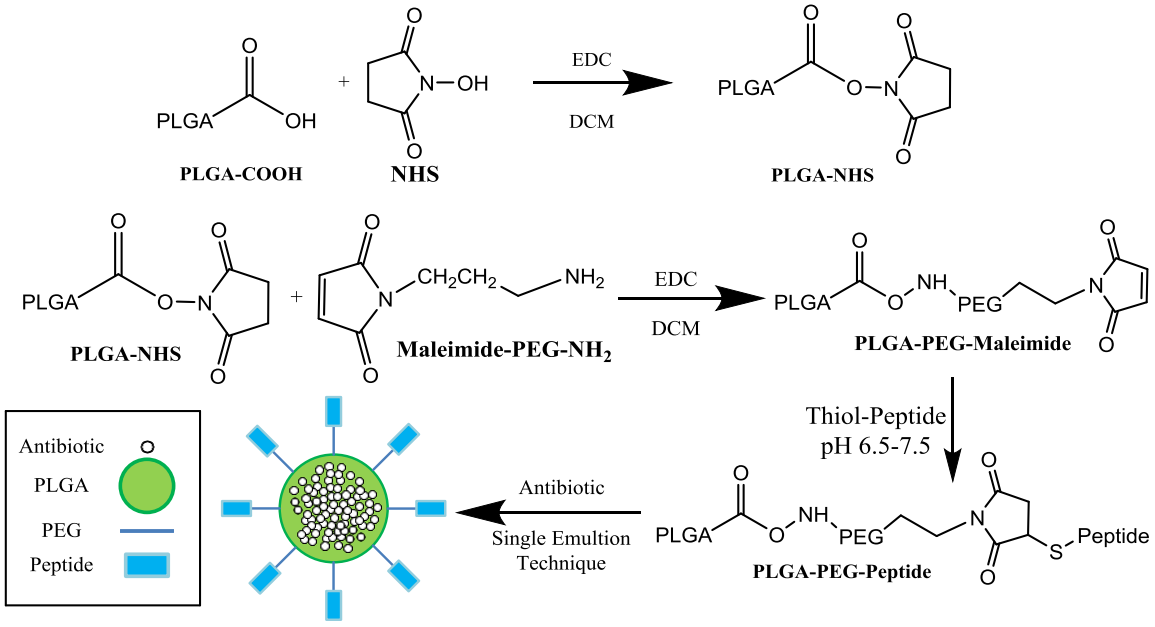
Sensitize drug-resistant bacteria to antibiotics using polymeric nanoparticles

Joshua Bader, Advisor: Dr. Xiaoyang Xu

Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark NJ 07102

Abstract: Methicillin-resistant staphylococcus aureus (MRSA), is a gram-positive, drug resistant bacterium that can cause illnesses ranging from acute skin conditions to life threatening ailments[1]. MRSA has adapted to become resistant to most antibiotics including, beta-lactam antibiotics and cephalosporins. In addition MRSA has strong biofilm forming capabilities[1], which are multicellular communities physiologically distinct from the host bacteria, that attach to abiotic surfaces and produce extracellular polysaccharides forming a protective layer around the bacteria. Antimicrobial cationic peptides (AMP) have a rapid action of activity against infectious agents, and remain unaffected by antibiotic resistant mechanisms[1].

AMP's mechanism to destroy biofilm is interfering with (p)ppGpp synthesis through RelA and SpoT enzymes, to inhibit the stringent response which controls the rate of growth in stressful conditions; lack of control leads to cell lysis[2]. Studies have shown that AMP's have synergistic potential with antibiotics. When used in conjunction, AMP's and antibiotics have greater success in treating antibiotic resistant bacteria, compared to when used individually.[1] Nanoparticles enhance the drug efficacy by targeting the disease site at higher concentrations, increase bioavailability, and release drug payload in a sustained fashion[3]. Herein, we propose a nanomedicine approach to treat MRSA using PLGA-PEG-Peptide tri-block as a nanoparticle matrix. PLGA-PEG is biodegradable, biocompatible, and has been approved by FDA. An antibiotic drug will be encapsulated inside the nanoparticle to be released in the MRSA bacteria. We hypothesize that antimicrobial cationic peptides can facilitate the drug-loaded nanoparticle by destroying the biofilm and therefore enhance the cellular uptake of drug payload.



Indium Injection into Flexible Polymer for Producing Flexible Conductors

Connor B. King, Abdus Ali, Blanca Kline
Advisor: Dr. Raquel Perez-Castillejos

Nanotechnology Program
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: This project aims at creating thin, highly conductive, flexible conductive structures for flexible electronic applications. As a demonstrator, we present here a flexible electrode made up of polydimethylsiloxane (PDMS) and indium. PDMS is a flexible, transparent, gas permeable polymer, widely used for the fabrication of microfluidic channels. Indium is a relatively soft, malleable metal with a low melting temperature that can be injected into microchannels formed in a PDMS matrix. PDMS channels of varying shapes and sizes can then be filled with molten indium metal, which then shapes up into solid conductive structures. Since the indium is maleable and surrounded by flexible PDMS, the metallic structures will continue to conduct electric current while bending. The combination of indium and PDMS allows for the production of flexible electronic systems with applications in wearable circuits. Indium-based flexible structures can undergo high stress as well as accommodate large strains without fracturing, which opens the door for the development of deformable electronics. We expect the method described here will facilitate to the production of devices for a variety of applications ranging from biological impedance sensors to electrical stimulation electrodes.

Acknowledgment: This project has been partially funded by NSF (NUE award # 1343716) and NJIT URI Student Seed Grant to A. Ali.

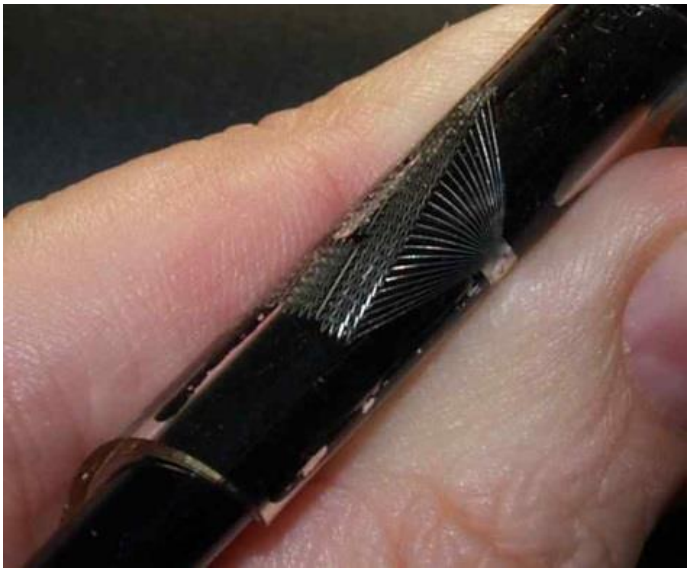


Figure 1: Example of bendability of indium structure.

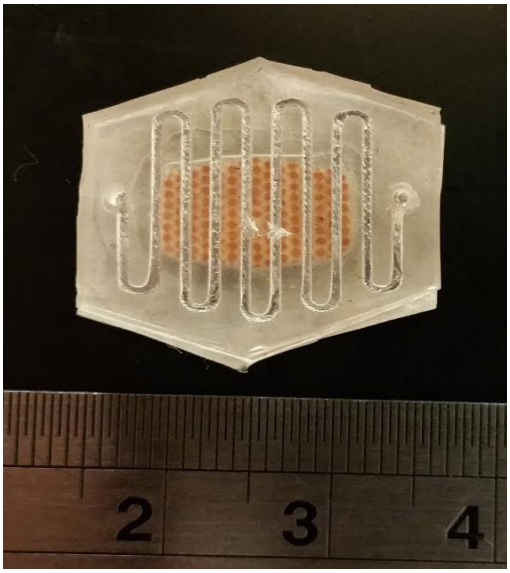


Figure 2: Indium electrode on an adhesive bandage.

Fabricating and Evaluating Bionanocomposites as Suitable Cartilage Mimics

Christine Kurian, Advisor: Dr. George Collins
Biomedical Engineering Department
New Jersey Institute of Technology, Newark, New Jersey, 07102

Abstract: Successful articular cartilage tissue regeneration has the potential to provide a more appealing alternative treatment option to the millions of patients currently suffering from chronic osteoarthritis. It has the ability to produce new functional cartilage that can simply replace the damaged tissue in a much less invasive surgical procedure, than total hip and knee replacement surgeries. Since no viable solution has yet been developed, it is not unreasonable to suggest a crucial detail is being overlooked for how the structure of articular cartilage results in its unique mechanical behavior. The extracellular matrix (ECM) of articular cartilage can be viewed as a fiber-reinforced composite material. As a composite material, the specific interactions within the ECM of articular cartilage are necessary for bringing about the tissue's robust mechanical behavior as well as aiding in the proliferation and viability of the mesenchymal stem cells, which serve as precursors for chondrocytes. The objective of this effort is to utilize nanotechnology to fabricate and evaluate the mechanical properties of bionanocomposite tissue engineering scaffolds that mimic the architecture and composition of the extracellular matrix of fetal articular cartilage. The bionanocomposites will be composed of k-carrageenan hydrogel and electrospun zein nanofibers, which will be used to mimic two of the main components of the ECM of native articular cartilage, chondroitin-4-sulphate and collagen fibers, respectively. Both zein and k-carrageenan are plant-derived, biodegradable, biocompatible materials, which make them favorable materials to be used in cartilage mimics. By using a chemical-linker to covalently bind the zein nanofibers with the k-carrageenan hydrogel in the bionanocomposites, a more accurate mimic of the ECM of articular cartilage can be developed. After creating bionanocomposites containing nanofibers linked with the hydrogel, the mechanical properties of these constructs will then be evaluated using a dynamic mechanical analysis instrument and then be compared with the mechanical properties that arise from bionanocomposites that contain nanofibers that are not linked with the k-carrageenan hydrogel. In the future, mesenchymal stem cells will also be incorporated into the bionanocomposites. The viability and proliferation of these stem cells will then be monitored and observed. The mechanical properties exhibited by the bionanocomposites and the viability of the mesenchymal stem cells within them, will test the ability of the bionanocomposites to serve as suitable cartilage mimics.

Ellipsometry studies of multiferroic materials for nanodevice applications at the Center for Functional Nanomaterials at BNL

Vladimir Martinez, Advisor: Dr. A Sirenko, Supervisor: T Stanislavchuk, RA

Department of Physics, New Jersey Institute of Technology, Newark NJ, 07102

The electrical manipulation of magnetic properties of materials is one of the mechanisms that provide a vast number of modern electronics with functionality on a nanoscale. For example, utilization of spin polarized current to manipulate magnetism is used in spintronic devices such as magnetic random access memories, standby-power-free integrated circuits, magnetic tunnel junctions, and domain wall motion devices. Spin polarized current utilized in magnetization switching in spintronic devices results in a Joule heating and thus in power dissipation. Another approach would be to switch magnetization with an electric field rather than current. In this case, only a small current would be needed to supply a sufficient charge to a capacitor, that would reduce energy consumption by the factor of 100 compared to that in spin polarized current devices. Thus, electric field control of magnetization is of importance for nanoelectronics.

We present our results for the optical properties of multiferroic orthoferrites: $TbFeO_3$ $DyFeO_3$ and $BiFeO_3$ ultra-thin films with the thickness between 2.6 and 43 nm. The spectroscopic ellipsometry measurements were done in a wide spectral range from far-infrared to near-UV at temperatures from 4 K and up to room temperature of 300 K. The main goal of these studies is to obtain information about the dielectric function modification on the nanoscale and the corresponding contributions from phonons (lattice vibrations), electronic interband transitions, magnons (spin oscillations), and free electrons. Fitting of the dielectric function to Lorentz oscillators in Matlab gave us information about phonon shifting caused by magnetostriction, which is the main mechanism of the magneto-electric coupling in multiferroics. The figure below shows the pseudo-dielectric function measured for $TbFeO_3$ bulk crystals and $BiFeO_3$ ultra-thin films grown on SrTiO3 substrates. Arrows indicate frequency of the phonons and electronic transitions.

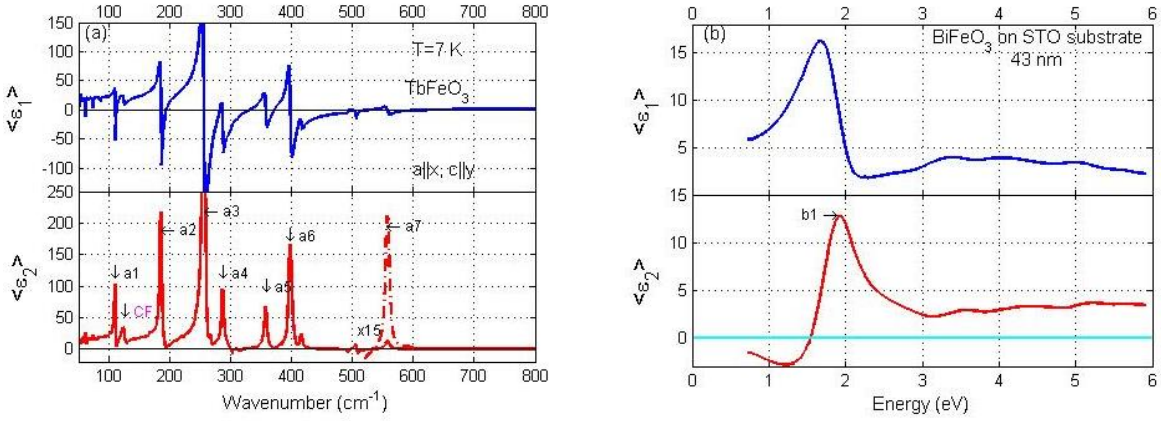
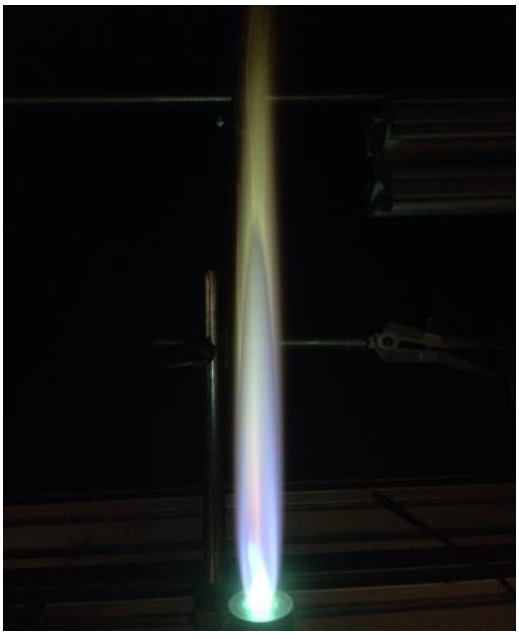


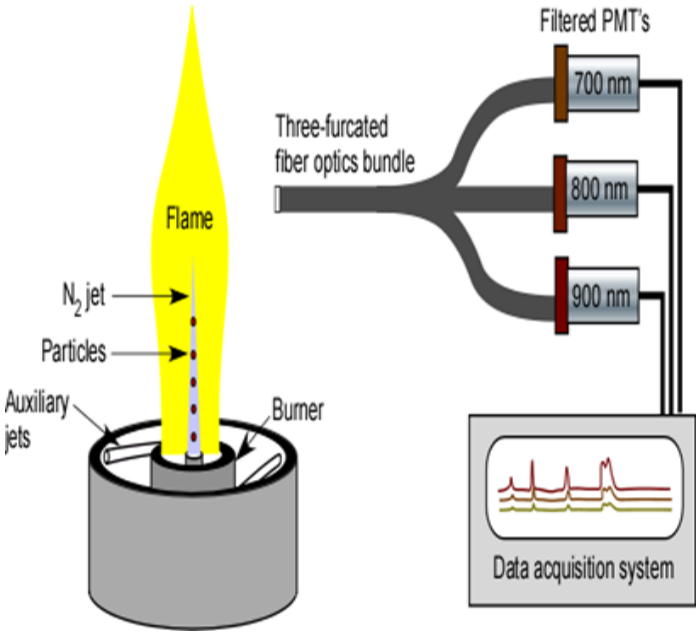
Figure1: spectra of real and imaginary components,$<\varepsilon_{1,2}>$, of the pseudo-dielectric function for (a) $TbFeO_3$ at 7K, and (b) $BiFeO_3$ 43nm film on $SrTiO_3$ substrate at room temperature.

Gas-Generating Boron Magnesium Hydride (B-MgH_2) Nanocomposite Materials

Quang Nguyen, Advisor: Edward L. Dreizin, Mentor: Kerri-lee Chintersingh
Department of Chemical, Biological and Pharmaceutical Engineering
New Jersey Institute of Technology, Newark NJ 07102

Boron, a high-combustion heat metalloid, is of interest for use as a potential fuel in many energetic systems such as solid propellants, pyrotechnics, thermobaric explosives, and explosives for mining/oil exploration. However, it is not easily ignited due to the oxide and hydroxide layers coating its surface, leaving its chemical energy of oxidation unused in many practical combustion systems. In order to augment the reactivity of boron by reducing its ignition temperature and increasing burn rate, mechanical milling is utilized to prepare a set of boron-based composites containing a reactive additive, magnesium hydride (MgH_2). Before milling, boron was washed with a solvent, acetonitrile, for 30 minutes in the shaker mill to dissolve and remove its oxidized surface layer. Acetonitrile was removed and refilled 3 times after the initial washing. Two composite material samples were prepared using ball milling with different liquid process control agents: one was milled under acetonitrile while the other was milled under hexane. Experiments were performed with the prepared materials to obtain their ignition temperatures and burn times using, respectively, an electrically heated filament and powder seeded hydrocarbon flame burner. Particle size distributions were measured from the Scanning Electron Microscope (SEM) images of powder particles passed through the powder feed system of the burner. It was observed that both samples ignited at lower temperatures and burned faster than as received commercial boron. The sample milled under acetonitrile ignited at a lower temperature (850 K) and burned faster than the one milled under hexane.





Membrane-Free Biofuel Cell Fueled by Glucose-Gel Electrolyte Fabricated Into a "Patch"

Ansel Ueshiro, Biao Leng, Dr. Zafar Iqbal

Department of Chemistry and Environmental Science, New Jersey Institute of Technology, Newark, New Jersey 07102

Using the fundamental methodology of a voltaic cell the goal is to create a membrane-free biofuel cell in a flexible "patch" and implantable form (see Fig. 1 below) to power small electrical devices, such as a pacemaker. The capability of making a biofuel cell which can supply sufficient energy for long durations of time can be a challenge due to the long-term instability of enzymes under electrical load, the slow depletion of glucose, and loss of moisture within the agar gel electrolyte. Past studies have shown that the agar biofuel cell can reach power densities of 167.2μW/cm^2 and last only up to 30 hours due to the loss of moisture from the agar gel. For successful power generation not only are we going to need to optimize the direct transfer of electrons at the electrodes and the immobilization of enzymes on the nanopaper, but we also must find a way to keep moisture in the gel electrolyte being used to fuel the cell with glucose.

The anode and cathode are constructed from multiwall carbon nanopaper consisting of a mesh of nanotubes fabricated by a filtration process. Due to the fact that nanotubes are highly conductive with a high surface area to volume ratio, they can act as efficient electrodes. Further enhancement of conductivity to increase the power output will be achieved by electrolessly drop coating gold on the nanopaper electrodes. To help immobilize the enzymes, glucose oxidase (GOx) and Laccase (Lac), on the anode and cathode respectively we will drop coat Nafion on the carbon nanopaper before using a carver press to mechanically compress the enzymes. Agar gel with added glucose will be sandwiched between the anode and cathode to act as fuel and electrolyte for the biofuel cell. Air will be pumped through a sealed flask containing water before entering the agar to maintain the moisture within the biofuel cell. We will present the analysis of the effects of these parameters for efficient and stable power generation from the biofuel cell.

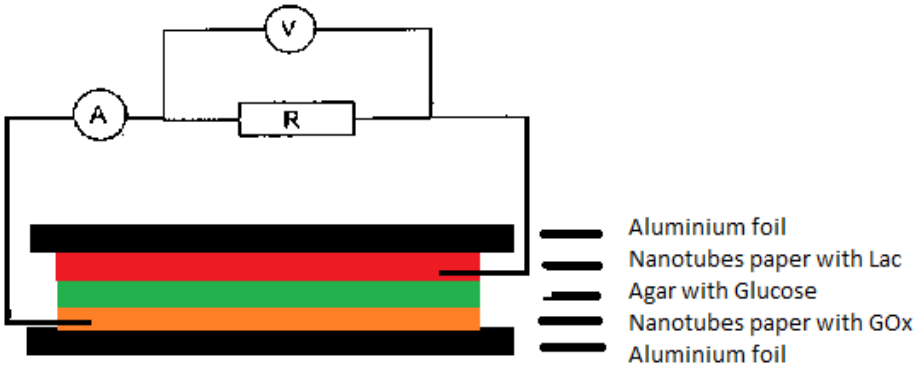


Fig. 1: Schematic design of a "patch" biofuel cell.

TechQuest Innovation

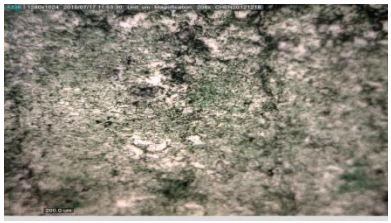
Fabrication of Conductive Scaffolds for Peripheral Nerve Regeneration

Sahitya Allam[1], Advisor: Dr. Michael Jaffe[1], Mentors: Dr. Richard Gregory[2], Dr. George Collins[1], Amir Hossein Rajabi Zamani[1], Gabrielle Busto[1]

1 – Department of Biomedical Engineering, New Jersey Institute of Technology
2 – Department of Chemistry & Biochemistry, Old Dominion University

Our nervous system, with its 2 billion neurons and fine-tuned synaptic connections, is one of the most intricate and sensitive systems in our body, significantly impacting our sensory and motor functions when damaged. Injuries to the peripheral nervous system, the branch of the nervous system that controls the extremities, affect nearly 20 million people in the United States each year, and are associated with a wide variety of both acute and chronic complications such as burning pain, muscle degeneration, paralysis, and organ or gland dysfunction. Clinical evaluations have repeatedly called for a new solution to replace highly ineffective nerve repair constructs, making tissue-engineered approaches that harness the biocompatibility of various polymers potentially attractive, new treatment strategies. The aim of this research is to fabricate and characterize novel conductive electrospun scaffolds that mimic a growing nerve and will act as favorable substrates for dorsal root ganglion (DRG) attachment, migration, and proliferation. Poly-L-lactic acid (PLLA) was used as the base of the scaffold due to its suitable biomechanical properties and ability to harmlessly degrade in the human body. A 7.5 wt% solution of PLLA in dichloromethane was electrospun into nonwoven and aligned mats of microfibers, as determined through SEM, see Figure 1A. Since the main means of communication in the nervous system is through the propagation of action potentials, electrical conductivity was imparted to the PLLA mat through coating in-situ with polyaniline (PANI), a cost-effective conducting polymer which can be acid doped to impart variable levels of conductivity. A thin-layer of PANI was coated onto the surface of the nonwoven and aligned PLLA mats – see Figure 1B - and the conductive properties of both doped and undoped mats were measured using a two-point probe resistivity measurement, confirming the PANI coating imparts good electrical conductivity. Along the longitudinal axis of both the random and aligned non-woven mats, it was found as expected that the conductivity increased with smaller spacing in between the electrodes. Thermal analysis using DSC suggested that the pure PLLA fibers exhibit a semi-crystalline structure and that the PANI coating does not cause significant change. ATR-FTIR analysis also implied the existence of intermolecular bonds between the PLLA and PANI chains. Cell studies will be conducted in the future to determine the viability of the scaffolds to DRG growth, which, if successful, will pave the way for animal studies as proof of principle for the use of conducting scaffolds for neural regeneration.

(A)



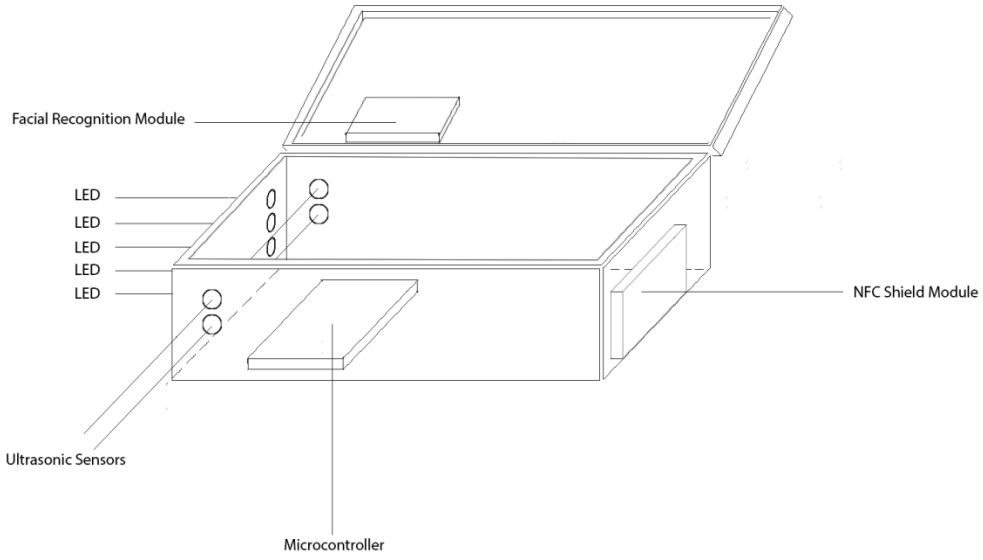
(B)

Figure 1. (A) Micrograph of 7.5 wt% nonwoven PLLA mat. (B) Micrograph of nonwoven PLLA mat coated with doped polyaniline.

Multiple Authentication Enclosure For Security

Einreb Funda, Umar Rao, Advisor: Mohammed Feknous
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark NJ 07102

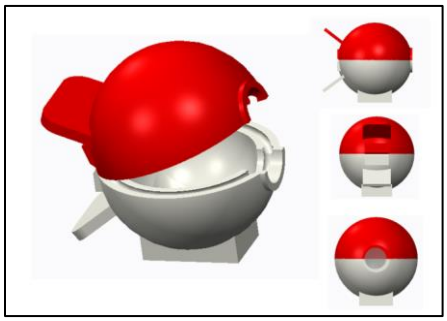
Abstract: MAES (Multiple Authentication Enclosure For Security) is a microcontroller and microcomputer based system that utilizes open source hardware to develop a device that features technological components such as a Bluetooth Proximity Sensor, a NFC (Near Field Communication) shield authenticator, Ultrasonic Sensors, and a Facial Recognition algorithm to create a truly advanced security system. By combining all these technologies into a singular system that revolves around a multiple authentication structure, MAES diversifies itself from anything currently on the market by using a unique multi-step system of validation. The central component and most vital part of the system is the Bluetooth proximity sensor. The purpose of this component is to seek out a system authorized device to proceed in opening the enclosure. It does so by reading the Bluetooth address of devices in its range and if a familiar address is read a signal will be triggered. The additional components mentioned will only work if the Bluetooth modem has activated the signal which allows for a secure link to be created between MAES and the user device. The NFC shield will be placed inside the enclosure which would allow the NFC registered device to open MAES by a NFC swipe. The Ultrasonic sensors will work by using multiple sensors. The first sensor will be tracing the person's body and then a second sensor will be activated which will require a unique hand gesture in order to open the enclosure. The Eigen Faces method is used for facial recognition. We improved the algorithm by making it sensitive to light rather than just focusing on the size of each pixel. This allows the facial recognition to be more secure and would prevent unauthorized access. A Raspberry Pi micro-computer is used to run all python scripts and other necessary facial recognition algorithms. Our goal is to create an affordable, technologically advanced, and most importantly, secure system that utilizes mobile devices as a gateway, or "key" for safe communication in an M2M (Machine to Machine) environment.



Portable UV Light Sterilization Device For Stethoscopes (PULS'D)

Maryam Haque; Advisor: Dr. Gordon Thomas
Department of Physics: Biophysics
New Jersey Institute of technology

Research has shown that the diaphragm of a stethoscope is the "dirtiest" part of the stethoscope, and only 8% of hospital emergency employees clean their stethoscope before seeing a patient. Doctors, who do not clean their stethoscope due to reasons such as "lack of time," or "forgetfulness," put their patients at risk for hospital derived infections. In order to reduce the amount of these infections, our Senior Design Capstone Group is producing a Portable UV-light Sterilization Device for stethoscopes. This device is designed to sterilize the diaphragm of the stethoscope quickly (<45seconds) using UV-light. UV-light at a wavelength of 250-280nm, UVC Germicidal, has been found to be a quick and efficient way of completely sterilizing various surfaces by breaking down the genetic components of bacterial/fungal cells to induce apoptosis. So, the device design has safely incorporated the UV-light mechanism for sterilization purposes. The PULS device is designed to operate by acting as a small portable sphere that will encloses on the head of stethoscope to sterilize it, then after sterilization it can be removed and put in the doctors white coat for storage. When the device is open, it is off, and when the device is enclosed around the head of the stethoscope while the switch is on, indicating ON, the UV light will be working to actively sterilize the diaphragm. As mentioned before, the product will be portable, where it weighs less than 170g, (lighter than an IPhone6) and smaller than 8cm in diameter. Also, the product will be cost efficient so that the hospital will be able to provide this device for all doctors to use.



PSEG Fellow

Assessing Recent Literature Regarding the Release of Fecal Coliform Pathogens within Drinking Water, and the Wide-Angle Conclusions Drawn from said Research

Calvin Allemand

New Jersey Institute of Technology, Newark NJ 07102

Abstract

The threat of waterborne illnesses produced by fecal pathogens is a threat that all nations great and small must contend with, even in these modern times. As our understanding of the threat grows, we as members of the scientific, environmental, and public health community have found ever more innovative ways to combat the threats of plague, child mortality, and heavy metal poisoning. At the same time though as we learn more about the nature of these threats we continuously find that the size of the monster is still far greater than our current capacity to contain it, and so must improve our modeling techniques, our cleaning procedures, our sample reading technology, etc. In this way has our understanding of the threat of waterborne fecal pollution expanded; each new improvement to current models or re-exploration of proposed theories revealing what more we can do to protect the public, and what more we still do not know. This report looks into the research done on the subject of waterborne fecal pathogens, how they incorrectly find their way into the water supply and put innocent lives at risk, what more we now know about the spread and transport of these pathogens from sources of feces including livestock, human septic tanks, and wildlife defecation, and what if anything can local governments do to efficiently neutralize the danger of these pathogens before they are allowed to cause pandemic harm. This report offers both a layman introduction into the subject of fecal bacterial contamination of water bodies, as well as an abridged compilation of the works of other worthy researchers whose resent studies may be useful for those interested in doing further research or tangential learning.

Glucose-Based Fuel Cells can Test the Glucose Concentration and Adjust Energy Output

Brian Capozzola, Alokik Kanwal, Gordon A. Thomas, Reginald C. Farrow
Department of Biology and Biophysics
New Jersey Institute of Technology, Newark NJ 07102

Improved energy output is discussed using a glucose-based fuel cell. It is predicted that using carbon nanotubes (CNTs) functionalized with glucose oxidase at the anode and bare CNTs at the cathode will produce a greater energy output than the cathode functionalized with laccase. The removal of laccase removes the limiting reactant, oxygen, while still maintaining a high voltage difference between the cathode and anode. This allows to focus specifically on the catalysis of glucose, energy production, as well as the enzymatic affinity to the glucose solution. In this study, an amperometric test is used to measure the current produced by the fuel cell over time as increments of 0.5 mM of glucose are added every 30 seconds. With the amperometric measurement we then produce a calibration curve (Current vs. Glucose Concentration) as well as a Lineweaver-Burk plot. We are then able to determine the Michaelis-Menten constant (Km) which gives an indication of the enzyme-substrate kinetics where a smaller value means a higher enzymatic activity and a higher affinity towards the substrate. This is calculated using the Lineweaver-Burk equation: $\frac{1}{Iss} = \frac{Km}{Imax}\frac{1}{C} + \frac{1}{Imax}$, where Iss is the steady-state current, Imax is the maximum current, C is the glucose concentration and Km is the Michaelis-Menten constant.

The experimental set up includes the biofuel mega-cell containing around three million pairs of carbon nanotube connected to a Keithely Electrometer with a resistance of 200TΩ. Using Ohm's Law V=IR where V is equal to voltage, I is current and R is resistance, this allows for current in micro-amps to be indirectly measured and plotted by measuring the change in voltage produced as glucose is added and catalyzed in the solution.

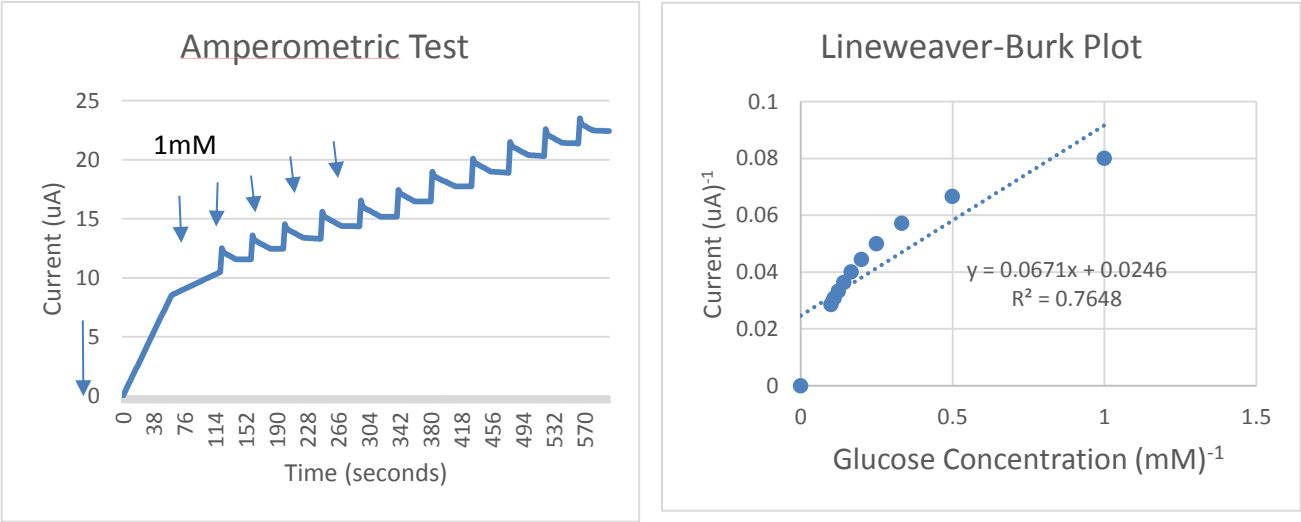


Figure: Predicted Amperometric Test (left) and Lineweaver-Burk plot (right) for finding substrate-enzyme kinetics.

Power Optimization of an Enzymatic Biofuel Cell By Varying Counter Electrode Density

Greg Hoffer, Dr. Alokik Kanwal, Dr. Reginald C. Farrow, Dr. Gordon A. Thomas
Biophysics Research Group
New Jersey Institute of Technology, Newark, NJ 07012

The objective of this experiment is to increase the power generated by a single cell biofuel cell. This device uses enzymes to convert chemical energy contained in glucose to electrical energy in the form of electrical current. Thus, increasing the amount of current will directly increase the power generated through the relation P=I*V. The cathode and anode have two different enzymes attached to single-walled carbon nanotubes: Glucose oxidase and laccase, respectively. These two enzymes operate at different rates in the environment of the biofuel cell. This difference leads to an overall loss of power, so the experiment proposed will attempt to equalize these rates of reaction.

In this system, laccase is the counter electrode because it receives the electrons freed by glucose oxidase. It has also been determined to be the limiting enzyme in the system. The goal is to establish if adding additional laccase enzymes in the presence of a single glucose oxidase will increase the current and power produced. If this occurs, then a curve similar to the prediction should be plotted (figure 1). The peak in the graph signifies the maximum current output that can be achieved with a single glucose oxidase enzyme. It also shows the ratio (of laccase to glucose oxidase) at which this maximum is achieved. The current then decreases after the peak due to the increasing difference between the rates.

The equipment that will be used to find the current generated by the fuel cell is a Keithly 6517A, which has a known input resistance of 200 TΩ. The Keithly will be measuring the voltage created by the fuel cell so it will be possible to calculate the current using Ohm's Law (V=I*R). This circuit will contain only the fuel cell acting as a power source and the Keithly acting as a voltmeter with the cathode connected to the input on the Keithly and the anode connected to the output.

If the current increases when moving from a 1:1 ratio to a 2:1 ratio, then the prediction is qualitatively correct and will eventually reach an ideal value where a maximum current is produced.

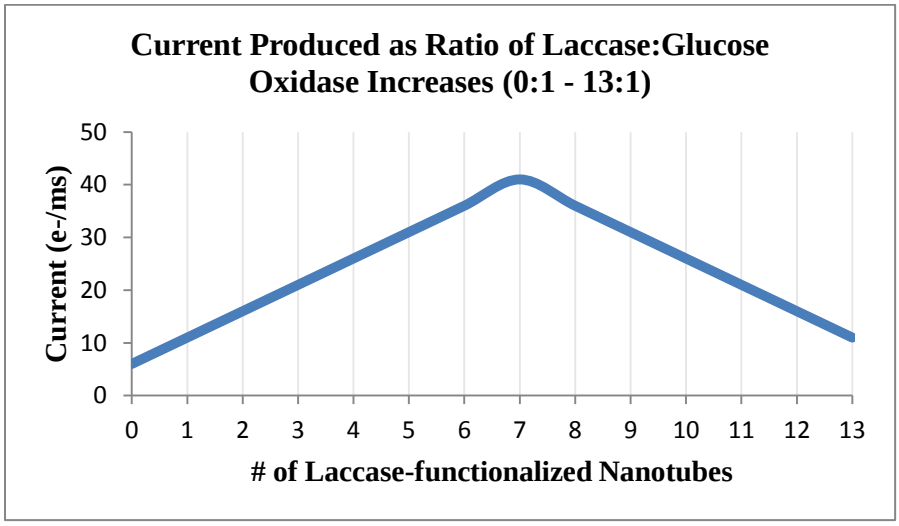


Figure 1: Prediction Graph

Algal Harvesting and Destabilization by Titania Reactive Electrochemical Membrane

Marah Angelica Magpile, Likun Hua, Wen Zhang*

John A. Reif, Jr. Department of Civil and Environmental Engineering, New Jersey Institute of Technology, Newark, NJ 07102. *Corresponding author: e-mail: wzhang81@njit.edu; Phone: 1-973-596-5520; Fax: 1-973-596-5790.

Abstract: Algae are one of the typical water contaminants that affect water quality and drinking water security. In biofuel industries, algae are the third generation feedstock for biolipid production. Due to low growth density in aqueous media, harvesting or removing algae from water is one of the technical hurdles for cost effective utilization of algae for biofuel derivation and also a challenge for drinking water treatment. Conventional methods, such as chemical coagulation, precipitation, filtration and flotation, among others have proven to be energy- and time-consuming. Recently, membrane filtration is one of the state-of-the-art processes for algal separation because of its simple operation, but traditional membranes suffer from fouling due to either the formation of a cake-like layer of algal cells, or organic matter adsorption onto the membrane surface. Our research goal is to develop a cost-effective and antifouling membrane filtration based on so-called reactive electrochemical membranes (REMs) or electrochemical advanced oxidation processes (EAOPs). REM utilizes direct current (DC) to driven the reactive species formation on the membrane surface to remove fouling and meantime oxidize algae, which could facilitate the downstream lipid extraction and reduce algal pretreatment. In this project, we assessed algal integrity by examining algal cells through optical microscopes, photosynthetic activity, and levels of dissolved organic matters in algal suspension before and after the REM treatment. The results show that the treated algae cells were significantly damaged (See SEM images below), as indicated by the deformation and released intracellular organics. Photosynthetic activity declined as the treatment time increased from 0 to 60 min under 500 mA and 20 V of DC charging. This work lays foundation toward the development of cost effective, sustainable membrane filtration systems for water treatment and biomass separation.

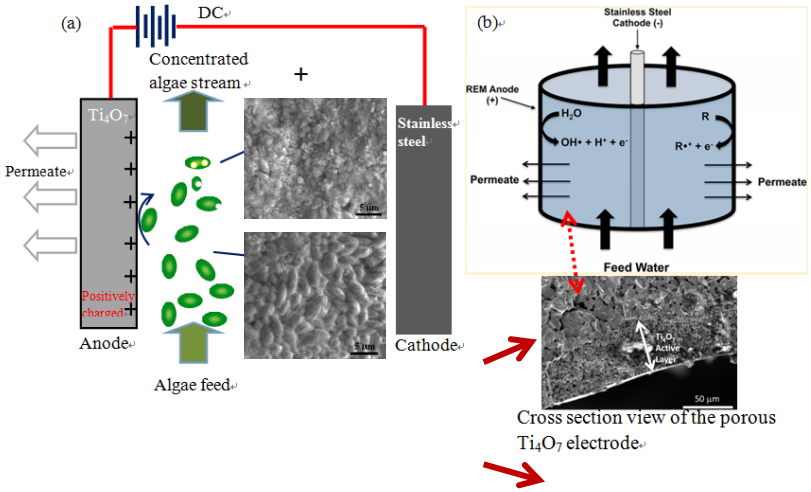


Figure (a) Schematics of algal concentration and destabilization during the REM filtration process. (b) the configuration of the feed water and permeate flux through the REM.

Carbon Nanotube Enhanced Membrane Distillation

Kabir Mitra, Advisor: Dr. S. Mitra, and Mentor: Dr. S. Roy, Postdoctoral Scholar
Department of Chemistry and Environmental Science
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract:

The purpose of this project is to develop novel membranes using carbon nanotubes (CNTs). These membranes, known as Carbon Nanotube Immobilized Membranes (CNIM), have breakthrough membrane properties, which make them ideal for generating pure water from seawater and brackish water through the process of membrane distillation (MD). This enhanced approach will reduce the energy requirements and costs for desalination and provides many advantages over conventional water treatment processes such as reverse osmosis (RO) and thermal evaporation. Some of these advantages include: the ability to treat water at high salt concentrations, significantly less membrane fouling, and longer membrane life. Since MD can be operated at low temperatures (60-90^{o}C), waste heat and alternative energy sources such as wind or solar energy can be used to drive the MD process.

Furthermore, this project targets energy related issues faced by power plants that require large amounts of power due to their high cooling requirements. Power plants require immense amounts of fresh water to cool their systems; therefore the global water shortage is a major concern for power generation. CNIM-MD is an ideal solution to reduce the fresh water intake of power plants by allowing them to use utilize desalinated seawater and brackish water to cool their systems. This would allow the towers to operate at higher cycles of concentration, and would allow the effluent to be used as boiler feed water, with minimal pretreatment. Perhaps one of the greatest advantages is that the waste heat released by the power plants can be used to drive the CNIM-MD process.

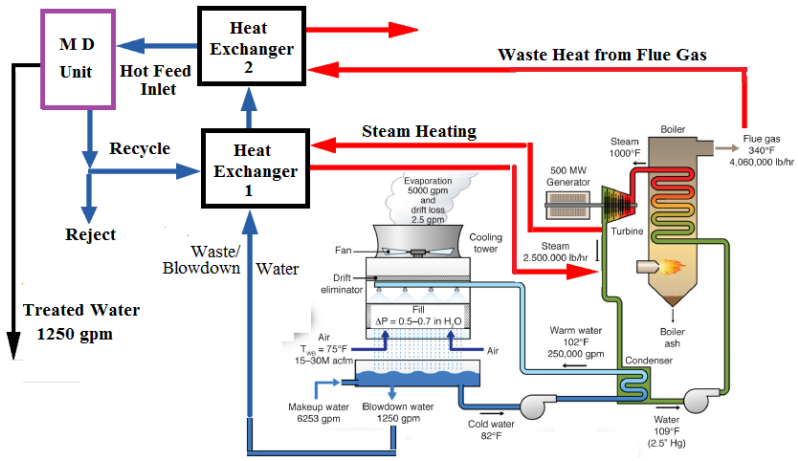


Figure 1: Schematic Diagram of Power Plant and M.D. system

Decellularization of 3D engineered tissue using a semi-automated flow system

Farah Mushtaq, Pamela Hitscherich, Eun Jung (Alice) Lee
Department of Biomedical Engineering
New Jersey Institute of Technology, Newark, NJ 07102 USA

Decellularized tissue matrices have emerged as one of the promising biomaterials available for tissue engineering applications. Decellularization of a tissue involves exposure to various chemical detergents, such as sodium dodecyl sulfate (SDS) and 3-[(3-cholamidopropyl)dimethylammonio]-1-propanesulfonate (CHAPS), causing cell membrane lysis and solubilization of cellular components that can then be washed away while retaining the ultrastructural organization and biological properties of the tissue. However, complete removal of cellular components is necessary to ensure the safety of the matrix for clinical applications, as cellular remnants can elicit an immune response upon implantation. Despite recent advancements, numerous limitations still exist for decellularized tissue due to the harsh nature of the necessary detergents. One such limitation is the disruption of tissue architecture, which can lead to changes in structural integrity and mechanical properties of the tissue [1, 2]. There can also be extensive protein and small molecule loss, including elastin, collagen and GAGs [1, 2]. Therefore it is essential to establish a balance between cellular removal and retention of extracellular matrix (ECM) proteins and small molecules.

The aim of this study is to optimize a decellularization protocol for obtaining cell free, engineered tissues that can serve as natural ECM scaffolds for tissue engineering applications. Two common decellularization detergents were used, SDS is one, which is more effective in penetrating thicker and denser tissues but can cause up to 80% ECM disruption [1, 2]. The other is CHAPS, which is less harsh on ECM but less effective in solubilizing cellular components [1]. Previously, decellularization performed under static conditions in both CHAPS and SDS detergents for 1 hour did not result in complete removal of cellular components. To facilitate enhanced efficiency of decellularization and washing process, a custom perfusion system was utilized and decellularization parameters, such as flow rate, detergent exposure and washing times, were optimized to maximize cell removal with minimal ECM loss. Experiments were conducted with engineered tissues created from type I collagen hydrogel seeded with rat mesenchymal stem cells.

Initial parameters used were perfusion of both CHAPS and SDS detergents at 2 mL/min flow rate for 1 hour followed by an overnight washing at 2 mL/min. Since this did not sufficiently remove all the cells, flow rates were increased to 10 mL/min. Increased flow rates and extended exposure time to CHAPs increased decellularization efficiency. It is necessary to perform additional assays to achieve complete removal of cellular components, as well as to characterize the decellularized matrix using a collagen assay, to determine how varying protocols affect ECM composition. Successful decellularization can lead to the formation of native ECM scaffolds, which can be used for the creation of *various* tissues *in vitro*.

[1] Petersen, T.H. et al., *Cells Tissues Organs,* 2012; 195, 222-231.
[2] Crap, P.M. et al., *Biomaterials,* 2011; 32, 3233-3243.

Accounting for Soil Moisture Variability in a New Jersey Catchment Using STI, Temperature, and Precipitation

Andrew Pennock, Advisor: Dr. Z. Qiu, and Mentor: Dr. S. Giri
Department of Chemistry and Environment Sciences
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: Growing concern regarding non-point source (NPS) pollution caused by storm runoff in humid areas has presented the need to accurately predict soil moisture distribution. Due to the complexity of the physical mechanism that controls soil moisture distribution, a parsimonious model is required for practical estimation of soil moisture. Numerous efforts have been made to predict soil moisture patterns using topographic indices (TIs), but with limited success in accounting for the spatial variability of soil moisture. Therefore, this study attempts to explain soil moisture variability using precipitation, temperature, and soil topographic index (STI) as inputs. Twelve days of soil moisture data were collected at two fields in northwestern New Jersey from the months of April 2013 to July 2015. Additionally, precipitation and temperature data were obtained from nearby weather stations for the same time period. All data were analyzed using linear mixed effect models, created with the "lme4" R statistical software package, where soil moisture was the response variable and the explanatory variables were precipitation, temperature, and STI. In the best case, these explanatory variables accounted for 41% of soil moisture variation. This analysis showed significant correlations between soil moisture and the explanatory variables. As expected, STI and precipitation were positively correlated with soil moisture, while temperature and soil moisture had a negative correlation. These observed trends in soil moisture distribution have practical implications for identifying denitrification hotspots and hydrologically sensitive areas (HSAs) in order to guide watershed mangers and policy makers in decisions that will protect water quality.

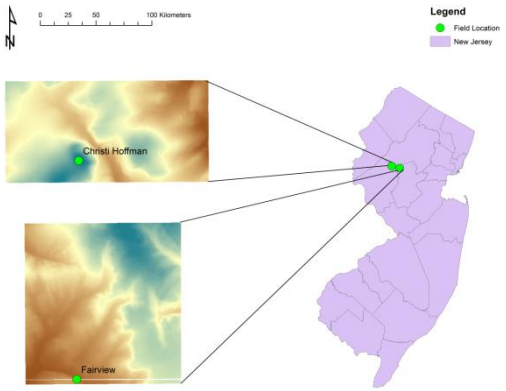


Figure 1. New Jersey field sample site locations (green dots). High elevation is indicated by dark blue. Low elevation is shown as dark brown. County lines are displayed as gray lines on the map of New Jersey.

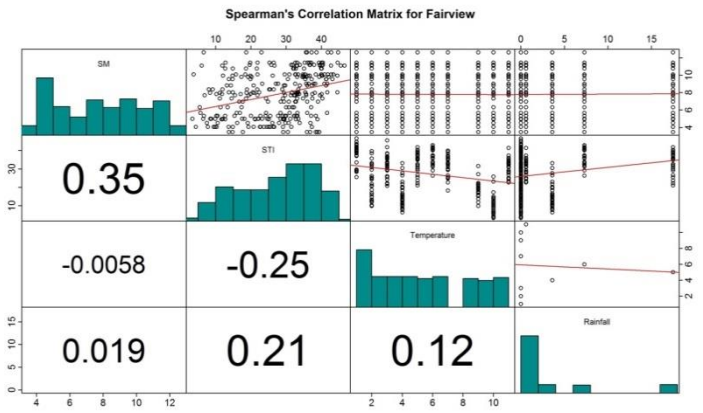


Figure 2. Spearman's correlation matrix for Fairview Farm. Scatterplots (upper triangle) of each row parameter plotted vs. each column parameter. Frequency distributions of each parameter shown as histograms (main diagonal). Spearman coefficients (lower triangle) of each row parameter plotted vs. each column parameter (significant coefficients in bold).

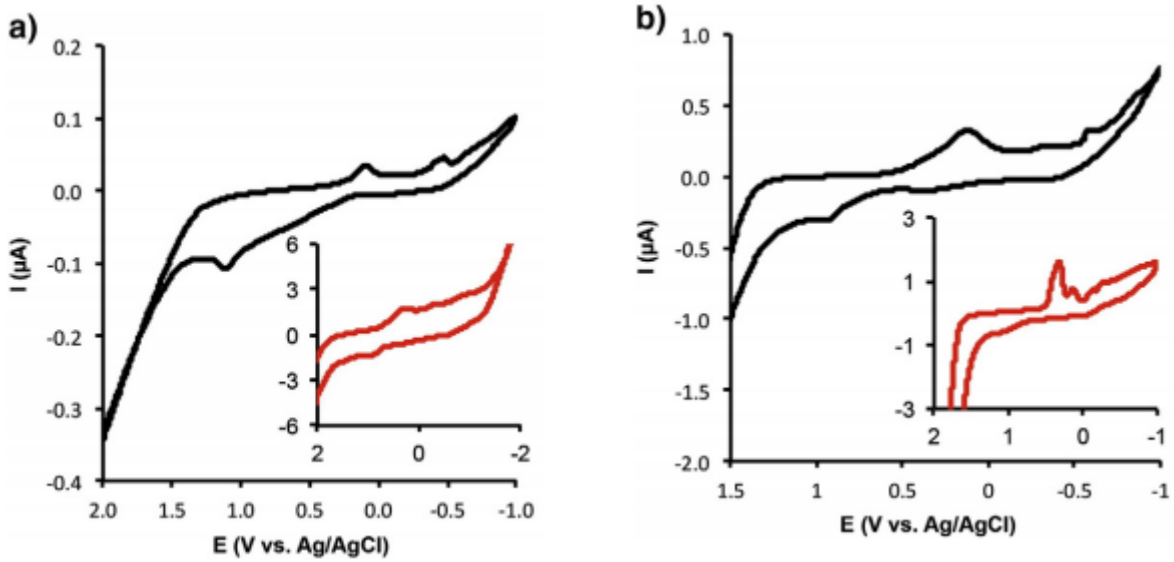
Micro Fuel Cell for Eye Pressure Regulator

Diego A Rios and Noor Shahin, Advisors: Dr. Alokik Kanwal and Dr. Gordon Thomas

Department of Physics

New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: We are working to improve the energy output from a micro fuel cell for an application involving glaucoma. A new way of controlling the pressure in an eye (which causes glaucoma) is to insert an eye pressure regulator. While a tonometer can measure and detect glaucoma, an eye pressure regulator can treat glaucoma and normalize the intraocular eye pressure.In order to power the regulator we need a source that has sufficient power and is very small so that it does not block vision. The fuel cell that we are using gives off energy from oxidation and reduction reactions with glucose and oxygen, using catalysts that are enzymes attached to the tips of carbon nanotubes. The first stage in improving the fuel cell is to study the process in which the enzymes are deposited, called cyclic voltammetry. We are studying the curves that monitor this process, and examples are shown in the two figures below.



*Black graph represents single pair of enzymes

** Red graph represents 3 million pairs of enzymes.

Optimizing Time for Enzyme Deposition on Single Wall Carbon Nanotubes Analyzing Cyclic Voltammetry Data

Noor A. Shahin, Diego A. Rios Dr. Alokik Kanwal, and Dr. Gordon Thomas
Department of Physics
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: The purpose of this project is to improve upon enzyme deposition protocol on to single wall carbon nanotubes (SWCNT) to be used in biofuel cell as energy sources. These fuel cells use SWCNT functionalized with glucose oxidase and laccase. The type of biofuel cells worked on are enzymatic using glucose and oxygen as fuel sources. Glucose oxidase and laccase are functionalized to SWCNT that make electrical contact with Titanium leads, and are used as electrodes. The oxidizing end is the anode where electrons from the oxidation of glucose by glucose oxidase enters into a circuit and the reducing end is the cathode where electrons leave the circuit to reduce oxygen to water. This functionalization is accomplished using cyclic voltammetry (CV) which monitors current with respect to voltage. This data was obtained from previous measurements. The electric field between the counter and working electrodes (running from positive to negative) causes the enzymes to move toward the working electrode that has a SWCNT mounted to be functionalized. CV also monitors the attachment of the enzymes since peaks created in the graphs as the voltage is cycled through a positive voltage to negative then back to positive indicates the deposition of the enzymes. The technique currently used, runs the CV for an hour. What I plan to do with the data obtained from the CV data is use MATLAB 2015a to find the time it takes to get the maximum current output at the oxidation and reduction peaks because it is suspected that maximum enzyme deposition occurs before this hour is up. The significance of finding the optimal time for enzyme deposition is to ultimately save time. When considering a biofuel cell being used in biomedical sensors and other similar applications, the time needed to deposited enzymes may be a bottle neck in production. Finding the optimal time means more devices can be made, which could in turn lower the costs of such devices.

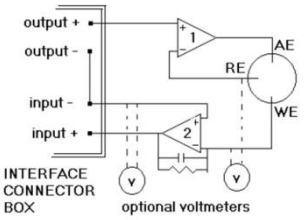


Figure 1: Circuit diagram of cyclic voltammetry. AE, RE, WE are the counting, reference, and working electrodes respectively. 1 is a voltage follower op amp and 2 is a current to voltage converter

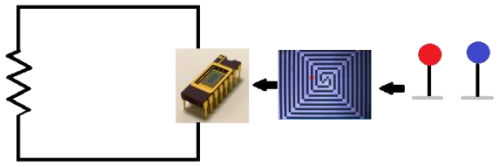


Figure 2: A mega cell containing 3 million pairs of carbon nanotubes functionalized with glucose oxidase and Laccase

Fabrication of a Biodegradable Piezoelectric Scaffold via Electrospinning for Tissue Engineering Applications

Bijin J. Vadasserril, Advisor: Dr. Treena L. Arinzeh, Mentor: Ateka Khader
Department of Biomedical Engineering
New Jersey Institute of Technology, Newark, New Jersey 07102 USA

Abstract: Piezoelectric materials for tissue engineering applications show promise because they can provide electrical stimulation in response to minute mechanical deformation, similar to properties found in native tissue. We have developed a biodegradable fibrous piezoelectric scaffold using the electrospinning technique. The three-dimensional fibrous structure formed acts as a mimic of the fibrous component of extracellular matrix, the environment in which cells attach and grow in the body. In this study, biodegradable piezoelectric scaffolds were fabricated by dissolving polycaprolactone (PCL), a biocompatible polymer, in methylene chloride and adding varying concentrations of the piezoelectric compound (BPC) to the PCL solution. The PCL-BPC solution was electrospun to generate a scaffold composed of fibers having uniform morphology and fiber diameters and interfiber spacing in the micron-range (Figure 1). This geometry is important for cell ingrowth and tissue formation. Fiber characterization was performed using a combination of light and scanning electron microscopy (SEM). An experiment determining the rate of degradation of the scaffold is currently underway. Characterizing the rate of degradation is important in order to establish its potential use in vivo. Findings will support future studies in evaluating cell growth and differentiation.

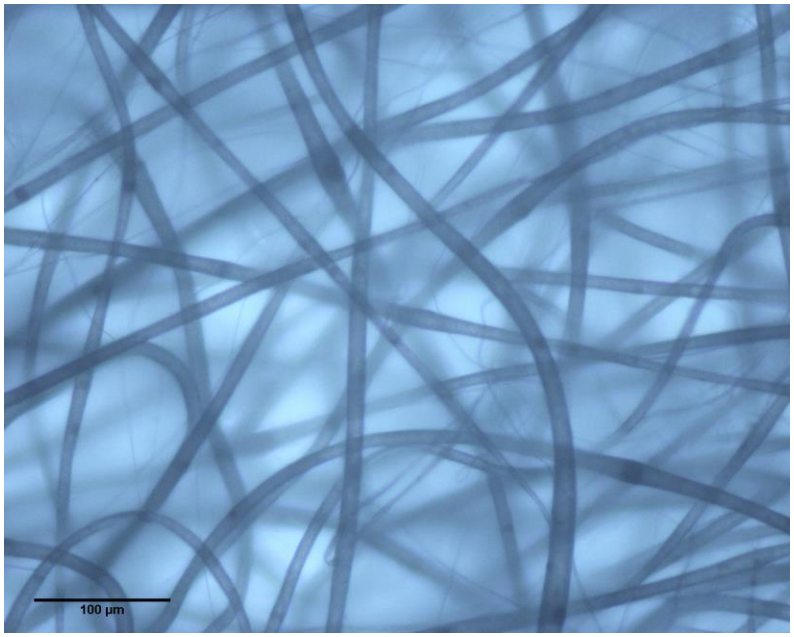


Figure 1: Light microscopy image of electrospun PCL-BPC scaffold (scale bar: 100 µm).

NJ Space Grant Consortium
Summer Research Program

Optimizing Geometries of Terahertz Metamaterial Filters

Christopher Bolton*, John F. Federici* and Caroline Brisson**
*Department of Physics
New Jersey Institute of Technology, Newark, NJ 07102 USA
**School of Theoretical and Applied Science
Ramapo College of New Jersey, Mahwah, NJ 07430 USA

Abstract: The growing need for faster wireless data transfer will soon require the use of terahertz range frequencies. In order to effectively accomplish this, components must be developed to spatially control the amplitude and phase of the electromagnetic (EM) waves. Typically this can be done using metamaterial filters, however it is a challenge to design and fabricate these filters in the terahertz spectrum of electromagnetic radiation. The goal of this project is to model a metamaterial structure which can spatially control the phase shift of a terahertz EM wave over its wave front. A second objective is to determine what geometric properties determine specific attributes of the filter such as the phase shift, resonant peak frequency, and bandwidth of the transmission through the filter. Using the model to design an optimized structure at a specific "design" frequency in the terahertz range, the filter can then be fabricated using additive manufacturing techniques.

In order to determine the ideal geometries, the metamaterial was modeled using Finite Element Method modeling software: COMSOL Multiphysics. Variations in physical dimension and geometric ratios were made, the computed outcomes observed, and all transmission data recorded. Theoretical analytic solutions for the transmission that are associated with the specific shape and pattern of the mesh were used, in conjunction with MATLAB, to confirm this data for the most elementary array of structures.

Future plans include the modeling and optimization of progressively more complex structures, and if proven advantageous, the printed manufacture and assembly. The final structure will be two layers of the metamaterial mesh on their print substrates with a layer of piezoelectric material in between the substrates. The piezoelectric will enable controllable variations in the index of refraction between two metamaterial filters by applying an electric potential. Combining this control with the optimized geometry will result in a phase-tunable filter for a selected frequency with a known bandwidth.

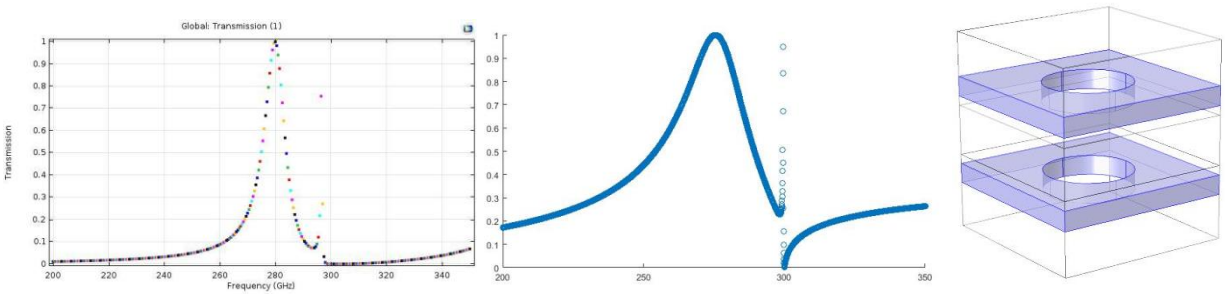


Image: COMSOL data (Left) and the corresponding data given by the analytic solution using MATLAB (Center) from a frequency range 200GHz to 350GHz shows a first resonant peak for given dimensions. Show on the right is a unit cell for the model of the completed filter, the conductive material highlighted in blue. The top and bottom boxes are modeled to contain air.

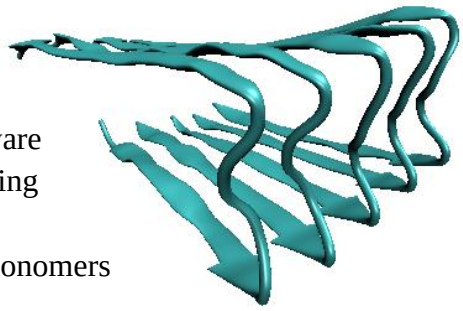
The Role of Urea in the Kinetics of Fibril Formation

Nicole Callen[1], Zhaoqian Su[2], Cristiano L. Dias[2]

[1]School of Theoretical and Applied Sciences, Department Engineering Physics.
Ramapo College.

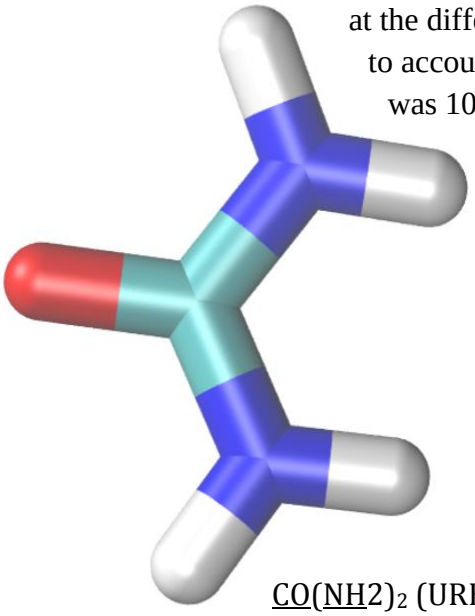
[2]New Jersey Institute of Technology, Newark, NJ

Protein aggregation in the brain, also known as fibrillization, is associated with many neurodegenerative disorders, e.g., Alzheimer's and Parkinson's. My research is centralized around the Aβ peptide (residues 16-21) which aggregates into fibrils similar to the ones found in amyloid plaques in the brain of Alzheimer's patients. Fibrils from Aβ peptides obstruct synapses, i.e., impulses between neurons, causing memory loss. Using the software package GROMACS, I have created a simulated environment containing eight monomers in order to observe the behavior of Aβ aggregation. Conditions in the simulation, such as periodic boundaries, force the monomers to become stretched and mimic aggregation in physical experiments. The solvent around Aβ peptides is an aqueous solution containing urea. The latter is a small molecule known to unfold proteins and it has also been reported to slow fibrillization at a rate proportional to its concentration. My aim is to replicate experimental data qualitatively to provide atomic level insights into the effects of urea in the kinetics of aggregation.



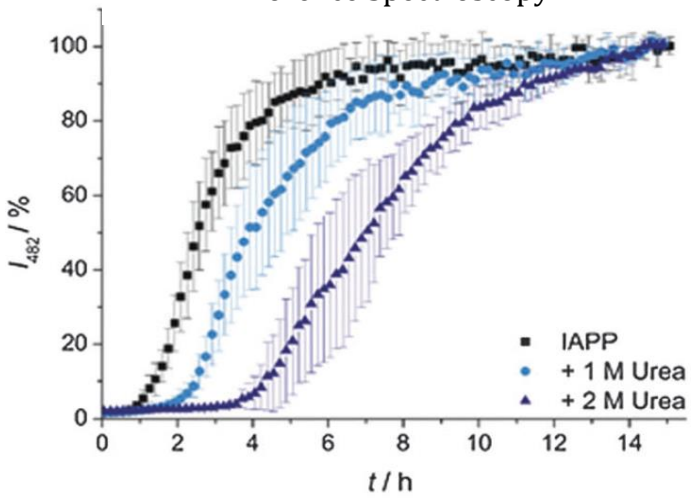
Aβ Peptide Fibril

Simulations were performed at four different urea concentrations. To quantify the aggregation process I counted the number of hydrogen bonds between Aβ molecules in the system at the different urea concentrations. This number was averaged over ten samples to account for proper sampling. Moreover, the simulation time of each sample was 100 nanoseconds. Hydrogen bonds are the primary interactions accounting for fibrils and secondary structures in proteins.



$CO(NH2)_2$ (UREA)

Speed of Aggregation Observed Using Florence Spectroscopy[1]



[1]*Seeliger, J., Estel, K., & Erwin, N. (2013). Cosolvent effects on the fibrillation reaction of human IAPP (R. Winter, Ed.). Phys. Chem. Chem. Phys., 2013,* ***15****, 8902-8907. doi:10.1039/c3cp44412k*

Comparing Different Enzymes to Optimize Power Output of a Biofuel Cell

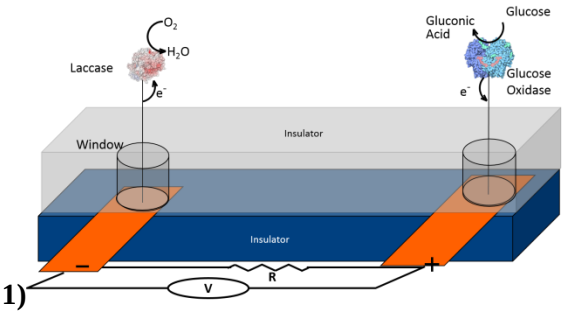
Lindsey Gray, Dr. Alokik Kanwal, Dr. Reginald C. Farrow, Dr. Gordon A. Thomas

Biophysics research group

New Jersey Institute of Technology, Newark, NJ 07102 USA

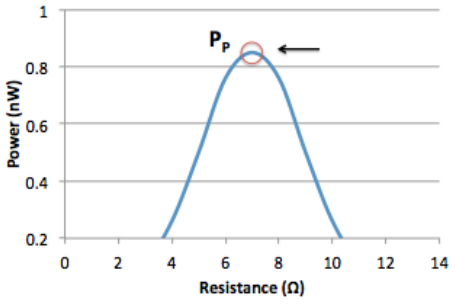
The goal of our experiment is to determine which enzyme combination generates the highest power output in the biofuel cell. Our biofuel cell is a device that currently uses glucose oxidase and laccase enzymes to oxidize glucose and reduce oxygen in order to produce a current, which travels through single-wall carbon nanotubes (SWCNT). As seen in Figure 1, each enzyme is covalently bonded to the tip of a SWCNT. For our experiment, we will be looking at four different combinations of enzymes and SWCNTs: glucose oxidase and a bare SWCNT, glucose oxidase and laccase, glucose dehydrogenase and a bare SWCNT, and glucose dehydrogenase and laccase.

In order to collect the data for each combination, we will be using a Keithley 6517A, which has an input impedance of 200 TΩ, to measure the voltage produced by the fuel cell as a function of load resistance. We will also be using a custom build computer controlled circuit designed to vary the load across the biofuel cell from 100MΩ to 1KΩ in increments. Using Ohm's law, V = IR, and the equation for power, P = IV, we will convert the data to create a graph of the power produced by the fuel cell as a function of the load resistance, as seen in Figure 2. For each graph we predict there will be a peak power output (P_P). The next step is to compare the peak power outputs of the various combinations as seen in Figure 3. By the end of this experiment we plan on finding which enzyme combination produces the highest power output.

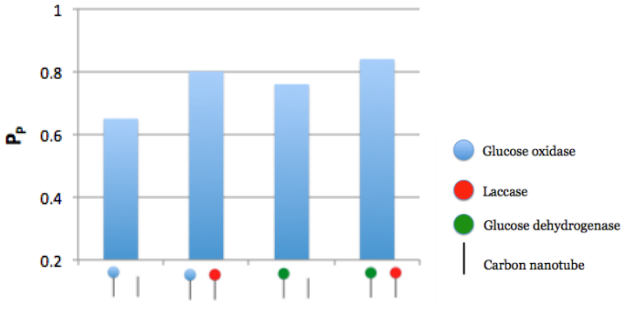


1)

An example layout of a biofuel cell



2)



3)

Predictions of peak power output

Heritage Institute of Technology – NJIT Summer Research Program

Study of Mechanical and Thermal Properties of Semiconductor Nanowires

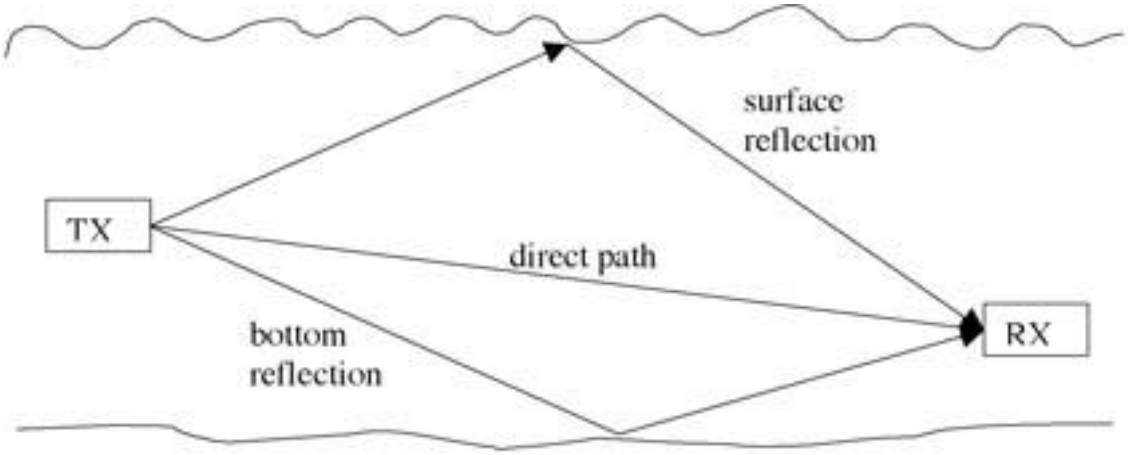
Jishnu Ganguly, Advisor: Dr. Leonid Tsybeskov, Mentor: Xiaolu Wang
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: Due to aggressive device scaling, Gordon Moore's law has been running a tight-rope for over a decade. In such a scenario, a bottom-up approach involving the growth of nanostructures, such as semiconductor nanowires, in which at least one critical device dimension is defined with near-atomic scale precision , often proves to be better than the traditional top-down approach. This paper involves a qualitative study of the mechanical and thermal properties of semiconductor nanowires aimed at shedding light on the stress-strain relationships and thermal conductivity of Silicon nanowires. Questions regarding how the semiconductor nanowires behave under the application of bending strains, their crystalline-amorphous transformations, have been concentrated upon. It has been seen that elasticity modulus of a semiconductor nanowire is independent on its diameter (for diameters greater than 80nm). It has also been seen that despite the anomalous properties of the nanowires, compared to the bulk materials, the size effect does not factor in the anomalistic mechanical properties.

Impact of Environmental Factors on Underwater Communication

Rahul Goswami, Advisor: Dr. Ali Abdi, and Mentor: Erjian Zhang PhD Student
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: Acoustic propagation can be characterized by attenuation that increases with signal frequency, time-varying multipath propagation and low speed of sound. Underwater acoustic channels are considered to be one of the most difficult communication media in use today. Sound propagates through water at a very low speed of 1500 m/s and propagates along several paths. The effect of such multipath propagation is interference at the receiver end which hampers reception of the correct information. There also exists ambient and site-specific noise in underwater fading channels. The aim of this study is to focus on the analysis of the Bit Error Rate (BER) with varying Signal-to-noise ratio (SNR) for Frequency Shift Keying (FSK) modulated signals over various conditions in underwater acoustic channels. With a primary objective of reducing the BER, different sediments are introduced to the underwater acoustic channel.



Multipath propagation in Underwater Communication

Mechanical Characterization of Polymer Composites for Advanced Lithium-ion batteries

Sanjana Pareek, Arnuparp Santimetaneedol and Dr. Siva P V Nadimpalli

Department of Mechanical and Industrial Engineering,

New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract

Polyvinylidene difluoride (PVdF) polymer is used as a binder in Lithium-ion batteries. Electrode particles and carbon powder are held together by PVdF, and it supports the electrical network (or path for electrons to move through the electrodes easier) necessary for battery operation. Failure of PVdF leads to capacity loss of battery. Hence, there is a need to understand the mechanical properties of PVdF-carbon powder composite to improve efficiency of batteries. These properties can be useful in developing accurate mathematical models of batteries.

The thin film, about 50 micron thick, composite samples are prepared by adding carbon powder to N-methyl-2-pyrrolidone solution with PVdF, mixing them thoroughly, and spin casting them. The films are cured in convection oven before testing them. The thin films are to be cut into dumbbell shapes, according to ASTM standard, and tested with a tensile testing machine. Effect of carbon content on the stress- strain behavior of the film was investigated.

Motion control of an insect-bot using spiking neural networks

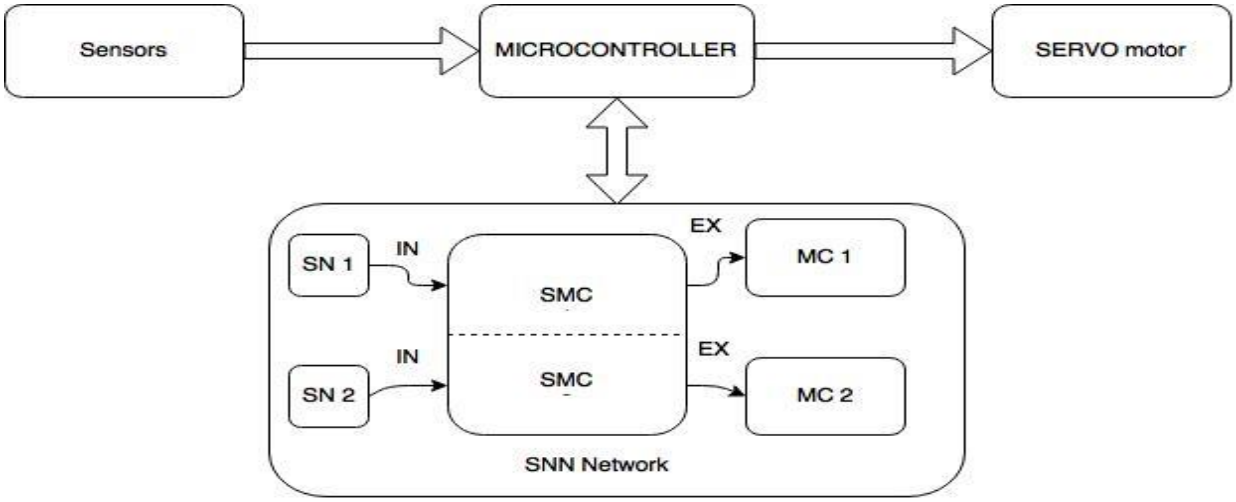
Sambarta Ray, Advisor: Dr. Edwin Hou

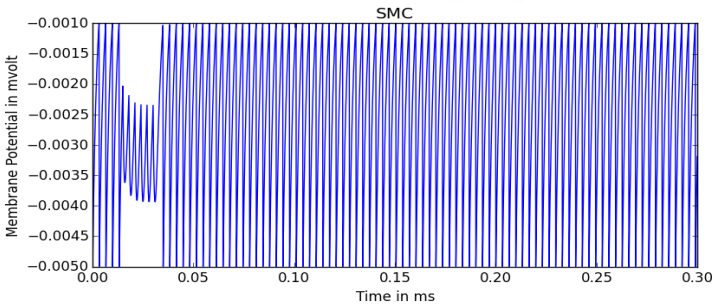
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, NJ 07102 USA

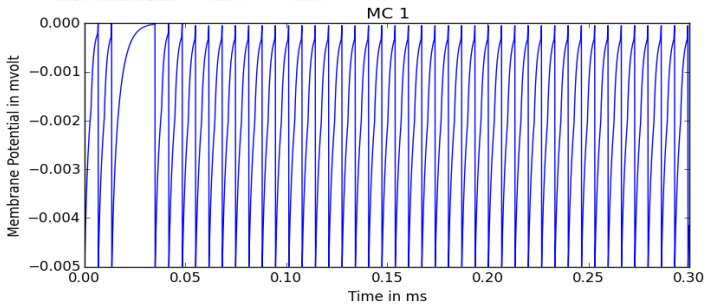
Abstract: Spiking Neural Network (SNN) is a third generation neural network which is highly inspired by the computational power of biological neural networks. They derive their characteristics from the accurate modelling of synaptic interactions between neurons, taking into account the timings of the spike firing. The presence and the timing of individual spikes are considered as means of communication and for neural computing.

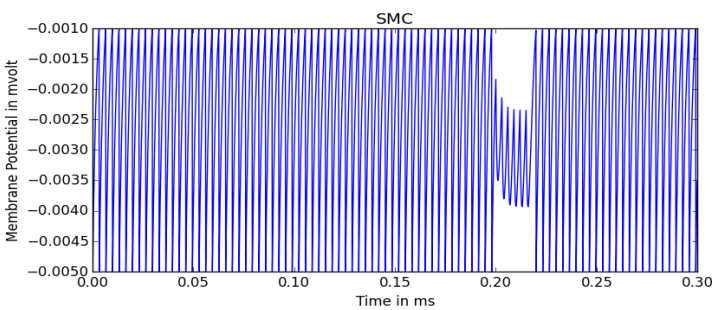
This research will propose a system where the computational power of SNN will be used to control the movement of an insect robot. The system consists of a microcontroller board, a servo motor and two sensors. The system will be able to detect the walls on both sides and send the information to the SNN network. The SNN network will then be able to send inhibitory signals to the motor and make it turn to avoid the walls.

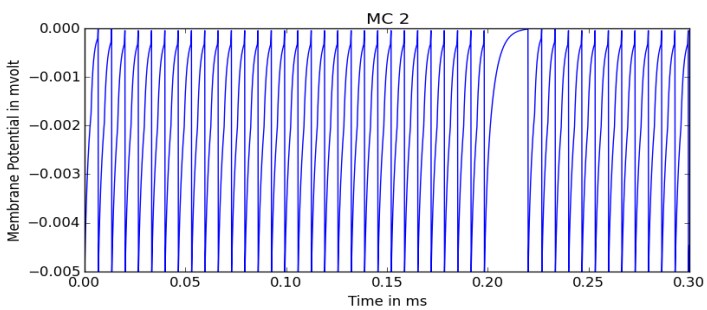
The system is described in the following way:











Massive MIMO Beamforming

Indrasis Roy, Advisor: Dr. Alexander Haimovich, Mentor: Haley Kim, PhD Student Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: MIMO stands for Multiple Input Multiple Output systems. *Massive* MIMO, or large scale antenna systems makes a clean break with current practice by the use of large excess of service antennas. The use of a large number of antennas enables to focus its energy in a small region of space and bring huge improvements in transmitted data throughputs and radiated energy efficiency. In this paper we will discuss Massive MIMO and the ways and methods to detect a target at a certain position. In particular, we will implement the use of beamforming techniques in Single Target, Multiple Target, MIMO and finally massive MIMO systems and discuss the constraints and future work in the implementation of Massive MIMO in communication technology.

In this paper we will try to implement beamforming, in massive MIMO. Since resources are limited, it is important to efficiently allocate the resource. Massive multiple-input multiple-output systems can provide a high degree of freedom in signal transmission, enabling to simultaneously serve a number of users with high transmission capacity. Conventional techniques can transmit multi-user signal while completely cancelling out noise and other interference. However, they may have implementation difficulty when applied to Massive MIMO systems mainly due to huge processing complexity. We use linear beamforming techniques to overcome the complexity problem and to locate the position of the target(s), taking into account the concept of a Virtual MIMO Array. In this paper, we will process the received signal with a phase change first by the use of steering vectors, to align the target waveforms and then finally the summation operator will be carried out to achieve the desired beampattern which is plotted as a function of the power of the signal versus the sine of the azimuth angle. We will show how a massive MIMO works more effectively in modern communication technology when compared to conventional MIMO and other SIMO (Single-Input Multiple-Output) systems.

Intelligent Task Repeatability of an Industrial Robotic Arm

Saunak Saha and Amitangshu Mukherjee, Advisor: Dr. Sanchoy K. Das, and Mentor: Babak Hoseini, PhD
Department of Mechanical and Industrial Engineering
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: Industrial robots are increasingly being used to perform intelligent tasks such as precision assembly, machine control interactions, and switching system activations. The ability of a robot to repeat a certain task indefinitely with minimal error is a measure of its repeatability and a key determinant of its performance in a given task. The goal of this research is to devise a unified formula to determine the repeatability of a "Lab Volt 5200" Robotic Arm in an experiment designed to simulate keyboard entry tasks. The keyboard entry task is used a surrogate for intelligent task functionality in general. The robot arm is programmed to type a predetermined character string by using its servo-controlled motion to reach the target key. The main obstacle in such an operation is the deviation of the acquired target from the expected target. This value of Deviation is seen to vary according to three factors, (i) Speed of movement, (ii) Complexity of motion and (iii) Number of experimental trials.

16 experiments, each with a 2-level factorial were designed and run in random order. Task error was measured by the percentage of characters missed. We analyze the errors occurring with respect to the combined variation of these three effects. The Standard Deviation of the acquired target serves as a tentative response factor for repeatability of the arm. Eventually, The Analysis of Variances (ANOVA) of these values provides us with noise-less coefficients against each factor and their combinations. The resulting Regression equation gives us the value of Repeatability of the Arm with as high as 96.67% credibility.

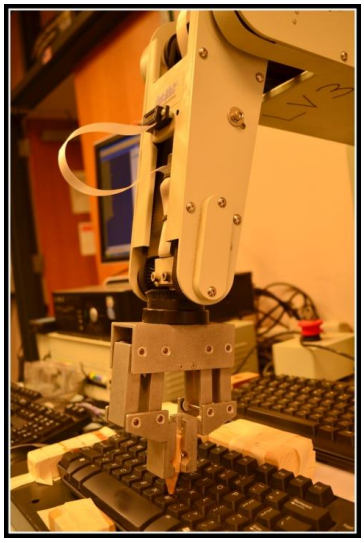


Figure 1: Lab Volt 5200

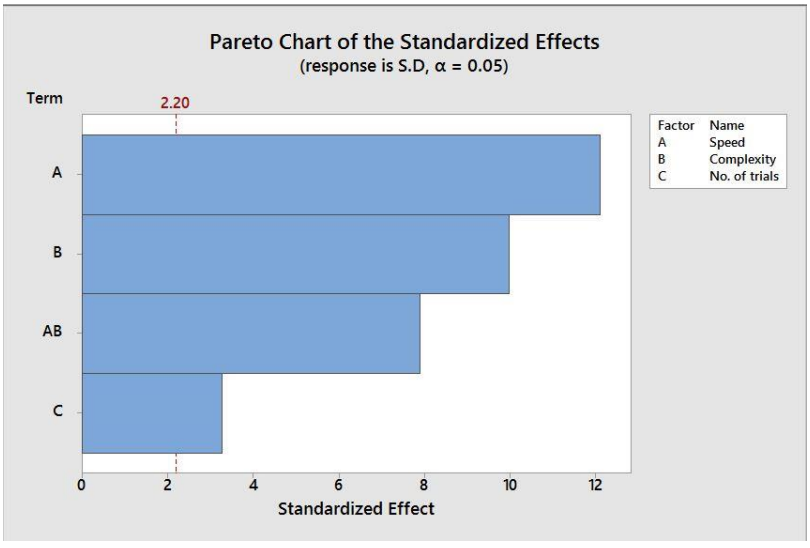


Figure 2: Pareto Chart for the final Regression Equation

Experimental Enhancement of TPM-based Authentication Mechanism for Apache Hadoop

Aditya Sanyal and Zouchao Dou, Advisor: Prof. Abdallah Khreishah

Abstract: Apache Hadoop is an open-source software framework for distributed storage and distributed processing of very large data sets on computer clusters built from commodity hardware. The core of Apache Hadoop consists of a storage part and a processing part. Hadoop splits files into large blocks and distributes them amongst the nodes in the cluster. A Hadoop System basically consists of a single master node and multiple slave nodes and the master communicates with the slaves individually and there can be intercommunication between the slaves as well. However the problem that lies with this system is that the network is not secured, which means, it is exposed to malicious attacks from outsiders who wants to access internal information of plant a virus in a network. To overcome this, The Hadoop Security design uses a computer network authentication protocol known as the Kerberos Protocol. The Kerberos Protocol works on the basis of 'tickets' to allow nodes communicating over a non-secure network to prove their identity to one another in a secure manner. These tickets are usually granted by a Key Distribution Center(KDC). However the Kerberos Protocol also had some drawbacks. The main drawback was that if the KDC was compromised or it crashed, the entire network would be exposed to outside threats. One of the main problems was that it is dependent on passwords, and the session key for the communication during the initialization is derived from the user's password. It was seen that these passwords were easy to break, due to hacking or lazy selection of passwords, thus compromising the integrity of the system. Also encrypting similar passwords into similar ciphers proved to be a problem. To overcome these problems, Hadoop devised a more complicated authentication mechanism, which proved to be highly complex and difficult to configure. Another problem that was encountered was the dependency on a third party to issue security keys. If anyone other than the proper user gained access to the key distribution centre the entire network would be compromised. To overcome this problem, TPM-based authentication mechanism for Apache Hadoop is being developed.

The full form of TPM is Trusted Platform Module. It's a dedicated microprocessor designed to secure hardware by integrating cryptographic keys into devices. Most of the computers have this chip built in the motherboard itself. So the objective is to use this TPM-chip to develop a secure authentication mechanism for Apache Hadoop. TPM offers facilities for the secure generation of cryptographic keys, in addition to a random number generator. We use the TPM because it basically creates images of the original configuration in the software or hardware and then it checks with that image whether it is the same or not. This is of great help as it verifies whether software or hardware has been tampered with or not. This is what we are looking for while developing the TPM-based authentication mechanism.

What we have to do basically is to implement a baseline Hadoop System using virtual machines, with 1 master node and preferably 2 slave nodes. After this is done, the Kerberos Hadoop system and then the TPM-based Hadoop system will be implemented as well. After these systems are implemented successfully on the virtual machines, they need to be deployed in real machines. After that, numerous tests and simulations are needed to be performed to check whether protocol is running correctly and conduct performance comparison among these 3 systems. This is what I intend to do for this project.

ALD High-K Gate Stacks for Next Generation CMOS Technology

Prashant Vurikiti, Rudrarup Sengupta, Dr. M.N.U. Bhuyian, and Dr. Durgamadhab Misra
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: As transistors are becoming extremely small in area, the gate oxide (SiO_2) has to be thin for high performance. Since decreasing gate oxide thickness results in exponential increase in tunneling probability, there is a significant leakage current through the gate. The leakage current results in greater power consumption. Hence high-k dielectrics are used as gate dielectrics to limit the leakage current, while compensating the capacitance value of the thin gate oxide. Initially, HfO_2-based high-k gate dielectrics were used. To reduce the equivalent oxide thickness (EOT) various new composite dielectrics are used. This work is based on leakage current analysis of $TiN/Hf_{1-x}Al_xO_y/SiO_2/Si$ gate stacks, where high-k layers were grown by Atomic Layer Deposition (ALD) followed by post-deposition annealing at 800^{o}C. The structural modification of HfO_2, is a promising method to increase its dielectric constant. In this study, the structural modification of HfO_2 has been effectively done by doping it with Aluminum. High temperature leakage current analysis (50^{o}C to 125^{o}C) proves that an optimized $Hf_{1-x}Al_xO$ is superior to HfO_2 as optimized Al concentration in the high-k stack gives lower leakage currents, at higher temperatures (Fig. 1). Additionally, high carrier mobility channel materials like Germanium along with high-k gate dielectrics is currently being introduced for faster device, with relatively lower leakage current, depending on the interfacial layer growth method. In this work we have also evaluated $TiN/Al_2O_3/ZrO_2/GeO_2/Ge$ gate stack's performance for three different interfacial treatments prior to high-k deposition (Fig. 2).

Faster battery drainage is the common problem of all nanoscale transistor devices. Analysis of the high-k samples indicates that, optimized $Hf_{1-x}Al_xO_y$ for Si stack, and SPA Plasma interface treatment technique for Ge stack, provides a lower leakage current. This ultimately hints at a better power efficiency for low power CMOS transistors.

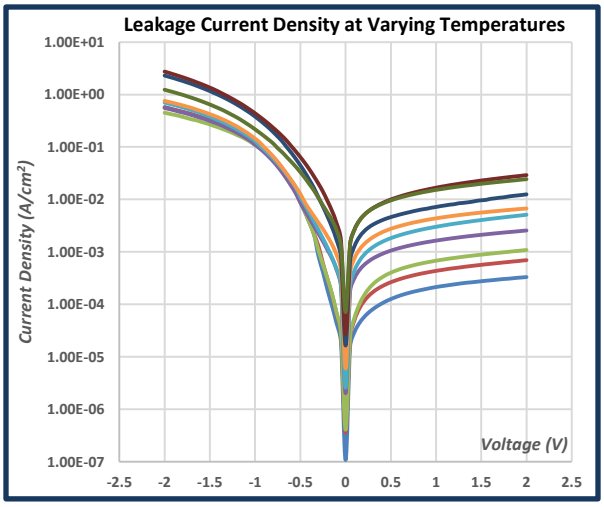


Fig 1 : Leakage Current density is plotted against voltage for the Si-substrate stack at varying temperatures ranging from 50 degree Celsius to 125 degree Celsius

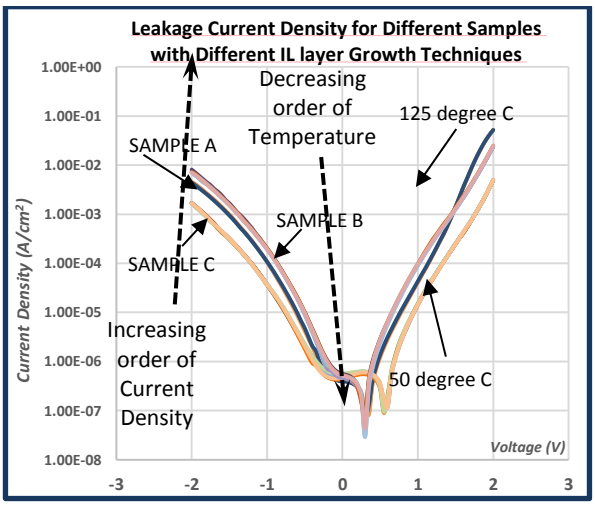


Fig 2 : Leakage Current density is plotted against voltage for the Ge-substrate stack for three different samples with different IL layer treatment techniques

Lean Startup Accelerator Program

AK Scripting - Premium Quality Scripts for Bot Software

Jose Andrew Gonzalez

Computer Science Undergrad

New Jersey Institute of Technology

AK Scripting is a software company focused on providing players of the popular MMORPG (Massively Multiplayer Online Role Playing Game) Tibia with reliable scripts for the hot botting software available to them. Botting software, or just “bots”, are carefully crafted programs that allow a player to automate actions to allow them to either improve their playstyle or to allow them to advance in game without investing too much of their time. The scripts AK Scripting will provide, at a competitive price, custom LUA scripts that these bots use to automate characters in-game. The scripts will tell the bot where to go, what to buy or sell, and what to kill. In addition to the basic functionality expected of a bot script, a custom heads up display (HUD) will be attached to every script sold, allowing the player to inquire about the profitability of a particular character at a glance.

There is always room to improve when it comes to automating players. Soon the scripts players purchase will be fully autonomous and ready for use right out of the box. All configuration will be done on the fly by the script itself, pushing even more performance out of a character. Compatibility with a specific bot software, WindBot, will allow certain scripts to cooperate together on different characters using their Navigation Server feature; this allows for more intense profit and experience gain. As the company grows and gains popularity among the community, expanding to other games is expected. Possible candidates being World of Warcraft, Diablo 3, Neverwinter, and Guild Wars 2.

```
    -- [[ SETTINGS ]] --

Config.Vocation = 'druid'

Config.Backpacks = {
    ['1. Supplies'] = 'Camouflage Backpack',
    ['2. Rares'] = 'Brocade Backpack',
    ['3. Stackables'] = 'Fur Backpack',
    ['4. Gold'] = 'Red Backpack' -- Needs to be always last
}

Config.Potions = {
    { name = 'mana potion', max = 150, min = 50 }
}

Config.Options = {
    ['Sell-Gems'] = true
}

Config.Sell = {
    ['gems'] = { 3030, 3033, 9057, 3029, 3033, 3032 }
```

Greek life Social Media Database for Connections and Job searches

Maxwell William Miller
School of Management Marketing
New Jersey Institute of Technology, Newark NJ 07102

Abstract: We all have had that moment in our lives where we scared of whether or not we would get a job. We do everything in our power to help ourselves. Some people join Greek organizations, 9 Million Americans to be exact. What my goal for this business is to create a social media platform where members of Greek organizations will have a database to interact with other Greeks of all ages. Focusing on the point of having the younger generation reach out to alumni who have or had careers in there desired field of study. A Greek organization is not just depicted in a social setting there are many more types of there organizations; some are charitable, national, or even secretive. Connections database will have a mobile platform for IOS and android as well as a web page. Having this database for all Greek organizations is a pivotal part in keeping the organizations heritage strong. Having a detailed list of alumni and contact information can make a large difference in a graduating students career. The importance of this database of profile for a chapter as a whole as well as its representative will enhance the Greek community's contact with one another and make accessing other chapter's history easier for each organization.

greekconnections.com

A Lean Startup Approach to a Component Based Content Management System (CMS)

Roberto Moller Computer Science student

New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: Content Management System Applications (CMS) are web systems that simplify several web tasks on the internet, a CMS user among other things can insert, delete, and update web-based content online and offline. Such a system is paradigmatically designed as a centralized platform in which potential users would have access to predefined features that can be used to build online content, for example: websites, or web applications. In this aspect the most popular systems provide a variety of features that despite their usefulness are bound to the constraints and limitations that the system is based on, for instance, programming language, web framework, or database engine. These constraints have presented themselves as an opportunity to provide an alternative to the traditional CMS. Therefore, with a business approach and invoking the Lean Startup methodology our company "205ventures" has designed a Components Based Content Management System, in which features are components that are language, and framework independent. These components are designed intelligently based on the host application or website needs. The requirements for a web component will be enumerated to our system which will pull dependencies from a large repository of code modules that can be put together to create a feature a user may need. The components are designed to be independent and autonomous, therefore allowing users to plug-in or plug out features that are needed or not. With this system we seek to relief users of the constraints created by providers that are limited by certain programming languages or technology.

The Point: Tapas Restaurant and Sports Bar

Christian Albert Monal

School of Management

New Jersey Institute of Technology, Newark, NJ 07102

Abstract: Recently, Bergen County has had many new bars and restaurants open up in the area. Now although some of them seem to be doing well, the majority of them won't last over a year. It's not that they don't serve good beer or food; it's that they are competing against the same type of bars and restaurants all over the county. My idea is to open up a Tapas Restaurant and Sports Bar in Lyndhurst. At this moment, Bergen County doesn't have any Tapas bars in, or around the area. To find a good Taperia around here you have to go to Newark or New York. My Taperia will serve Caribbean and Brazilian Style Tapas and over twenty different types of Craft Beer. At the same time, we'll be viewing local and worldwide sports on our various Plasma Television screens. With optimal seating from our bar stools, to our leather booths, what's not to like. So come on in and sit with us for a while, our bartender, Jayme, would be more than happy to make you one of his famous Caipirinha's from scratch. Be sure to try our fan favorite Cuban style Croquetas, and our Brazilian style Churrasco.

THE POINT

Floss Thimble - Designing a More Environmentally Friendly Solution to Flossing Inside and Outside Households

Lawrence Njume, Moka Co., Advisor: Dr. Michael Ehrlich

Abstract: This project's initial concept came from the realization that floss as a standalone product, that doctors recommend daily use of, does not have an adequate bathroom equivalent to a toothbrush & toothpaste combo. Other than a package of plastic floss picks, which individually have limited use and are bad for our environment, user are left to struggle with their floss by hand. The absence of any type of reusable product lead to the designing of the Floss Thimble. The Floss Thimble can be treated as a tool like a toothbrush would be, and at which point floss is treated as a commodity like toothpaste. We wanted to design something simple, reusable, and viable outside a person's home as much as it is inside. The Floss Thimble will be portable and roughly the size of an okay gesture that way it's easy to find and easy to store when outdoors. This summer's research has yielded the best methods to penetrate a market that has remained unchanged for such a long time. The Floss Thimble will use regular floss that is tied between the tip of a finger and its first knuckle, and will be flexible enough to fit a thumb or index finger. It's aimed to help the general population heed their dentist's advice as studies from the CDC show that about half of the US population suffers from some form of gum disease from inefficient dental hygiene.

DIY Auto Garage

Keyur J. Patel, Advisor: Dr. Michael Ehrlich
School of Management

New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: These days, consumers are doing their best to purchase an affordable car that's easy on gas, easy on maintenance and mainly easy on cost for repair. People purchasing new vehicles in this country has been on a rise. The United States is not a third world country. We use a car as a means of transportation rather than a scooter or a motorcycle like other countries would. This means added cost for repair and service. The more cars in the country the more dealer tend to make money off them. Taking a car to the dealers these days can be a very stressful task. From scheduling an appointment to waiting while your car get serviced, its takes a toll on people's lives. What we are trying to create is a brand new market for people that need car servicing at an affordable rate. We will be introducing a new system, either you can do it on your own, have some help from a certified car tech, or have the tech work on your vehicle for a much cheaper rate than what a dealer might charge you. SAVES YOU TIME AND MONEY. Do it yourself is the motto for this business, and if you can't, we will help you.

Gourmet Ice Cream With a Classic Feel

With A Cherry On Top

George Smith, Advisor: Michael Ehrlich

New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: Kids running after an ice cream truck eager to buy their favorite frozen treat is a sight that is slowly dying. With A Cherry On Top looks to bring back this classic experience, while offering a vintage flair and providing gourmet frozen dessert in a street vending setting. An elaborate vintage ice cream truck will be providing gourmet ice creams, gelatos, and tartufos to the general public. Customers will receive their desserts from a server that will be wearing classic ice cream man apparel. By doing this I hope to create recurring consumers because of the delicious frozen desserts, and classic nostalgic environment.

IceBreaker App

Terrence Smith, Advisor: Michael Ehrlich

New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: The IceBreaker App is an developing free app that focuses on help those that have an hard time starting a convocation or breaking that awkward feeling in any situation. We provide questions and actives one can do in order to feel more comfortable in their situation rather its at a party, a class setting, a first date, holiday events, the list goes on. As of now we are mainly focusing on college students, according to the Washington post, more than 1,800 students die every year of alcohol-related causes. This is one of the reasons this app is under development, we want to cut down on the number of alcohol-related deaths that accrue yearly in America. With this app parents and loved ones will have to worry less about their college student drinking to much, because this app helps everyone feel more comfortable and will not have to use the same amount of substances they would to get comfortable.

Your Business

Harekrishna Tripathi, Advisor: Dr. Michael A. Ehrlich
School of Management
New Jersey Institute of Technology, Newark NJ 07102 USA

Abstract: In today's generation 89 percent of consumers use search engines for purchases or services they are looking for. It has becomes a necessity for small businesses to have an Internet presence. Search engines such as Google, Yelp, and Bing are the primary drivers for Internet marketing. According to the Small Business Administration, "Immigrants are found to have higher business ownership and formation rates than non-immigrants. Roughly one out of ten immigrant workers owns a business and 620 of 100,000 immigrants (0.62 percent) start a business each month." It can become very difficult for the immigrants who speak English as second language to promote their business online. Since there is a language barrier among the immigrants who run a small business in the United States, I have come up with the idea to start an SEO firm that will help foreign language business owners promote their business online. "Your business" will educate business owners the importance of Search Engine Optimization and how it will help them build an Internet presence and grow their business. This will be done through tutorial video(s), so it will help them understand the importance of Keywords on their webpage, and regular social feed updates. We will be targeting English, Spanish, Mandarin, and Hindi speaking small business owners. The way we will market this concept will be through online newspaper(s) that have high traffic in the respective language.

Pulchritudinous Extensions

Hair is the New Accessory!!!

Somali Wright, Advisor: Michael Ehrlich
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: Pulchritudinous is Latin for beautiful, every woman wants to look and most importantly feel beautiful! My idea to start a hair extensions company came from my own thinning hair, having thin hair or suffering from hair loss can most definitely crush your self-esteem. Over the years I always wanted full hair, and I thought hair extensions would be a great solution to my problem. Hair extensions made me feel more confident and beautiful and that's what I believe every woman should feel like.

My goal is to provide 100% virgin hair extensions, wigs, toupees and clip in extensions, through e-commerce and gradually open a store front. There are so many people who are insecure about their hair, my target market are people like me who suffer from hair loss, cancer patients, alopecia aerate, trichotillomania, and many other causes for hair loss. Another target market is African American Women, African-American women make up 70 percent of the hair extension market. There are 10,000 beauty supply stores that specifically target African-American consumers, only 1 percent of these beauty supply stores are owned by African Americans.

What people may not know is that people wear extensions for other reasons besides medical. Celebrities like Beyoncé', Kim Kardashian, Nicki Minaj, Taylor Swift, Britney Spears, etc. are prime examples of that. The hair industry is a Multibillion dollar industry, and what I can provide is 100% virgin hair extensions that will look and feel as if it's your own natural hair. Hair extension textures will consist of, Straight, Wavy and Curly and lengths will be 8inches-32inches, you can also have your hair custom colored upon arrival. I hand pick my extensions so that it matches the texture of my customers hair perfectly, unlike local beauty supply stores that sells hair that will only last you 3 months, my hair is guaranteed to last you 2 years with proper care.

Look Beautiful, Feel Beautiful, Be Beautiful… Pulchritudinous

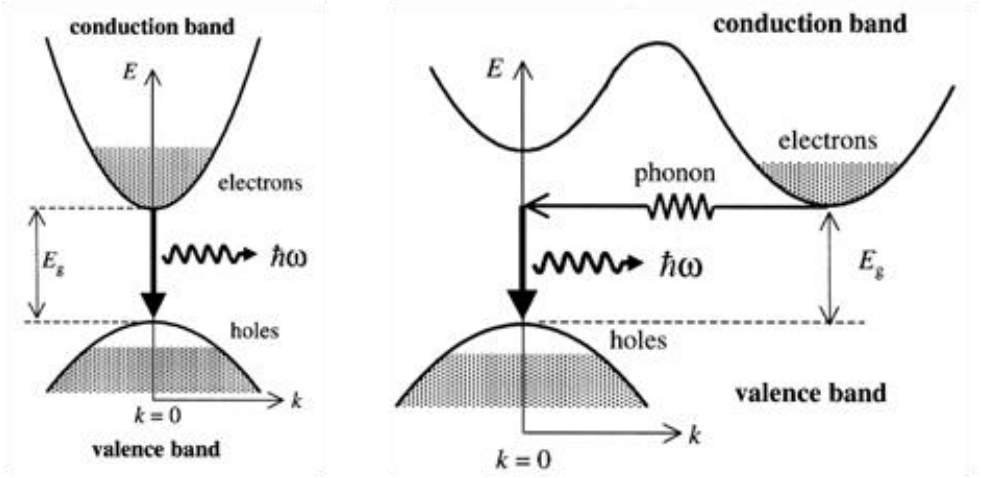
Brazil Scientific Mobility Program

Light Emitting Devices

Cassia Carvalho Calaço and Dr. Durgamadhab Misra
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark NJ 07102

Abstract: The goal of this study is to understand how the process of light emission works on devices made by semiconductors. In order to understand the process, we need to take a look in the crystalline structure of a semiconductor. The most important part in this study is the valence band, the conduction band and the difference of energy between this two bands, called bandgap. At room temperature some of the electrons on the valence band are able to jump to the conduction band, so the atom can conduct current. Eventually these electrons will lose energy and come back to valence band and recombine with the holes that they leave. When the minimum energy of the conduction band lies directly above the maximum energy of the valence band in momentum space energy, the semiconductor have direct band gap (Fig. a). But if the minimum energy in the conduction band is shifted by a k-vector relative to the valence band, the semiconductor have indirect band gap (Fig. b). There are two types of recombination, the radiative recombination that will emit a photon (direct band gap) and the non-radiative recombination that will generate heat (Indirect band gap). The way that the electron come back to the valence band will determine if the semiconductor emit light or not. Which means that when the electron needs to come back to the valence band, it will not change the amount of momentum just the quantity of energy, and in order to obey the principle of energy conservation the electron will emit a photon. The compound semiconductors (III-V) mostly form the direct band gap materials. By varying the composition the band gap can be modified and subsequently the wavelength of the emitted light can be defined.

Reference:



(a) direct-band-gap structure

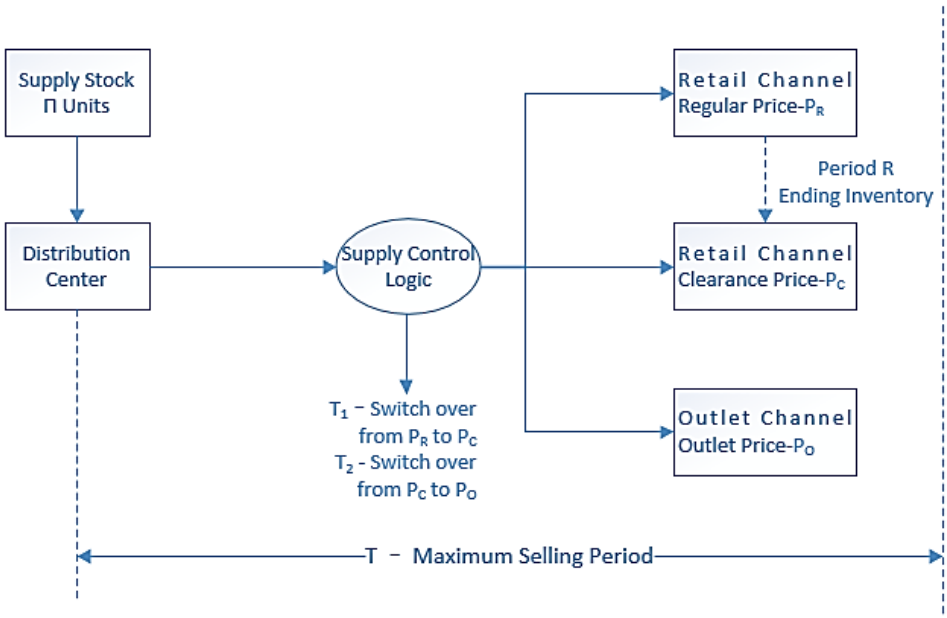
(b) indirect-band-gap structure

http://www.laserdiodesource.com/images/figure-5.png

Descriptive Modeling of Channel Switch Overs in a Fast Fashion Supply Chain

Paula Camila Dias Portes, Advisor: Prof. Sanchoy Das,
and Mentor: Jingran Zhang, PhD Student
Department of Mechanical & Industrial Engineering
New Jersey Institute of Technology, Newark, NJ 07102 USA

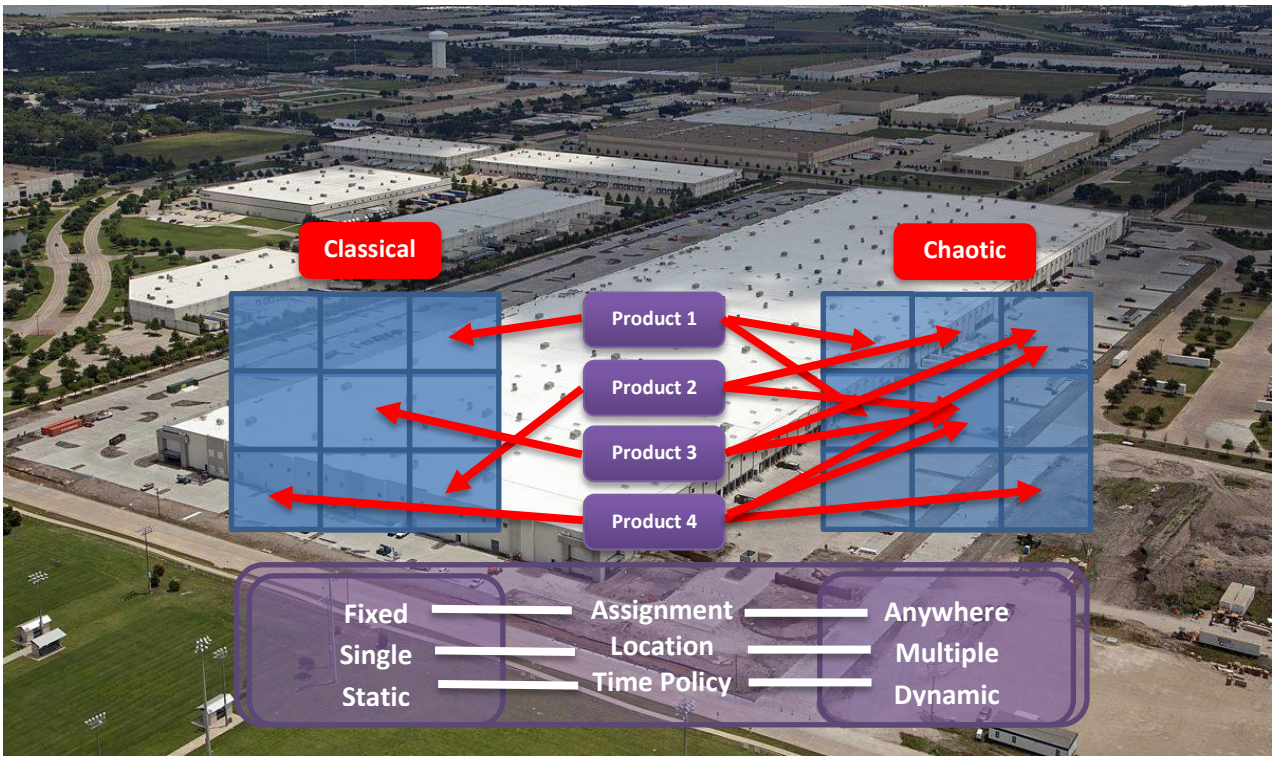
Abstract: We consider a fast fashion supply chain in which Π units of product are to be sold in T time periods, through three distribution channels. These supply chains makes sequential switch overs between the channels: (i) Regular retail with selling price P_R (ii) Store clearance with selling price P_C and (iii) are Outlet retail with selling price P_O. A fast fashion system combines quick response production capabilities with enhanced product design capabilities to both design "hot" products that capture the latest consumer trends and exploit minimal production lead times to match supply with uncertain demand. The focus is on modifying the ordinary supply model to generate a new replenishment policy (Q, R) with reducing the response time to uncertain demand and an appropriate switching control policy with maximizing selling profit during selling season. Demand forecasting is a critical issue in a fast fashion supply chain, and we define demand by an integrated moving average process with exponential-weighted moving average used for forecast, with three parameters (i) initial purchase ratio (ii) channel discount (iii) decelerating rate. Therefore, a descriptive simulation model is elaborated by two decision variables – the switch time $\{T_1, T_2\}$ with results showing the tendency of objectives, sales revenue TR and marketing rate S. Further a sensitivity experiment on objective curve affected by demand simulation parameters will be shown. Using a simulation model we show that the objective function is concave in nature as a function of T_1 and T_2.



Simulation Analysis of Chaotic Storage Policies in Amazon Class Fulfillment Centers

Leonardo Mattos, Advisor: Prof. Sanchoy Das, Mentor: Sevilay Onal, PhD Student
Department of Mechanical & Industrial Engineering
New Jersey Institute of Technology, Newark, NJ 07102 USA

This research focuses on an evaluation of storage policies in Amazon Class Fulfillment (ACF) Centers. These are designed primarily to serve internet based retail with a same day shipping objective. ACF centers differ significantly from classical warehouse design in that they implement a chaotic storage policy. In traditional warehouses for each SKU the location is predetermined and generally one-to-one fixed with a static transaction time between consolidations. In chaotic storage approach, space utilization is assumed to be very close to 100%, and all locations have equal access probability so that available locations can be randomly selected equally likely from any of the storages within the warehouse. Therefore, transaction time in a warehouse that uses chaotic storage policy is dynamic. Consequently, using chaotic storage policy may lead us shorten the overall response time by using randomly storage policy and picking homogenously interspersed items within the warehouse. We simulated both approaches to and compared some performance measures such as average fulfillment time.



Civil Engineering Summer Research Program

Community based Pollution Prevention in Construction Industry

Bruno Bezerra De Souza, Bárbara Sanches Aguiar and Samuel Hussin Couto,
Nelson Augustine and Jay N. Meegoda

New Jersey Institute of Technology, Newark, NJ 07102 USA

Pollution can be seen as a deficiency in the production process of a company as generating residues of any kind that may contaminate the environment. The pollution prevention aims to reduce or eliminate pollutants at the source thereby reducing waste and saving money. The goal of this project was analyze the construction industry production process and assist them with suggestions to reduce waste and pollution, as well as to reduce the overall cost. This research involved providing voluntary services to three companies in construction industry in Newark and Jersey City. The efforts involved finding companies in construction industry that would accept our services, performing a general survey of the company to assess the pollution prevention needs and a detailed survey by performing a walk through. One such company was Newark Industrial Spraying, specializes in paintings using spray-applied. The main method used is powder coating, where the ink is in the form of dry powder instead of liquid. When a piece is painted with powder, it receives an opposite electrical charge to the part, causing the powder attachment on the piece. After this procedure, the piece is brought into heat, and when this happened, the ink liquefies and subsequently hardens, forming a film of high-end, uniform and strength. We have completely analyzed the production process and provided pollution prevention designs to reduce pollution and also for company to reduce production cost.

Community based Pollution Prevention in Auto Repair

Andre Flizicoski, Andrew Camara, Iury Gonzaga, Lucas Nunes, Rodrigo Bragatto, Anthony Bassett, and Jay N. Meegoda
Department of Civil and Environmental Engineering,
New Jersey Institute of Technology, Newark, NJ 07102

Pollution Prevention (P2) refers to practical process, techniques and technologies to eliminate pollutants volume, toxicity and concentration. It includes changes in equipment, processes, procedures, redesign of products, and raw materials. The automotive repair is one of the industries that generates waste. Such waste would be generated from service stations with service bays, vehicle dealerships, mechanical and collision repair shops, towing services, vehicle recycling operations, radiator repair shops, quick lubes and trucking firms. This research involved providing voluntary services to five auto repair companies in Newark and Jersey City. The efforts involved finding auto repair companies that would accept our services, performing a general survey of the company to assess the pollution prevention needs and a detailed survey by performing a walk through. This presentation describe the details of one such pollution prevention design for one company in Newark.

A Low Cost Family Water Filter for Developing Countries

Patrick DeLong Bruno Bezerra, Janitha Hawa Betagoda, Jay Meegoda and Wen Zhang
Department of Civil and Environmental Engineering,
New Jersey Institute of Technology, Newark, NJ 07102

The New Jersey Institute of Technology is working to develop a low cost family water filters for developing nations. The filter will remove pathogens as well as pesticides and heavy metals such as Pb, Cd, and As in drinking water due to the application of agricultural chemicals. The aim is to use the locally available materials such as bio-char, charcoal and hematite found in the developing nations for the development of low-cost clay-pot filters. Design: The design of the compact clay-pot filters involves the impregnation of locally available additives such as bio-char, charcoal and hematite. Proposed filters will be a variation of the clay-pot filters that were previously developed for Milot, Haiti by our research team. The outstanding capabilities of hematite and magnetite for heavy metal absorbance, active carbon of charcoal or bio char for organics removal and colloidal silver in clay-pot technology for pathogen removal will be integrated for water purification. The amount of additives, thickness of filter and the pore structures of the filter will be varied to optimize the removal efficiency. Particularly, the pore structure of the filter will be varied by the addition of saw dust, which will be burned inside the kiln to produce micro-pores. Sustainability: The proposed filter is fully sustainable designed with the ability to purify water at affordable costs. The production is a low energy process where agricultural waste will be combusted in the Kiln to heat the air dried filters. The filtering system will have the capability to operate under adverse economic, social, and environmental conditions. Assessment: The design will be evaluated in terms of the removal efficiency of pathogens, organics and heavy metals in the raw water to be filtered through. A surrogate mixture of pathogens, organics and heavy metals representing drinking water from North Central Province of Sri Lanka will be used for the above evaluation. We will also perform a qualitative assessment to monitor the life improvement of the areas where heavy metals in drinking water have severely impacted the lives of the communities in developing nations. Education: The project will educate NJIT students involved; specifically they will learn concepts of sustainability through research and through the instructions by the principle investigator. Students not directly involved will be educated by other forms such as workshop series. The proposed design requires the coordination of interdisciplinary expertise from civil, environmental, and chemical engineering.

Community based Pollution Prevention in Auto Body

João P. Puccette, Laise Gobira, Luiz Vieira, Macgayver Marques, Patricia Alves,

Darian Capellan and Jay N. Meegoda

Department of Civil and Environmental Engineering

New Jersey Institute of Technology, Newark

This research program intend to help companies in Newark and Jersey City area that have limited knowledge about pollution prevention and the potential economic benefits of using new approaches and technologies to reduce waste while they can also reduce the use of solvents, hazardous materials, etc. The auto body shops are one of the industries that generates waste. Those companies usually perform the same type of job such as: sanding, painting, welding and different auto repair jobs. This research involved providing voluntary services to five auto body shops in Newark and Jersey City. The efforts involved finding auto body shops that would accept our services, performing a general survey of the company to assess the pollution prevention needs and a detailed survey by performing a walk through. Considering the basic knowledge and the size of those companies, it is a challenge to get in touch and work alongside with them, one of the first obstacles is because their size, usually the owner/manager who can answer all the details about the operation is responsible for multiple tasks, which usually decreases his interest in working with something that is not mandatory to the company in that moment. Suggestions to reduce pollutant materials and procedures are provided with possible economical advantages of becoming an environment friendly company.

Condition Assessment of Concrete using Ultrasound

Jessica Barcelos, Ellis Hadyn, Zhenting Zou and Jay N. Meegoda
Department of Civil and Environmental Engineering,
New Jersey Institute of Technology, Newark, NJ 07102

The performance of concrete is influenced by the voids in cement-based materials. The entrained *air void*s make the *concrete* susceptible to long term damage caused by leaching of calcium ions as well as freeze-thaw damage. Also when these voids percentage exceed a certain range, the strength and durability of the concrete is decreased. The propose of this research is a method to quantify the air void size distribution, using the concept of ultrasonic wave attenuation. The percentage of air voids results in the increase of the ultrasound wave attenuation, which is measured and compared with a theoretical model where three-dimensional information of air voids.

Enhancing Electroosmotic Consolidation of Soils

Camila Loeffler Carapajó, Martin Lucas and Jay N. Meegoda
Department of Civil Engineering
New Jersey Institute of Technology, Newark NJ 07102

During the construction in clay soils, it is necessary to wait for the complete soil settlement by preloading before construction of foundations. The issue is that consolidation settlement can take many years and use of electro-osmosis can accelerate the soil settlement. The electro-osmosis consists of applying an electrical potential across the soil mass. The electrical potential moves positively charged ions from the anode to the cathode, which also carry water molecules while the ions are moved through the soil. However, the main drawback of this method is that the soil pH changes with the application of electrical potential and this causes many problems. The anode pH is reduced to between 2 to 3, becoming very acid and the cathode pH is increased to around 13 becoming very basic. When this occurs, the soil resistance increases and the currents drops, raising the cost of treatment. Hence the focus is this research the optimal condition to achieve expedited settlements, providing advanced method to enhance civil engineering field.

Community based Pollution Prevention in Beauty Care

Bruna De Queiroz Freire, Camila Florencio de Sousa, Marina De Castro Rodrigues,
Afzal Sayeed and Jay N. Meegoda
Department of Civil and Environmental Engineering,
New Jersey Institute of Technology, Newark, NJ 07102

The Pollution Prevention is a concept to minimize or eliminate the use of hazardous chemical processes/materials at the source. It includes changes in equipment, processes, procedures, redesign of products, and raw materials. The beauty care industry is one of the industries that generates waste. This research involved providing voluntary services to three beauty care companies in Newark. The efforts involved finding beauty care companies that would accept our services, performing a general survey of the company to assess the pollution prevention needs and a detailed survey by performing a walk through. Beauty care industry has a lot of concerns. One of the issues is the regular use of chemicals which the majority of workers and employers do not identify as hazardous substances. Acetone, for example, is commonly used as nail polish remover in all beauty salons. What the owners and employees usually are not informed is that long exposure could cause persistent headaches, dizziness, and irritated eyes, skin, and throat. Using non-acetone nail polish remover as a replacement would minimize or eliminate such harm and would not affect the process. There are many pollution prevention solutions and most of them consist in employee training and clients awareness. To summarize, Pollution Prevention Design is necessary to make the workplace safer and minimize environmental impacts.

Remediation of Passaic River Sediments with Ultrasound

Andre Luiz Condessa de Carvalho, Laryssa Teixeira Ribeiro,
Janitha Hewa batagoda and Jay N. Meegoda
Department of Civil and Environmental Engineering
New Jersey Institute of Technology, Newark, NJ 07102 USA

The objective of this study to develop an in-situ remediation method to remediate the heavily contaminated Passaic River. The Passaic River basin drains almost 935 square miles in northeastern New Jersey and southeastern New York. Over 100 of the industrial facilities have been identified as potentially responsible for discharging a number of contaminants to the river, including, but not limited to, PCDD/F, PCB mixtures, PAH compounds, DDT1 and other pesticides, mercury, lead and other metals.

Prior research carried out in New Jersey Institute of Technology proved the success of acoustic cavitation due to ultrasound energy in removing contaminants in the dredged soil from Newark Bay [1]. Ozone is a powerful oxidizing agent that can be put to numerous beneficial uses within different fields of applications. It has an oxidation potential about 1.2 times greater than hydrogen peroxide. Ozone is 10 times more soluble in water than is pure oxygen. The objective of the study is to combining ultrasound with ozone to remediate the contaminated sediments in the Passaic River by oxidizing the contaminant.

Laboratory experiments were carried out with variations of with and without ozone and variation of five variables: power, water sediment ratio, sonication time, impact of pH change, and temperature. Laboratory scale experiments will be carried out with various combinations of these parameters according to the factorial design. Once the optimized combinations of above parameters are found, a pilot scale experiment will be carried out to optimize and design the field applications.

Stability of Nano Bubbles

Noah Thibodeaux, Janitha Hewa batagoda and Jay N. Meegoda
Department of Civil and Environmental Engineering

New Jersey Institute of Technology, Newark, NJ 07102 USA

Micro-nano bubble (MNBs) technology has been demonstrated to have great potential for purposes of remediation of contaminated soils. This is due to their large specific surface area, negatively charged surface, long stagnation period, and high oxygen transfer efficiency. The application of nano bubbles in environmental remediation is being studied closely at this time. Ozone is a very strong chemical that has gained attention due to the fact that it is a strong oxidant with a higher oxidation potential than that of hydrogen peroxide. Previously, Ozone injection has been used as a bioremediation technique. The issue then, is the potential of ozone to escape and render its time of effectiveness too low to be considered an economical method of bioremediation.

The purpose of this research is to combine the use of ozone infused nano bubbles and ultrasound as a means for remediation of contaminated sediments in the Passaic River. The use of ultrasound will be limited to the cleaning of the sediment while the ozone infused nano bubbles will be used as a detoxification method. Based on the mechanics of nano bubbles, the stability of the bubble structure may prove effective in keeping the ozone around for a longer period of time. Nano bubbles have been shown to stay present for up to a month. This effect does not exist in larger bubbles that have a higher tendency to collapse in a short time. The high pressures that exist inside nano bubbles relative to the surrounding medium mean that the diffusion rate is high. It has also been shown that as the mass transfer rate increases with the decrease of the bubble radius, meaning that as the bubbles approach collapse, they become even more effective. Combining these characteristics with the cleaning properties of ozone should prove effective in remediation purposes. What is not clear is the characteristics of the stagnation period of ozone infused bubbles and what the mechanics of the bubbles are near the end of stability. This study will give close attention to these parameters. As a means by which we can observe the behavior of infused nano bubbles, we will study zeta potential, bubble size distribution, and stagnation period.