GEMSTONE
Honors College
University of Maryland

The **Gemstone Honors Program** is a unique multidisciplinary four-year research program for selected undergraduate honors students of all majors. Under guidance of faculty mentors and Gemstone staff, teams of students design, direct and conduct significant research, often but not exclusively exploring the interdependence of science and technology with society. Gemstone students are members of a living-learning community comprised of fellow students, faculty and staff who work together to enrich the undergraduate experience. This community challenges and supports the students in the development of their research, teamwork, communication and leadership skills. In the fourth year, each team of students presents its research in the form of a thesis to experts, and the students complete the program with a citation and a tangible sense of accomplishment.

Our Mission

The Gemstone Honors Program engages students in a rigorous and rewarding undergraduate research experience utilizing a multidisciplinary team approach. In partnership with extraordinary faculty, Gemstone research teams advance knowledge and explore society's urgent questions. The Gemstone Honors Program challenges and supports student growth and learning in a community that values leadership, mentoring and relationship building.

15th Annual Gemstone Honors Program Team Thesis Conference

Friday, April 11, 2014

University of Maryland, College Park

GEMSTONE
HONORS COLLEGE
UNIVERSITY OF MARYLAND

Gemstone Staff

Dr. Frank Coale, Faculty Director

Dr. Kristan Skendall, Associate Director

Mrs. Vickie Hill, Assistant Director for Operations

Mrs. Leah Kreimer Tobin, Assistant Director for Student Engagement

Mr. James Trainor, Coordinator for Student Engagement

Ms. Faith Rusk, Coordinator for Operations and Team Support

Please join us…

You are cordially invited to attend

the Fifteenth Annual

Gemstone Citation Ceremony

Wednesday, May 21, 2014

4:30pm

University of Maryland Memorial Chapel

College Park, Maryland

Reception immediately following the Ceremony in the Adele H. Stamp Student Union

SO GREEN: Suburban Optimization of Green Roof Efficiency and Economic iNquiry

Team Members: Benjamin Borchers, Connie Chow, Matthew Doelp, Lawrence Ent, Raquel Hakes, Chung Heo, Kenneth Hunsley, Sree Sinha, Courtney Swaim, Anna Whittaker
Faculty Mentor: Dr. Andrew Ristvey, Extension Specialist for Commercial Horticulture, University of Maryland Extension, Wye Research & Education Center
Librarian: Mr. Alexander Carroll, University Libraries, University of Maryland

Research Description
Erosion and water pollution due to stormwater runoff are major problems in the Mid-Atlantic region, especially in the Chesapeake Bay watershed. One solution to these problems is the implementation of green roofs; however, the majority of these green roofs are only implemented on flat, commercial buildings. Team SOGREEN seeks to create a green roof retrofit that could be implemented on sloped roofs and residential buildings, thereby filling the gap in green roof use and availability. The Team created and tested lightweight substrate mixes, developed experimental roof systems of different slopes, and designed a retrofit system. In addition, the Team gauged consumer interest and aesthetic preferences to determine whether the product could be marketable. The Team's research fills the gap in green roof availability by creating a lightweight retrofit that can be used by homeowners.

Team Virtual

Team Members: Emily Cheung, Christopher Lim, Sharise Marshall, Christopher Purdy, Christina Winkler
Faculty Mentor: Dr. Yiannis Aloimonos, Professor, Department of Computer Science
Librarian: Mr. Glenn Moreton, University Libraries, University of Maryland

Research Description
Parenting styles have a major impact on child behavior, and poor parenting is a strong predictor of negative child outcomes. Behavioral Parent Training (BPT) is a well-established therapy that effectively reduces parent stress and child externalized behaviors. However, variables such as cost and program location can prevent parents from utilizing BPT. To address this issue we are creating an online BPT game that will be cost effective and easily distributed. We will explore the extent to which a digital version of BPT is an engaging and effective platform for future parents to learn from. This game draws from BPT literature and teaches five specific parenting skills, which users then practice by interacting with a child avatar. We will test the game on future parents, specifically, undergraduate students at the University of Maryland, College Park. We will administer a pretest-posttest BPT knowledge assessment to measure learning, and compare results to a control group who takes the assessment but does not play the game. A qualitative survey will measure the appeal and interactivity of the game. We hypothesize that a digital version of BPT will be both informative and engaging. We also hypothesize that users who play the game will demonstrate a higher gain in test scores than the control. This project is unique, as no similar therapy exists in the form of an online game. Future researchers can expand upon this project to encompass other behavioral therapies, or target specific populations, such as low SES users or single mothers.

PATH: Predicting Animal Travel Habits

Team Members: Connor Gibb, Michael Kleyman, Maria Koelbel, Rebecca Natoli, Kyle Orlando, Matthew Rice, Claire Weber, William Weston-Dawkes
Faculty Mentor: Dr. William Fagan, Professor/Department Chair; Department of Biology
Librarian: Mr. Otis Chadley, University Libraries, University of Maryland

Research Description
The Mongolian gazelle resides in the immense and dynamic Eastern Mongolian Steppe. Rampant habitat fragmentation due to human development projects is a serious threat to the nomadic Mongolian gazelle because it inhibits individuals from obtaining resources (Olson et al., 2011). We created a model using an Individual-based Neural Network Genetic Algorithm (ING) to predict how habitat fragmentation affects animal movement, using the Mongolian Steppe as a model ecosystem. We used data garnered from satellite collars to "train" our general model specifically to the Mongolian Steppe. Finally, we used our findings to provide recommendations to relevant government and conservation groups to assist in mitigating the disruptive effects of future human development projects.

QUANTUM SEA: Quantum dot Usage As a New Technique to Unleash Maximum Solar Energy Absorption

Team Members: James Chen, David Gagner, Kevin Griffiths, Emily Hitz, Akira Horiguchi, Ryan Joyce, Byung Kim, Michael Lee, Seongwoo Lee, Alexander Raul, DoRonne Shyu, Zachary Siegel, Steven Silberholz, Douglas Tran
Faculty Mentor: Dr. Jeremy Munday, Assistant Professor, Electrical and Computer Engineering, Institute for Research in Electronics and Applied Physics (IREAP)
Librarian: Mrs. Nevenka Zdravkovska, University Libraries, University of Maryland
Research Description
We wish to investigate the potential of quantum dots (QD) as part of a dual purpose photo-luminescing and anti-reflecting layer to increase solar cell efficiency. To quantify how a QD layer changes the external quantum efficiency (EQE), and Current-Voltage (IV) of a solar cell, we modeled the photovoltaic process. QDs that, in our model, maximized a cell's EQE were embedded in a toluene and poly(lauryl methacrylate) (PLMA) solution, which was then spin coated on to the cell. IV and EQE measurements were taken before and after each layer application. We found that simply coating a cell with just PLMA increased its EQE. Though this increase is not necessarily due to the refractive index of the polymer, we hypothesize that the full QD layer, when tested, will produce a further increase in EQE.

Team Silver

Team Members: Mohammad Ahmed, Emily Brode, Thomas Brown, Somayah Eltoweissy, Stephanie Gross, Seth Markowitz, Michael McCuthen, Reed Portney, Jacob Reinhart, Cristian Salgado, Melissa Walsh, Sean Wassel
Faculty Mentor: Barney Woodard, Director of Biotechnology Research and Education Program
Librarians: Ms. Nedelina Tchangalova & Mr. Connor Wynn, University Libraries, University of Maryland

Research Description
In the United States alone, bacterial infections caused by MRSA, E. coli, and Salmonella take the lives of 90,000 people annually1. Over 70% of nosocomial infections in the United States are resistant to one or more traditional antibiotics2, yet there continues to be an insufficiency of novel avenues of treatment mechanisms. Metal ions are theorized to render bacterial cells non-viable by three different methods: breaking the bacterium cell wall, inhibiting vital enzymatic functioning, or directly attacking the bacterium DNA3. Due to the variety of antimicrobial properties in the arsenal of metal ion treatments and the relatively minute levels of developed resistance, their use has become an attractive alternative to the regimen of antibiotic treatments currently in place. Our study aims to chelate Gallium (Ga) onto siderophore compounds, specifically Desferrioxamine (DFO), in order to effectively treat resistant bacteria. Once we have synthesized this DFO-Ga complex, we will test it against different bacterial strains to determine the specificity of siderophore uptake by the bacteria.

Team Thesis Conference Schedule-at-a-Glance

Time	Team	Room
3:30-4:15 p.m.	BE PURE	A
	MEGA	B
	BLAST	C
4:30-5:15 p.m.	ADEPT	A
	ELECTRODE	B
	ADDICT	C
5:30-6:15 p.m.	MEDICS	A
	RITALIN	B
	PRESSURE	C
6:30-7:15 p.m.	POLITIC	B
	RIO	C

BE PURE: Algae-based Purification of Landfill Biogas Using a CO2 Removal System and Helical Photobioreactor in Series

Research Team

Jason L. Albanese, Cell Biology & Molecular Genetics
Mindy L. Chen, Neurobiology & Physiology and Psychology
Yu-Chieh Chiao, Chemical & Biomolecular Engineering
Lawrence S. Cho, Statistics and Psychology
Hubert Z. Huang, Chemical & Biomolecular Engineering
Brian C. Lin, Neurobiology and Physiology
Melissa L. Meyerson, Chemistry and Chinese Language minor
Praveen S. Puppala, Biochemistry and Physiology & Neurobiology
Anjana Sekaran, Finance (Premedicine)
Yoon Shin, Chemical & Biomolecular Engineering
David Wang, Computer Engineering
Melissa A. Yu, Physiology & Neurobiology
Cary Zhou, Computer Science

Faculty Mentor

Dr. Steven Hutcheson, Professor, Department of Cell Biology & Molecular Genetics

Librarian

Ms. Nedelina Tchangalova, University Libraries, University of Maryland

Discussants

Dr. Feng Chen, Associate Professor, Institute of Marine and Environmental Technology
Dr. Gary Felton, Associate Professor, Nutrient Fate & Transport Research Group
Dr. Stephanie Lansing, Assistant Professor, Water Quality Laboratory
Dr. Ganesh Sriram, Keystone Assistant Professor, The Sriram Lab
Dr. Ben Woodard, Director, Biotechnology Research & Education Program; Bioprocess Scale-Up Facility

Research Description

Biogas is a natural product composed of a mixture of methane and other gases and is produced by the metabolism of common microorganisms in combination with methanogens. Landfills produce an enormous volume of biogas as waste, which has the potential to be harnessed as an effective and renewable energy source. However, biogas in its crude state also contains carbon dioxide (CO2), which reduces its energy efficiency, and hydrogen sulfide (H2S), a noxious, toxic and highly corrosive gas. These gases must be removed efficiently for biogas to maximally fulfill its energy potential. Because chemical methods of removal are expensive and environmentally hazardous, this project investigated an algal-based system of purifying biogas with the intent for scale up. As there are no nearby landfills that could be used as a source of biogas, an in house anaerobic digester was used to mimic landfill biogas. Several different H2S and CO2 removal systems were evaluated. Based on the results, an iron oxide H2S adsorption column and an alkaline spray CO2 absorption column were selected. The alkali solution used in the CO2 absorption column was added to a helical photobioreactor where the algae metabolized the dissolved CO2. Excess solution flowing from the photobioreactor passed through a gravity sand filtration system and was recycled back to the CO2 absorption column. While technical issues prevented complete testing of the system, these data provide estimates for the efficiency of the system design on an industrial scale.

Acknowledgements

We would like to thank Dr. Stephanie Lansing and her graduate students for their immense knowledge, advice on anaerobic digesters and the inocula used for starting our biodigester; Dr. Ganesh Sriram and Andrew Quinn for supplying us with and helping us grow the algae; the ACCIAC Fellows Program, University Sustainability Fund, and the Gemstone Program for funding our project; our librarian, Nedelina Tchangalova, for her help with our literature review; the Gemstone staff for their guidance and support through the peaks and the valleys; Alma Polo-Barrios and Jay Corckran for their help; and finally our mentor, Dr. Steven Hutcheson, for his patience, encouragement, expertise, editorial services and lab space, without which we would never have accomplished as much as we did.
A special acknowledgement to our former teammate, Alex Song, for his leadership and initiative during the early stages of our project. We wish him all the best.

NAVIGATE: Navigational Aid for the Visually Impaired via GPS And Three- dimensional rEcognition

Team Members: Alexander Belov, Guodong Fu, Janani Gururam, Francis Hackenburg, Yael Osman, John Purtilo, Nicholas Rossomando, Ryan Sawyer, Ryan Shih, Emily True, Agnes Varghese, Yolanda Zhang
Faculty Mentor: Dr. Rama Chellappa, Professor and Chair, Department of Electrical and Computer Engineering
Librarian: Ms. Robin Dasler, University Libraries, University of Maryland

Research Description

It is estimated that 3.1 million individuals suffer from visual impairment ranging from severe vision impairment to blindness (Lighthouse International, 2012). For these individuals, the seemingly innocuous task of maneuvering through places made for people with no severe vision impairment would be a formidable task, such that it discourages 30% of blind individuals from venturing from their home alone (Coughlan & Manduchi, 2009). To put it simply, "The inability to travel independently and to interact with the wider world is one of the most significant handicaps facing the vision--impaired" (Coughlan & Manduchi, 2009).
Our solution to this problem is to develop a portable indoor navigational aid for the blind using the Microsoft Kinect. We began by interviewing members of the blind community to determine what features should be incorporated into the product and whether or not our solution would be received favorably by our user base. Next, we researched platforms on which to control the Kinect and eventually settled on the Windows 8 SurfacePro. We then incorporated a haptic feedback system into our product so we have a means of providing directional information to the user. Concurrently, we developed computer vision algorithms to detect edges, flat spaces, and obstacles that rely on Kinect data.

Team PANCREAS: Preventing Adverse Neurological Consequences Of Reduced Episodic Amounts of Sugar

Team Members: Joseph Frankel, Kelley Gunther, Lex Matthews, Siddarth Plakkot, Eileen Ser, Melanie Shapiro, Andrew Shaw, Peter Weng, Danielle Wilkin, Linhan Xu
Faculty Mentor: Dr. Erica Glasper, Assistant Professor, Department of Psychology
Librarian: Dr. Svetla Baykoucheva, University Libraries, University of Maryland

Research Description

Type 1 diabetes is an autoimmune disorder that affects a significant portion of the population. In order to regulate blood glucose levels, type 1 diabetics must administer insulin. Such self-regulation introduces the risk of hypoglycemia, or low levels of blood glucose, which has been linked to brain injury. Previous studies have shown that moderate hypoglycemia results in damage to the dentate gyrus, a hippocampal area involved in emotional regulation and some types of learning and memory. Although anxiety and depressive-like behavior are known to increase following an episode of moderate hypoglycemia, the underlying structural changes to the dentate gyrus associated with these behavioral changes have yet to be elucidated. According to the neural plasticity theory of depression, reduced adult neurogenesis in the dentate gyrus may lead to depressive-like behavior, providing a possible hypothesis leading to behavioral change post hypoglycemia. This study seeks to examine whether moderate hypoglycemia will reduce hippocampal function as related to resultant lack of hippocampal cell proliferation. Bromodeoxyruridine (BrdU), a marker of DNA synthesis, was used to label proliferating cells at the time of insulin-induced moderate hypoglycemia, or control treatment, in male Sprague-Dawley rats. Twenty-four hours following the hypoglycemic episode or control treatment, hippocampal function was evaluated via the elevated plus maze test to assess anxiety-like behavior and the forced swim test to assess depressive-like behavior. Rats were then transcardially perfused and brains were removed, sectioned, and stained via immunohistochemistry to assess survival of newborn cells within the dentate gyrus. These findings may elucidate a relationship between diminished hippocampal function following moderate hypoglycemia and new cell production.

CLOT: Catalyzing Localized Onset of Thrombosis

Team Members: May Bayomi, Yooni Choi, Katerina Christodoulides, Parinaz Fathi, Anjali Ghodasara, Jocelyn Knazik, Kristen Langan, Benjamin Miller, Michael Sikorski, Hemi Thaker, Mike Titcomb, Omasiri Wonodi
Faculty Mentor: Dr. Peter Kofinas, Professor and Associate Dean, Fischell Department of Bioengineering
Librarian: Ms. Svetla Baykoucheva, University Libraries, University of Maryland

Research Description
Hemorrhage is the leading cause of preventable death post trauma. Existing commercial hemostatic agents have various disadvantages leading to limited use. These disadvantages include high costs and short shelf lives for biologically active surgical hemostats, and reduced hemostatic efficacy and the occurrence of exothermic reactions in common military hemostats. Polymer hydrogels are promising alternatives for promoting hemostasis and controlling hemorrhage. This project aims to develop a hydrogel that stops blood loss by using both biological and mechanical mechanisms. This will be achieved by the utilization of components that serve as a mechanical barrier to blood loss in addition to activating the coagulation cascade to augment primary and secondary hemostasis. To accomplish this, microparticles composed of chitosan and alginate and loaded with a procoagulant, zeolite, were synthesized and characterized. Swelling studies were conducted to validate the efficacy of mechanical hemostatic mechanisms. Bead composition was verified through the use of both an amine dye and FTIR analysis. In addition, the hemostatic ability of the hydrogel was confirmed by in vitro coagulation studies. Cytotoxicity assays and Scanning Electron Microscopy will be used to verify in vitro biocompatibility and bead porosity respectively. In vivo hemostatic efficacy will then be assessed in a sheep model. The results may translate into a safe, cheap, and effective hemostatic agent with potential use in the military, surgery, and emergency medicine.

EPIDEMICS: Eradicating Pathogens through Immunization against Diseases Everywhere Using Microparticles in Controlled-Release Shots

Team Members: Rachel Brown, Ellen Cesewski, Jonathan Fix, Devon Freudenberger, Kara Higgins, Eileen McMahon, Vanessa Niba, Hoon Park, Gabriela Perdomo, Anna Seo, Avantika Srivastava, Christina Tsui, Aaron Whiteman, Rebecca Zubajlo
Faculty Mentor: Dr. John Fisher, Professor**,** Fischell Department of Bioengineering
Librarian: Ms. Nedelina Tchangalova, University Libraries, University of Maryland

Research Description
The human papillomavirus virus (HPV) is the leading cause of cervical cancer and the most prevalent sexually transmitted disease worldwide. The HPV vaccine requires a multi-dose regimen for individuals to gain immunity. However, the multi-dose nature of the vaccine contributes to low patient compliance. We addressed lack of adherence to the multi-dose HPV vaccine by developing a controlled-release vaccine delivery system using biodegradable poly(D, L -lactic-co-glycolic acid) (PLGA) microparticles. The system will gradually release HPV virus-like particles, inducing a sustained immune response. We hypothesize that the strength of the immune response produced by our single-dose, controlled release system will be comparable to that produced by the traditional, multi-dose vaccine. The microparticles were fabricated using a double emulsion process and ovalbumin (OVA), a model protein, was encapsulated. Polyvinyl alcohol (PVA) concentration and stirring times were manipulated. To determine the effects of these parameters, OVA encapsulation efficiency was measured with a BCA assay. For PVA concentrations between 5% and 15%, lower PVA concentrations resulted in the highest encapsulation of OVA. Both microparticle size and encapsulation efficiency were not significantly affected by changes in stirring times between 12 and 20 hours (P=0.000). 10% PVA was chosen because it resulted in the desired microparticle size and encapsulation efficiency. Future research will be conducted to determine the degradation and release profiles and to determine the immune response induced by the microparticle delivery system. These results will be used to create a viable controlled-release HPV vaccine.

BLAST: Investigation of Blast Wave Propagation: Correlating External Pressures to Brain Injury Predictors

Research Team
Judith Beaudoin, Mechanical Engineering and Computer Science minor
Hallie Green, Physiology & Neurobiology
Jonathan Henricks, Physiology & Neurobiology
Samuel Jones, Physiology & Neurobiology
Catherine Kennedy, Cell Biology & Genetics
Julie Peluso, Aerospace Engineering
Michael Reilly, Mechanical Engineering
Benjamin Schwartz, Electrical Engineering and Computer Science
Andrew Shapiro, Computer Engineering
Camilla Yanushevsky, Finance

Faculty Mentor
Dr. Miao Yu, Associate Professor, Department of Mechanical Engineering

Librarian
Ms. Nedelina Tchangalova, University Libraries, University of Maryland

Discussants
Dr Balakumar Balachandran, Mechanical Engineering Department Chair, University of Maryland
Dr. Casey Cremins, Senior Lecturer, Department of Mathematics, University of Maryland
Ms. Amy Dagro, Mechanical Engineer, U.S. Army Research Lab
Mr. Haijun Liu, PhD. Candidate, Department of Mechanical Engineering, University of Maryland
Dr. Cara Meixner, Assistant Professor, Graduate Psychology, James Madison University
Mr. Doug Olson, Mechanical Engineer, National Institute of Standards and Technology
Dr. Joshua Singer, Assistant Professor, Department of Biology, University of Maryland

Research Description
Due to the increased use of improvised explosive devices, blast-induced Traumatic Brain Injury (bTBI) has become the signature injury of the wars in Iraq and Afghanistan. The prevalence of bTBI has prompted investigation into blast wave injury prevention, detection, and treatment methods. We created novel analysis methods for studying pressure wave propagation to determine appropriate sensor configurations in a helmet. These configurations allow for detection of pressure propagation outside the skull, which can be correlated to internal injury predictors. We used computer simulations and laboratory experiments to generate data for our analysis.

Our Finite Element (FE) model, a 2D cross-section of the brain, skull, and helmet, was loaded with a blast wave. We generated pressure time-histories for nodes on the inner and outer surfaces of the helmet and inside the brain, which were then cross-correlated. Using the correlation coefficients, we located positions inside the helmet that correlate best to specific brain nodes. Pressure sensors placed at these positions can be used to monitor brain tissue response during a blast event. The laboratory experiments provided a validation method for the FE model and demonstrated the potential for a helmet-mounted pressure sensor system to record predictive information about a blast event. Future research can apply our methods to evaluate the effectiveness of helmets in protecting the wearer from blast waves. With a better understanding of bTBI, our analysis methods combined with helmet-mounted sensors can be used to detect and diagnose bTBI earlier and more accurately than existing techniques.

Acknowledgements
We would like to thank our mentor, Dr. Yu, for her guidance and support. We are grateful to William Ani and Andrew Mawhinney for their contributions. Thank you to Dr. Balakumar Balachandran and Dr. Marcelo Valdez (UMD) for their assistance with the FE model. Thank you to Dr. Douglas Olson (NIST) for providing sensors and Dr. Hyungdae Bae (UMD) for his help and for providing a blast chamber. We are grateful for the advice from Ms. Amy Dagro (ARL) and our librarian, Ms. Nedelina Tchangalova. We appreciate the feedback from our discussants: Dr. Joshua Singer, Dr. Casey Cremins, and Dr. Haijun Liu (UMD). We thank Liz Buckshaw for her support throughout our project. Finally, we would like to thank the Gemstone staff, especially Dr. Coale, Dr. Skendall, Dr. Wallace, and Dr. Thomas, for supporting our projects over the past 4 years, both CRASH and BLAST.

Friday, April 11, 2014
3:30-4:30pm
Room B

MEGA: Evaluating Alternative Nutrient Sources in Subsistence-Level Aquaponic Systems

Research Team

Jonathan Alejandro Aguilera-Titus, Mechanical Engineering
Yusi Cao, Mechanical Engineering and Germanic Studies minor
Eric Francis Kazyak, Mechanical Engineering
Kalyani D. Kumar, Cell Biology & Genetics and Spanish Language & Cultures minor
Kevin Fang Li, Mechanical Engineering
Adam W. Louie, Architecture and Mathematics minor
Alan W. Louie, Mechanical Engineering
Jessica Lu, Neurobiology/Physiology and Religious Studies minor
Winston E. Mann, Electrical Engineering
Kelly Anne Misner, Civil Engineering and Project Management minor
Luke Vincent O'Connor, Economics and Sustainability Studies minor
Miriam Esther Tarshish, Mechanical Engineering and Nanotechnologies minor
Chenmuren Zhang, Computer Science
Daniel Mirsky, Electrical Engineering and Mathematics

Faculty Mentor

Dr. Andrew Lazur, Assistant Dean and Assistant Director Natural Resource and Sea Grant Program Leader University of Maryland Extension

Librarian

Ms. Nevenka Zdravkovska, University Libraries, University of Maryland

Discussants

Dr. Thomas Miller, Professor and Director, Chesapeake Biological Laboratory
Mr. Mark Rath, Aquatics Project Manager, Charles River; NIH - Contractor
Ms. Ellen Perlman, Owner/Operator, Chesapeake Aquaponics
Dr. David Love, Assistant Scientist, Public Health & Sustainable Aquaculture Project, Johns Hopkins Center for a Livable Future
Mr. Richard Schuck, Owner, Maryland Aquatic Nurseries
Mr. Christian Melendez, Manager, Edmonston Urban Farm

Research Description

Many food production methods are both economically and environmentally unsustainable. Our project investigated aquaponics, an alternative method of agriculture, that could address these issues. Aquaponics combines fish and plant crop production in a symbiotic, closed-loop system. We aimed to reduce the initial and operating costs of current aquaponic systems by utilizing alternative feeds. These improvements may allow for sustainable implementation of the system in rural or developing regions. We conducted a multi-phase process to determine the most affordable and effective feed alternatives for use in an aquaponic system. At the end of two preliminary phases, soybean meal was identified as the most effective potential feed supplement. In our final phase, we constructed and tested six full-scale aquaponic systems of our own design. Data showed that soybean meal can be used to reduce operating costs and reliance on fishmeal. However, a more targeted investigation is needed to identify the optimal formulation of alternative feed blends.

Acknowledgements

We extend our sincerest gratitude to all the individuals who helped us along this three year journey. Most of all, we thank our mentor, Dr. Lazur, for his support, commitment, and guidance, without which, none of this would have been possible. We thank the UMD Sustainability Council for funding our project; Gary Seibel, Greg Thompson, and Allison Lilly for sharing their facilities; Crystal Caldwell and the UMD Farm for donating nutrient sources; and Mindy Abrams-Payne for managing the countless supplies we ordered. We thank our librarian, Nevenka Zdravkovska, Dr. Coale, Dr. Skendall, Dr. Wallace, Dr. Thomas, and the entire Gemstone staff for their direction. Lastly, we thank our families for their unconditional support.

JUNIOR PREVIEW

AWE: Artificial Wind Energy

Team Members: Russell Brown, Jason Burtnick, Ralph Fairbanks, Patricia Firmin, Benjamin Friedman, Francis Gross, Edward Lin, Bethany McCrone, John Osmond, Zachary Titus
Faculty Mentor: Mr. Bryan Quinn, Director of Technical Operations, Department of Electrical Engineering and Institute for Systems Research
Librarian: Ms. Zaida Diaz, University Libraries, University of Maryland

Research Description

Team Artificial Wind Energy (AWE) intends to contribute to the growing field of renewable energy research by investigating the feasibility of using winds generated in urban environments. We seek to answer how to optimally place a small-scale, vertical-axis wind power generator in areas of artificial wind through field testing and computer modeling. The data collection phase of our project consisted of measuring artificially-generated winds from motor vehicles and architecture with anemometer arrays. Our second phase intends to take our measurements and apply them in models using geographic information systems and computational fluid dynamics software. We can then use these models to predict other similar areas with artificial wind, as well as the optimal placement of a wind turbine within those areas.

Bass: Poultry Litter-Induced Intersex in Regional Largemouth Bass Populations

Team Members: Christine Kim, Angela Leasca, Winston Liu, Shivani Patel, Laura Poulsen, Shefali Shah, Taylor Throwe, Renuka Tripu

Faculty Mentor: Dr. Lance Yonkos, Assistant Professor, Environmental Science & Technology
Librarian: Ms. Nevenka Zdravkovska, University Libraries, University of Maryland

Research Description

The discovery of intersex, specifically testicular oocytes, in male largemouth bass (LMB) throughout the Chesapeake Bay watershed has raised concerns for the aquatic food web and the quality of regional drinking water sources. Intersex has been correlated with endocrine disrupting compounds present in point sources of pollution such as wastewater treatment plant effluents. However, windows of particular sensitivity and the effect of non-point source pollution, such as agricultural runoff of poultry litter, are not well understood. The goal of this three-year project was to induce endocrine disruption in hatchery-reared LMB. We exposed discrete groups of fish at ages of 2-3 months post hatch (mph), 5 mph, 12 mph, and 18 mph for 14 days to aqueous poultry litter mixtures, an estradiol positive control, and a negative control. At the end of each exposure, we sacrificed a subset of fish. We collected gonad tissue samples for histological examination and blood plasma for the analysis of vitellogenin, an egg yolk lipoprotein indicative of exogenous estrogenic exposure in male fish. The remaining fish were maintained to an age of approximately 21 months before being sacrificed. Liquid chromatography/mass spectrometry and a Bioluminescent Yeast Estrogen Screen (BLYES) quantified the estrogenic activity in the exposures. Tissue and plasma collection were completed in the spring of 2014, and analysis of biological samples is currently underway. Understanding the causes of intersex may help to reduce endocrine disruption-related impacts to aquatic resources from agricultural practices.

Friday, April 11, 2014
6:30-7:30pm
Room C

RIO: Reducing Information Overload for College Students

Research Team

George Henry Kinchen, Electrical Engineering
Chris Paul Gennaro, Electrical Engineering
Derek Ryan May-West, Computer Engineering
Peter Liu, Computer Science
Joshua Scott Koehler, Computer Engineering
Jason Zhang, Computer Science and Economics
Colin Sawyer Adamson, Aerospace Engineering

Faculty Mentor

Dr. Aravind Srinivasan, Professor, Computer Science

Librarian

Mr. Karl Nilsen, University Libraries, University of Maryland

Discussants

Dr. Jessica Vitak, Professor, College of Information Studies
Dr. Evan Golub, Professor, Department of Computer Science
Dr. William Gasarch, Professor, Department of Computer Science
Dr. Jon Froehlich, Professor, Department of Computer Science
Dr. James Purtilo, Professor, Department of Computer Science
Dr. Kent Norman, Professor, Department of Psychology

Research Description

College students receive a wealth of information through electronic communications that they are unable to process efficiently. This information overload negatively impacts students' affect, which is officially defined in the field of psychology as the experience of feeling or emotion. To address this problem, we postulated that we could create an application that sorts and presents incoming content in a manner that optimizes users' ability to process information. First, we conducted surveys that quantitatively measured each participant's psychological affect while handling electronic communications, which was used to tailor the features of the application to what the users desire. After creating and implementing our application, we again measured the user's affect while using this product. Our goal was to find that the program promoted a positive change in affect, and that over time our application more accurately sorted users' information according to their preferences.

Acknowledgements

Team RIO would like to thank everyone that has supported us over the previous years in developing our research and application. We would like to especially thank our mentor Dr. Srinivasan, our librarian Mr. Nilsen, and the entire GEMSTONE staff. Without their leadership, guidance, and assistance, our project would not have reached the level that it did. We would also like to thank Dr. Norman, who graciously provided us with facilities for our testing. Finally, we would like to thank the people that encouraged and propelled us to complete our thesis - our family, friends, and fellow members of our cohort.

Friday, April 11, 2014
4:30-5:30pm
Room C

ADDICT: Effect of Addiction-Modeling Reinforcement Schedules on Delay Discounting

Research Team

Shir Boger, Chemical & Biomolecular Engineering
Luqman Croal-Abrahams, Biochemistry
Milad, Emamian, Bioengineering, Economics and Government & Politics
Spencer Ollayos, Physiology & Neurobiology and Psychology
Avi Packer, Economics
Jennifer Rottenberg, Physiology & Neurobiology
Sina Shahamatdar, Physiology & Neurobiology
Casey Smith, Chemical & Biomolecular Engineering
Jigisha Srivastav, General Biology
David Teitelbaum, Electrical Engineering
Louis Wolff, Mechanical Engineering

Faculty Mentor

Dr. Richard Yi, Research Associate Professor

Librarian

Ms. Gerri Foudy, University Libraries, University of Maryland

Discussants

Dr. Will Aklin, Program Official, Behavioral & Integrative Treatment Branch, National Institute on Drug Abuse
Dr. Redonna Chandler, Chief of Services Research Branch, National Institute on Drug Abuse
Dr. Rebecca Hamilton, Associate Professor, Department of Marketing, Robert H. Smith School of Business
Dr. Carl Lejuez, Director, Center for Addictions, Personality and Emotion Research; Department of Psychology
Dr. David Haaga, Professor and Department Chair, Psychology, American University

Research Description

Elevated delay discounting, where delayed rewards quickly lose value as a function of time, is associated with substance use and abuse. Currently, the direction of causation is unclear: while some research indicates that elevated delay discounting leads to future substance use, it is also possible that chronic substance use and specifically the rate of reinforcement associated with drug use, leads to elevated delay discounting. This project aims to examine the latter possibility. Nearly 60 participants completed ten 30-minute daily sessions of a visual attention task, and were reinforced at a rate intended to model drug use (fixed ratio 1) or drug abstinence (fixed ratio 10). Baseline and post-training rates of delay discounting were assessed for hypothetical amounts of $50 and $1000. Area under the curve of the indifference points as a function of delay was calculated. A greater area under the curve suggests more self control, whereas a lower value represents more impulsiveness. While the control participants generally became less impulsive between baseline and final sessions, results for the FR-1 and FR-10 groups remained approximately flat, showing that training made these groups more impulsive in relation to the control.

Acknowledgements

We would like to thank Dr. Richard Yi, Ms. Alli Stuppy, the Gemstone Staff, and Ms. Gerri Foudy for their endless support and guidance through our time in the Gemstone Program and our studies at the University of Maryland. Also, we would like to thank our thesis discussants; Dr. Joydeep Srivastava, Dr. Rebecca Hamilton, Dr. Carl W. Lejuez, Dr. Redonna Chandler, Dr. David A. F. Haaga, and Dr. Will Aklin for taking the time to critique and finalize our thesis.

Friday, April 11, 2014
4:30-5:30pm
Room A

ADEPT: A Videogame-Integrated sEMG Biofeedback Device for Use in Physical Therapy

Research Team

Hayes E. Converse, Computer Engineering
Laura E. Jones, Cellular Biology & Molecular Genetics and French Language and Literature
Daniel Y. Jean, Electrical Engineering
Vikas Mendhiratta, Electrical Engineering
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Faculty Mentor

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Librarian

Ms. Robin Dasler, University Libraries, University of Maryland

Discussants

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Dr. Adam Hsieh, Associate Professor and Associate Chair, University of Maryland
Dr. Robert Armiger, Senior Staff Member, Johns Hopkins University Applied Physics Laboratory
Mr. Frank Digiovonantonio, Physical Therapist, Rehabilitation Center of Southern Maryland
Dr. Wes Lawson, Professor of Engineering and Associate Chair for Undergraduate Education, Department of Electrical and Computer Engineering, University of Maryland
Dr. Scott Mathews, Associate Professor Electrical Engineering and Computer Science, The Catholic University of America

Research Description

Physical therapy is a strenuous process requiring significant effort to regain lost abilities. The difficulty of physical therapy can dishearten patients, resulting in inadequate progress. We seek to ease the physical therapy process by designing an electrode-lined sleeve that will interface with a biofeedback function within a videogame. We hypothesize that by incorporating wireless technology, our device will be more user-friendly and more effective than traditional physical therapy, or physical therapy using similar devices using bare, wired electrodes. We will test this by comparing patients reactions to unaided physical therapy, the bare electrodes, and our sleeve device. We hope that this research will allow us to bring the substantial benefits of game-based therapy to more patients.

Acknowledgements

We as a team would like to show our deepest gratitude to those whom this project would not have been possible without. Our mentor Dr. Pamela Abshire, Ph.D. for her guidance and patience. Teressa Ferraro for the tireless and excellent work she performed while a part of our team. Texas Instruments for the wonderful donations of their time, products, and industry experience to us. The ACCIAC for awarding us a grant utilized in the purchase of the materials necessary for our project. Dr. Rita Shapiro, DPT for her help in identifying and classifying exercises useful to our project. Last but not least we would like to thank the Gemstone Staff and Administration for motivating us and giving us the opportunity to grow as both professionals and academics.

Friday, April 11, 2014
6:30-7:30pm
Room B

POLITIC: Developing Quantitative Methodologies for the Digital Humanities: A Case Study of 20th Century American Commentary on Russian Literature

Research Team

Robert Cai, Neurobiology & Physiology
Matthew Thomas Carr, Neurobiology & Physiology and Psychology
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Librarian

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Discussants

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Dr. Piotr Kosicki, Professor, Department of History
Dr. William Reed, Professor, Department of Government & Politics
Ms. Nataliya Pratsovyta, Graduate Assistant, Department of English
Dr. Michael Israel, Associate Professor, Department of English

Research Description

Using scientific methods to engage the humanities is at the forefront of objective literary analysis. However, processing big data is particularly complex when the subject matter is qualitative rather than numerical. Large volumes of text require specialized tools to turn ideas and sentiment into quantifiable data. Our team researched the extent to which these tools can test hypotheses about qualitative information. We examined the claim that literary commentary exists within political environments and used US periodical articles concerning Russian literature in the early twentieth century as a case study. Both supervised and unsupervised tools generated useful quantitative data that allowed us to run stepwise binary logistic regressions. These statistical tests allowed for time series experiments using sea change and emergency models of history, as well as classification experiments with regard to author characteristics, social issues, and sentiment expressed. Both types of experiments supported our claim with varying degrees, but more importantly serve as a definitive demonstration that the use of digitally enhanced quantitative forms of analysis can apply to qualitative data. Our findings set the foundation for a wide scope of further experiments and applications throughout the emerging field of digital humanities.

Acknowledgements

All of us would like to express tremendous gratitude to our mentor, Dr. Peter Mallios, for his incredible expertise and tireless motivation throughout all four years of our project. We are indebted to Travis Brown and Nicholas Slaughter, as well as the entire faculty at the Maryland Institute for Technology in the Humanities and all those involved with the Foreign Literatures in America Project, without whom this research would not have been possible. We thank the Gemstone staff and our librarian, Tim Hackman, for their enthusiastic support from day one, and extend a special acknowledgement to Dr. William Mallios and Dr. Ronna Mallios for their consultation in substantiating our results.

RITALIN: Impact of Prenatal Nicotine Exposure on Impulsivity and Neural Activity in Medial Prefrontal Cortex

Research Team
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Dr. Elizabeth Redcay, Assistant Professor, Department of Psychology
Dr. Gregory Bissonette, Postodoctoral Scholar, Department of Psychology
Dr. Thomas Stalnake, Research Fellow, National Institute on Drug Abuse

Research Description
Prenatal nicotine exposure (PNE) is linked to a large number of psychiatric disorders, including attention deficit hyperactivity disorder (ADHD). Current literature suggests that core deficits observed in ADHD reflect abnormal inhibitory control governed by the prefrontal cortex, which is structurally altered by PNE. Yet, it is unclear how neural firing in the medial prefrontal cortex (mPFC) is affected during tasks that assess behavioral inhibition, such as the stop-signal task, nor do we know if neural correlates of inhibitory control are affected after PNE in awake behaving animals. Lastly, it has been shown that PNE affects attention and hyperactivity, but it is unknown if it impacts performance on stop-signal tasks.To address these issues, we recorded from single mPFC neurons in control rats and rats prenatally exposed to nicotine as they performed our stop-signal task. We found that PNE rats were faster for all trial types and were less likely to inhibit the behavioral response on stop trials. Neurons in mPFC tended to fire more strongly on STOP trials and were correlated with accuracy and reaction time. Although the number of neurons exhibiting significant modulation during task performance did not differ between groups, overall activity in PNE was reduced. We conclude that PNE makes rats impulsive and reduces firing in mPFC that carries signals related to response inhibition.

Acknowledgements
We would like to thank our mentor, Dr. Matthew Roesch, and all of the extremely talented members of his lab: Amanda Burton, Dan Bryden, Dr. Greg Bissonette, Vadim Kashtelyan, Ronny Gentry, and Nina Lichtenberg. They have provided us with countless hours of support, hard work, and education. We thank Dr. Frank Coale and Dr. Kristen Skendall for their wonderful coordination of the Gemstone program. We thank Dr. Rebecca Thomas, Dr. Heather Creek, and Dr. Jim Wallace for their inspiring guidance through the initial stages of our project. We thank our helpful thesis proposal and thesis defense panel members. We thank Kaci Thompson and the HHMI for their grant assistance. We thank Leah Kreimer and Vickie Hill for all of their great help. We thank our librarians, Jim Miller and Francy Stillwell, for all of their research advice. Last, but most certainly not least, we thank our ever-supportive families and friends!

ELECTRODE: The Application of an External Linear and Radial Electrical Field to an In Vitro Chronic Diabetic Ulcer Model for Evaluation as a Potential Treatment

Research Team
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Brendan Bui, Neurobiology & Physiology and Spanish Language
Ariana Feizi, Neurobiology & Physiology
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Discussants
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Dr. Amy Karlsson, Assistant Professor, Department of Chemical and Biomolecular Engineering
Dr. Richard Payne, Professor, Department of Biology, University of Maryland
Dr. Jesse Placone, Faculty Research Associate, Department of Bioengineering, University of Maryland

Research Description
Chronic diabetic ulcers affect approximately 15% of patients with diabetes worldwide. Current treatments include dressings, dermagrafts and pressure therapies, which are either unreliable or expensive. Applied electric fields are currently being investigated as a reliable and cost-effective alternative. External electrical fields accentuate the body's natural endogenous field. These fields may promote the migration of cells to the wound site and angiogenesis, both of which are inhibited in chronic wounds. This in vitro study aims to determine the effects of an applied electric field on three factors: endothelial cell migration, proliferation and mRNA expression of angiogenic genes. This study evaluates both a constant electric field and a spatially variable electric field that increases in intensity as it approaches the wound site. Both electric field types are tested at control settings, 0.01V, 0.1V and 1V. Results for a constant electric field indicate that at 0.1V, migration at short time points increases 11-fold and proliferation at short time points increases 1.3-fold, both compared to the control. Results for a spatially variable electric field indicate that at 1V, migration at short time points increases 1.8-fold, while at 0.01V, proliferation at long time points increases 1.5-fold, again both compared to the control. Results show that both electric fields can promote cell migration, proliferation and mRNA expression of angiogenic genes. Future research that explores a wider range of intensity levels may be able to more clearly identify the optimal design specifications of a spatially variable electric field.

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We would like to thank Dr. John Fisher, our mentor, for his support and guidance over the years. In addition, we would like to thank the graduate students in Dr. Fisher's laboratory, especially Kimberly Ferlin, for their assistance with laboratory experiments. We would also like to thank Dr. Mario Dagenais and his graduate student, Tiecheng Zhu, for their help with creating our device. We would also like to acknowledge our librarians, Mr. Jim Miller and Ms. Nevenka Zdravkovska, for their help with research and writing. We are extremely grateful to the previous Gemstone staff for their introduction to the Gemstone program and team research. We are also appreciative of the current Gemstone staff, Dr. Frank Coale, Dr. Kristan Skendall, and Ms. Vickie Hill for their encouragement and advice. Finally, we would like to extend a warm thanks to the Howard Hughes Medical Institute for their essential support through a grant.

MEDICS: Salvianolic acid B Inhibits Growth of Cervical Cancer Cells in vitro via Induction of Apoptosis through the Extrinsic Pathway

Research Team

Chia-Min Chen, General Biology and Computer Science minor
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Discussants

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Dr. David Straney, Professor, Department of Cell Bio & Molecular Genetics, University of Maryland

Research Description

In 2014 alone, over 12,000 women are expected to be diagnosed with cervical cancer and of these women about 3,909 will die of the disease. Despite developments in prevention methods, cervical cancer remains a major health concern for women. Growing evidence suggests that Salvianolic acid B (Sal B), a major component of the Chinese herb Danshen, may inhibit cancer cell growth and help fight against cervical cancer. This study characterizes the potential of Sal B as a cervical cancer drug through in vitro testing on HeLa cells. We hypothesized that application of Sal B to HeLa cells will result in decreased cell viability and increased apoptosis in a dose dependent manner. HeLa cells were treated with varying concentrations of Sal B: 25µM, 50µM, 100µM, and 200µM. Cell viability was determined through colony formation assay, cell death ELISA, and nuclear morphology. An inhibitor study was also conducted for further apoptosis pathway analysis. Colony formation assay demonstrated a significant decrease in cell viability with increasing concentrations of Sal B with 75% viability at 50µM down to 0% viability at 200µM. Cell death ELISA and the analysis of nuclear morphology via Hoechst staining reported significant levels of apoptosis at concentrations equal to 50µM and greater. Inhibitor study indicated that caspase-8 inhibitors significantly reduced the apoptotic effect of Sal B. In conclusion, our results demonstrate that Sal B inhibits cancer cell growth by a mechanism that involves apoptosis induction through the extrinsic pathway.

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PRESSURE: Wind-Induced Vibration Energy Harvesting using Piezoelectric Transducers Coupled with Dynamic Magnification

Research Team

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Kathryn Moira Connolly, Chemical & Biomolecular Engineering
Lauren F. Dorsey, Chemical & Biomolecular Engineering
Ian Andrew Grissom, Electrical Engineering
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Librarian

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Discussants

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Dr. Robert Proie, Electronics Engineer, US Army Research Laboratory
Dr. Ronald Polcawich, Team Lead, RF MEMS & mm-Scale Robotics, US Army Research Lab
Dr. Johan Larsson, Assistant Professor, Department of Mechanical Engineering
Dr. Norman Wereley, Minta Martin Professor and Department Chair, Department of Aerospace Engineering

Research Description

Flexible cylindrical structures subjected to wind loading can experience significant vibrations resulting from the periodic shedding of vortices in the wake of these structures. Such vibrations can be excessive particularly when the natural frequencies of the vibrating cylinder coincide with the frequency of vortex shedding (Strouhal Frequency). The energy associated with such vortex-induced vibrations can be harvested, conditioned, and stored. In this study, the vortex-induced vibrations of a cylindrical structure are transmitted to a flexible beam housed inside the structure via an optimally designed dynamic magnifier system. This system amplifies the vibrations of the beam and the strains experienced by piezoelectric patches to which it is bonded in order to maximize the conversion of the vortex-induced vibrational energy into electrical energy. Real-world applicability is tested by placing the structure in a wind tunnel to create vortex shedding, and the results are compared to finite element modeling that shows the structural vibrational modes.A crucial part of this study is conditioning and storing the energy from the harvester, the analysis of which is presented with special focus on theoretical modeling, design parameter optimization, and experimental evaluation and validation. Furthermore, the behavior of the integrated systems is investigated to demonstrate the practicality of energy harvesting using piezoelectric transducers coupled with dynamic magnification. The developed system can be invaluable in designing efficient wind-induced energy harvesters for numerous applications, such as smart street light pole systems, which are excellent means for harnessing renewable wind energy to meet the pressing necessity for vast energy resources.

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