17th Annual Gemstone Honors Program Thesis Conference

Friday, April 15, 2016
University of Maryland, College Park
Riggs Alumni Center

GEMSTONE
HONORS COLLEGE
UNIVERSITY OF MARYLAND

Gemstone Staff

Dr. Frank J. Coale, Director
Dr. Kristan Skendall, Associate Director
Vickie Hill, Assistant Director for Operations
Leah Tobin, Assistant Director for Student Engagement
Jessica Lee, Coordinator for Student Engagement

Please join us…

You are cordially invited to attend

The 17th Annual
Gemstone Citation Ceremony
Tuesday, May 17, 2016
7:00 PM

University of Maryland Memorial Chapel
College Park, Maryland

Thesis Conference Schedule-at-a-Glance

Time	Team	Room
1:30-2:15 PM	BIKES	Ballroom A
	JUDGMENT	Doetsch (B)
	PANACEA	Heise (C)
2:45-3:30 PM	MUSIC	Ballroom A
	TESLA	Doetsch (B)
	BASIC	Heise (C)
4:00-4:45 PM	SAVIOR	Ballroom A
	ATTENT	Doetsch (B)
	FORGET IT	Heise (C)
5:15-6:00 PM	HAPTIC	Ballroom A
	BRAIN BLAST	Doetsch (B)
	UMD ROUTE	Heise (C)
6:00-7:30 PM	Please join us for a reception in the rotunda	

Throughout the day, please view the work of our junior teams, displayed in the hallway outside of the presentation rooms.

ATTENT: Attention Deficit Hyperactivity Disorder: Neural and Behavioral Effects of Tartrazine in Spontaneously Hypertensive Rats

Research Team
Shoshana M. Bloom, Bioengineering
Kevin C. Chiang, Physiology & Neurobiology and Mathematics
Sharlene S. Demehri, Physiology & Neurobiology
Sara Kreshpanji, Biochemistry and Economics
Erin F. McCaffrey, Microbiology
Karishma Patel, Physiology & Neurobiology and Nutritional Sciences
Tracy Sebastian, Economics
Salwa Shan, General Biology and Secondary Education
Leah W. Sukri, Physiology & Neurobiology and Psychology

Faculty Mentor
Dr. Thomas Castonguay, Professor, Department of Nutrition and Food Science, UMD

Librarian
Celina McDonald, University Libraries, UMD

Discussants
Dr. Ricardo C. Araneda, Associate Professor, Department of Biology, UMD
Dr. David Baer, Research Physiologist, United States Department of Agriculture
Dr. Bonnie Dixon, Professor, Department of Chemistry and Biochemistry, UMD
Dr. Kaci Thompson, Director, Undergraduate Research and Internship Programs, UMD

Research Description
As holistic treatments gain popularity, there is a need for further investigation into the influence diet has on Attention Deficit Hyperactivity Disorder (ADHD) symptoms. This experiment explored how tartrazine, a food additive commonly known as Yellow No. 5, impacts impulsivity, hyperactivity and levels of neural dopamine. We administered varying concentrations of tartrazine to Spontaneously Hypertensive Rats (SHR), which mimic human ADHD behavioral symptoms. We examined the biochemical effects of tartrazine by measuring dopamine levels in selected sections of brain tissue using Enzyme-Linked Immunosorbent Assay (ELISA) analysis. Behavioral testing used a T-maze and open field chamber to measure impulsivity and hyperactivity, respectively. Further research should be conducted on the dopaminergic pathway present in the brain in relation to human subjects to conclusively determine whether or not tartrazine should be removed from ADHD patients™ diets.

Acknowledgements
Team ATTENT would like to thank the Central Animal Resources Facility, the Food and Drug Administration, the United States Department of Agriculture, the Castonguay Lab, Molly Hyer and the Glasper Lab, the College of Agriculture and Natural Resources, the Gemstone Staff and Alexander Grillo.

BASIC: A Study of pH Manipulation on Tumor Proliferation and the CTL Response

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Lienna Feleke-Eshete, Government & Politics
Allen Kao, Chemical & Biomolecular Engineering
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Saadiya W. Sehareen, General Biology
Benjamin E. Tunick, Bioengineering
Julia J. Wainger, Cell Biology & Molecular Genetics

Faculty Mentor
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Librarian
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Discussants
Dr. Stephen K. Anderson, Senior Investigator, Cancer and Inflammation Program, Center for Cancer Research
Dr. Kenneth Frauwirth, Lecturer, Department of Cell Biology and Molecular Genetics, UMD
Dr. Douglas Julin, Associate Professor, Department of Chemistry and Biochemistry, UMD
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Dr. Meiqing Shi, Assistant Professor, Department of Veterinary Medicine, UMD
Dr. David Straney, Associate Professor, Department of Cell Biology and Molecular Genetics, UMD
Dr. Kimberly Stroka, Assistant Professor and Capstone Mentor, Fischell Department of Bioengineering, UMD

Research Description
Cancer constitutes one of the leading causes of death worldwide. Common treatments for cancer, such as chemotherapy and radiation therapy, damage non-cancerous tissue and cause debilitating side effects. Furthermore, these treatments cannot always treat advanced malignancies or prevent recurrence. Adoptive Cell Transfer (ACT) therapy is a novel cancer treatment that uses the body's own immune system to recognize and destroy tumors, which focuses the treatment to only cancerous cells. However, when used for treatment on its own, it is inefficient, time consuming and costly. We hypothesized that this inefficiency stems partly from the acidic extracellular environment characteristic of cancerous tumors. Using an in-vitro model with B16-OVA melanoma and EG-7 lymphoma, we tested to see how buffering and pH shock affected the efficiency and efficacy of ACT.

Acknowledgements
Team BASIC would first and foremost like to thank our mentor, Dr. Zhengguo Xiao for his dedication, patience and enthusiasm throughout our project. He has been extremely generous with his time and resources and we cannot thank him enough. We would also like to recognize Dr. Lei Li and Anjuli Bhadurihauk for their training and assistance in the lab. Additionally, we would like to thank Dr. George Lorimer, Dr. Laura Ellestad and the entire Gemstone staff: Dr. Frank Coale, Dr. Kristan Skendall, Ms. Vickie Hill, Mrs. Leah Tobin and Ms. Jessica Lee. Last but not least, thank you to all of our Launch UMD donors for making our project possible. Thank you all for your wholehearted support for these past 4 years!

BIKES: A Stationless Bikeshare Proof of Concept for College Campuses

Research Team
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Librarians
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Discussants
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Alison Donlan, Director Product Portfolio, Kryptonite, Allegion
Nil Gurel, Graduate Research Assistant, Autonomous Vehicle Laboratory, UMD
Jeffrey Holliday, Coordinator, Adventure Programs, UMD

Research Description
Bikeshares promote healthy lifestyles and sustainability among commuters, casual riders and tourists. However, the central pillar of modern systems, the bike station, cannot be easily integrated into a compact college campus. Fixed stations lack the flexibility to meet the needs of college students who make quick, short-distance trips. Additionally, the necessary cost of implementing and maintaining each station prohibits increasing the number of stations for user convenience. Therefore, we developed a stationless bikeshare based on a smartlock permanently attached to bicycles in the system. The smartlock design incorporates several innovative approaches to provide usability, security and reliability that overcome the limitations of a station-centered design. To create a pleasant user experience, we designed a unique, two-step lock system that is intuitive to operate while mitigating user error. To ensure security, user access is limited through near field communications (NFC) technology connected to a mechatronic release system. To track rentals and maintain the system, each bike is fitted with an XBee module to communicate with a scalable ZigBee mesh network. The network allows for bidirectional, real time communication with a Meteor.js web application, which enables user and administrator functions through an intuitive user interface available on mobile and desktop. The development of a smartlock to replace bike stations is essential to meet the needs of modern students.

Acknowledgements
Team BIKES would like to thank Dr. Robert Newcomb for his invaluable mentorship through the duration of this project. His expertise in electrical systems and continued interest in the progress of the overall project allowed for more creative solutions than first imagined. We also want to express our gratitude to team librarians Ms. Robin Dasler and Ms. Elizabeth Soergel, for constant support throughout the entire research process. Also, we want to thank Mr. Majid Aroom and Dr. Robert Bonenberger for allowing us to use their labs, as well as their technical guidance and support. The team wants to thank the University of Maryland Sustainability Fund for providing essential financial support for our research. Finally, we would like to thank all of the Gemstone staff for their never-ending support and encouragement over the past four years.

BRAIN BLAST: Investigating the Diabetic Brain: The Effects of TZDs and Insulin on the Cellular Processes and Pathology of Alzheimer's Disease

Research Team

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Faculty Mentor

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Discussants

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Dr. Matthew Roesch, Professor, Department of Psychology, UMD
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Research Description

Alzheimer's disease (AD) is the sixth leading cause of death in the United States and the only disease in the top ten without a cure. AD is informally referred to as Type III diabetes because AD and diabetes are both characterized by issues with glucose metabolism. Preclinical studies suggest that increasing insulin levels in the AD brain decreases disease pathology although the mechanism remains unclear. We used Thiazolidinediones (TZDs), a class of diabetes drug, with insulin to sensitize downstream insulin signaling through activation of PPARγ and to allow more glucose into neurons. Our study administered this drug combination to investigate its effect in transgenic mice expressing AD pathology. The AD mouse model helped us elucidate the role of the insulin signaling pathway and the long-term effects of increased glucose uptake on AD brain pathology. Our study devised a method to bypass the blood brain barrier with intranasal TZDs and administer the drug directly to the brain with fewer peripheral effects. Preliminary results using a GC-MS fluxomics method to determine the flow of molecules through biochemical pathways suggested the drug combination increased glucose uptake and metabolism in the brain. In addition, preliminary analysis of immunohistochemistry data indicated that TZD with insulin decreased the pathology observed using primary antibodies to identify Aβ plaques, p-tau tangles and activated microglia in the subiculum sub-region of the hippocampus when compared to insulin and saline controls. This suggests that our attempts at increasing glucose uptake in the brain alleviated some AD pathology.

Acknowledgements

Team Brain BLAST would like to thank Dr. B for inspiring us and our research from the beginning to the end. Thank you to Kara Duffy, who was always helpful and stepped up when we needed her. Thank you to Dr. Skendall, Dr. Coale and the rest of the Gemstone staff for always supporting us in our research and team-building endeavors. Thank you to Nedelina Tchangalova for her editing help over the years. Thank you to Dr. Castonguay for providing us with guidance and materials when needed, Leslie Juengst for going above and beyond helping us figure out our project, and the Department of Animal Sciences, especially Dr. Angela Black and Tikina Smith, for making our animal research a reality. Thanks to all of our Launch UMD donors who made our project possible. Without any of the people above, we would not be where we are today.

FORGET IT: Exploring Pathophysiological Factors Regarding Pre- and Post-Concussion

Research Team

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Librarian

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Discussants

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Research Description

Neuronal stretching during concussion alters glucose transport and reduces neuronal viability, also affecting other cells in the brain and the Blood Brain Barrier (BBB). Our hypothesis is that oxidative stress generated in neurons during concussions contributes to this outcome. To validate this, we investigated: (1) whether oxidative stress independently causes alterations in brain and BBB cells, namely human neuron-like, neuroblastoma cells (NCs), astrocyte cells (ACs) and brain microvascular endothelial cells (ECs), and (2) whether oxidative stress originated in neurons (as in concussion) is responsible for causing the subsequent alterations observed in ACs and ECs. We used H_2O_2 treatment to mimic oxidative stress, validated by examining the resulting reactive oxygen species, and evaluated alterations in cell morphology, expression and localization of the glucose transporter GLUT1, and the overall cell viability. Our results showed that oxidative stress, either directly affecting each cell type or originally affecting NCs, caused changes in several morphological parameters (surface area, Feret diameter, circularity, inter-cellular distance), slightly varied GLUT1 expression and prompted a redistribution between the cell center and its periphery, and lowered the overall cell viability of all NCs, ACs, and ECs. Therefore, we can conclude that oxidative stress, which is known to be generated during concussion, caused alterations in NCs, ACs, and ECs whether independently originated in each cell or when originated in the neuronal cells and could further propagate the ACs and ECs.

Acknowledgements

Team FORGET IT cannot express enough thanks to the Gemstone Staff for their continued support and encouragement, especially Dr. Frank Coale, Dr. Kristan Skendall, and Ms. Vickie Hill. We are also grateful to our librarian Ms. Nevenka Zdravkovska for providing us with resources to use to gather background information for our thesis. Our utmost gratitude to Dr. Silvia Muro, our mentor, who worked closely with us, conducted our weekly meetings and supported us throughout our research to help ensure our success. We would also like to thank members of Muro lab for providing day-to-day assistance in and out of the lab, our Launch UMD donors, and the discussants that served on our panel and provided feedback to help perfect and solidify our thesis.

HAPTIC: A Haptic System for Depicting Mathematical Graphics for Students with Visual Impairments

Research Team

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Discussants

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Dr. Carolyn Fink, Professor, Department of Counseling, Higher Education and Special Education, UMD
Dr. Paul Jaeger, Professor and Program Director, College of Information Studies, UMD
Dr. Al Maneki, National Federation of the Blind
Greg Topel, Chief Executive Officer, Tanvas

Research Description

When teaching children who are blind or visually impaired, educators generally rely on tactile tools to deliver visual mathematical topics to their students. Currently, tactile media, such as embossed paper and 3D-printed objects, are used to convey graphical information. Although these tools are easy to use and relatively inexpensive, they are based solely on touch and are not modifiable. Dynamic and interactive technologies such as pin matrices and haptic pens are also commercially available but tend to be more expensive and less intuitive. This study aims to bridge the gap between easy-to-use tactile tools and dynamic, interactive technologies in order to facilitate the haptic learning of mathematical concepts. Specifically, we designed an electrostatic haptic system using a commercially-available electrostatic touchscreen that provides the user with multimodal (tactile and visual) output. Three methodological steps comprise this study: (1) a systematic literature review of the state of the art of haptic assistive devices, (2) a user-centered design of an electrostatic haptic interface, and (3) testing of the systems effectiveness via user testing and analysis. The study validated the basic effectiveness of this haptic system, while also clearly indicating the need for future research of multi-touch, multimodal haptic devices.

Acknowledgements

Team Haptic would like to thank the Gemstone staff (in particular Dr. Kristan Skendall and Vickie Hill), our corporate partners Tanvas (specifically Greg Topel and Michael Peshkin), the Maryland School for the Blind, Robin Dasler, Dr. Caroyln Fink, National Federation for the blind (especially Ann Taylor), Judy and Lloyd Rasmussen, Dean Chang, Rama Chellappa, all of our Launch UMD donors, Mancy Liao, Lewis Swartz and of course our wonderful mentor, Dr. Marcio Oliveira.

JUDGMENT: The Effect of Psychological Distance on Willingness to Participate in Ideologically Motivated Violence

Research Team

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Librarians

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Discussants

Alejandro Beutel, Researcher, National Consortium for the Study of Terrorism and Responses to Terrorism (START), UMD
Dr. Cory Davenport, Senior Researcher, START, UMD
Dr. Katarzyna Jasko, Research Associate, Department of Psychology, UMD
Michael Norton, Doctoral Student, Department of Sociology, UMD
Dr. David Webber, Faculty Research Assistant, Department of Psychology, UMD

Research Description

To address the pressing threat of violent extremism, research on the cognitive and decision-making processes of individuals who choose to engage in violent extremism is vital. The present research applied Construal Level Theory (CLT) to determine the likelihood of who to engage in violent extremism. Specifically, CLT states that an abstract mindset (high-level construal), compared to a concrete mindset (low-level construal), is associated with a greater likelihood of engaging in motivated, self-controlled behaviors. To the extent that violence associated with extremism is typically goal-directed, we hypothesized that activation of high-level construal should result in an increased likelihood of engaging ideologically based violence. We first developed and pilot tested 24 vignettes covering controversial topics and assessed them on features such as relatability, emotional impact and capacity to elicit a violent reaction. The ten most impactful vignettes were selected for use in the primary investigation, and a two-study sequence examined the effect of construal manipulations on self-reported likelihood of engaging in ideologically based violence. The results of the study were analyzed using ANOVA. Preliminary analyses using ANOVA indicated no relation between abstract mindsets and acts of violent extremism.

Acknowledgements

Team JUDGMENT would like to thank those who have been instrumental to the success of our project. First, we would like to extend our gratitude to our librarians Eric Lindquist and Judy Markowitz. We would also like to thank Dr. Cory Davenport, Dr. Jonathan Wilikenfeld and Dr. Peter Henne for providing us with feedback. We want to thank CAPER research assistants Alli Stuppy and Kayla Tormohlen, for guiding us through the testing process and Nadia Bounoa for providing her assistance in construal validation. Thank you Dr. Derek Iwamoto for assisting us in factor analysis. We would like to recognize the Gemstone staff for giving us all the resources to succeed throughout our four years. Finally, we want to thank our friends and family who have supported us and our mentor, Dr. Richard Yi, who guided us through the entire research process.

MUSIC: On the Incorporation of Psychologically-Driven MUSIC™ Preference Models in Music Recommendation

Research Team

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Faculty Mentor

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Librarian

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Discussants

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Dr. Shihab Shamma, Professor, Institute for Systems Research, Department of Electrical and Computer Engineering, UMD
Dr. Bob Slevc, Assistant Professor, Department of Psychology, UMD

Research Description

There currently exists a data deluge of music information bombarding the public with upwards of 75,000 albums released yearly, necessitating the use of automatic music recommendation systems. Most current music recommendation systems, such as Spotify and Pandora Internet Radio, only account for rigidly-defined, quantitative musical elements of songs, failing to consider aspects of human perception of music and therefore alienating the listener's individual preferences from the recommendation process. Our research investigated the relationships between perceptual elements of music with calculated features of music, accessed from The Echo Nest API, in an effort to determine how a psychological representation of music preference can be incorporated into automated recommendation systems to effectively and accurately embody an individual's music preferences. We evaluated a widely accepted model of musical preference, generated through a series of rigorous psychological experiments involving music perception by Rentfrow et al., in its ability to model user preferences and generate recommendations. Through a machine learning application, we determined the most accurate predictive model for generating perceptual MUSIC values based on song feature values calculated by The Echo Nest API. This application allowed the music preference model to be applied to an extensive amount of songs, including songs not previously investigated through psychological research. Through this analysis, we have demonstrated that the five-factor MUSIC model has promising music recommendation applications through its ability to model listener preferences and generate predictions for new songs. Incorporating this model into recommendation methodologies used by current systems could therefore allow for improved personalized listening experiences.

Acknowledgements

Team MUSIC would like to thank everyone who made our unique undergraduate research experience possible, most notably the outstanding Gemstone staff, including Dr. Kristan Skendall, Dr. Frank Coale and Vickie Hill. We would also like to recognize those who have provided invaluable help to us along this intensive research process: our mentor, Professor Ramani Duraiswami; our librarian, Steve Henry; as well as researchers Dr. David Meichle, Dr. Bob Slevc, Dr. Jason Rentfrow and Dr. Daniel Levitin. Thank you to those who funded our team to attend and present at the 2015 Meeting of the Society for Music Perception and Cognition. Finally, we would like to thank all of the discussants that are present to critique our thesis.

PANACEA: Therapeutic Potential of RNAi through Endocytotic Methods

Research Team

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Dr. Silvia Muro, Professor, Fischell Department of Bioengineering, UMD

Research Description

The ability to manipulate gene expression promises to be an important tool for the management of infectious diseases and genetic disorders. However, a major limitation to safe, effective and targeted delivery of therapeutic RNA to living cells is the cellular toxicity of conventional techniques. A novel method for delivering small interfering RNA (siRNA) to alter cellular gene expression was recently developed at the NIH. This method uses a modular recombinant protein vehicle consisting of a specific ligand coupled to a Hepatitis B Virus-derived RNA binding domain (HPV-RBD). Team PANACEA's research objective was create new reagents based on this novel small-molecule delivery system. Two such recombinant delivery proteins were developed: one composed of Interleukin-8 fused to the HPV-RBD, the other consisting of the Machupo Virus GP1 protein joined to HPV-RBD. The recombinant proteins were produced in yeast P. pastoris and purified to homogeneity. After incubating with specific siRNA cargo, the recombinant proteins were used to transfect CEM (a human T-cell line) and HeLa (epithelial) cell cultures. Changes in specific mRNA levels in both the CEM and HeLa cells were measured using qRT-PCR. The gentle nature of this technology has the potential to overcome limitations of current methods and could provide a platform for the expansion of personalized medicine.

Acknowledgements

Team PANACEA would like to thank the following people for their help and support throughout this project. We appreciate the time that everyone contributed towards making our project a success: Dr. Jonathan Dinman, Dr. Denis Wafula, Dr. Vivek Advani, Dr. Frank Coale, Dr. Kristan Skendall, Vickie Hill, Gemstone Staff, Nedelina Tchangalova, Carol Marques Dos Santos Vieira, Dr. Chanda Arya, Kevin Diehn, Dr. Arturas Meskauskas, Andrea Bajcsy, Our Friends and Family, Donors, Atlantic Coast Conference Innovation and Creativity (AACIAC) Fellows Grant, and Discussants.

SAVIOR: Angler Perception and Population Dynamics of the Invasive Northern Snakehead (*Channa argus*) in the Potomac River

Research Team

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Lauren E. Amrhein, Chemical & Biomolecular Engineering
Robert B. Fitzgerald, Operations Management & Business Analytics; Statistics minor
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Yasmine Hentati, Environmental Science & Policy
Brian S. Kang, Computer Science
Yvette V. L. Mann, Bioengineering
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Librarian

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Discussants

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Dr. David Hawthorne, Professor, Department of Entomology, UMD
Dr. Joseph Love, Tidal Bass Manager, Maryland Department of Natural Resources
Joshua Newhard, Fish Biologist, Maryland Fishery Resources Office, United States Fish and Wildlife Service

Research Description

Our research addresses the extent to which the northern snakehead, an invasive fish species, represents a threat to the Potomac River ecosystem. The first goal of our research was to use a survey to determine the perceptions and opinions of recreational anglers on the snakehead population's effect on the Potomac River. To determine angler perceptions, we created and administered surveys which we based off of the MFRO Creel surveys. The results of these surveys were analyzed using SPSS. These survey results suggested that there has been a decrease in target species, specifically largemouth bass, according to recreational angler perceptions. The second goal of our research was to determine the health and potential for expansion of the snakehead population in the Potomac River. We used microsatellites derived from previous research to compare DNA samples from harvested snakehead tissue and analyzed our results with NeEstimator and GenAlEx. Our analysis supported the hypothesis that there are multiple introductions of northern snakehead into the Potomac River system; however, overall snakehead diversity remains relatively low.

Acknowledgements

Team SAVIOR would like to thank Dr. David Hawthorne for graciously training us and allowing us to use his laboratory; Dr. Joseph Love and Mr. Joshua Newhard for their extensive involvement and assistance throughout the course of our project; Ms. Eileen Harrington and Mr. Alex Carroll for their assistance as our team librarians; Dr. Matthew Hamilton for acting as one of our discussants today; Dr. Timothy King for publishing the microsatellites with which we performed our genetic analysis; Jessica Lee for guiding our early team development; the Gemstone staff for their tireless support of our team; and Dr. Tom Miller for three years of guidance, wisdom, unwavering support and Christmas crackers!

TESLA: Time Reversed Electromagnetic Wave Propagation as a Novel Method of Wireless Power Transfer

Research Team

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Dr. Ray Sedwick, Associate Professor, Department of Aerospace Engineering, UMD
Dr. Vladimir Talanov, Staff Physicist, Northrop Grumman Corporation

Research Description

We investigated the application of time reversed electromagnetic wave propagation to the emerging field of wireless power transfer technology. In order to demonstrate the applicability of this technique, we created and evaluated both theoretical models of the system and physical experiments. Time reversal is a signal focusing method that exploits the reversed time invariance of the lossless wave equation to direct signals on a single point in space. This process has been well documented for selective targeting of either a linear or nonlinear object. We have explored a method of selective targeting between two nonlinear objects simultaneously present in such an environment. We demonstrate selective targeting between two diodes with separate voltage knees in a two-dimensional ray-chaotic billiard and observed a transmitted power aspect ratio of 6.35 for delivered target power versus non-target power. Additionally, we explored this technique's ability to transmit energy to a moving target. We examined the spatial profile of the collapsing wavefront around the target antenna and demonstrated that time reversal can be used to transfer energy to a receiver in motion. We investigated the construction of a dual-purpose rectenna which can simultaneously function as nonlinear signal source and rectifier. Through the evaluation of these experiments, we demonstrated that time reversal is a promising method for wireless power transfer and has many advantages over existing technologies.

Acknowledgements

Team TESLA would like to express much gratitude to all of the following individuals for their efforts and contributions to our research: To Dr. Anlage for the guidance, mentoring, equipment and inspiration. To Bo Xiao for his knowledge and gracious assistance in the laboratory. To Dr. Sun Hong, Dr. Jarek Wosik and Dr. Franco Moglie for their collaboration. To the Gemstone staff for their dedication and for making this program a reality. Thank you, your support of our team has been invaluable to our growth and success!

umdRoute: Quantitative and Qualitative Evaluation of Drowsy Driver Detection Methods: Single Electrode Wearable EEG Device, Multi-Electrode Wearable EEG Device, and Head-Mounted Gyroscope

Research Team
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Dafydd D. Durairaj, Mathematics and Economics
Bohr O. Hew, Electrical Engineering and Computer Science
Mark G. Hoppel, Mechanical Engineering
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Faculty Mentor
Dr. Aravind Srinivasan, Professor, Department of Computer Science, UMD

Librarian
Cynthia Frank, University Libraries, UMD

Discussants
Dr. William Gasarch, Professor, Department of Computer Science, UMD
Dr. Siddharth Potbhare, Co-Founder & Chief Executive Officer, Untethered Labs LLC
Dr. James Purtilo, Associate Professor, Department of Computer Science, UMD
Dr. Gang Qu, Professor, Department of Electrical and Computer Engineering, UMD
Dr. Paul Rau, Lead, Vehicle Automation Safety Research, National Highway Safety Administration

Research Description
Drowsy driving is the principle cause in more than 100,000 automobile crashes with 1,500 fatalities each year (NHTSA, 2003). Currently, drowsy driving detection is inconvenient and costly. There are no detailed trade-off analyses for the cost, accuracy, detection time and ergonomics of drowsiness detection methods. The goal of the research is to analyze trade-offs between the cost and accuracy of different devices to find the most effective way to alert a drowsy driver. Existing research has demonstrated several options for drowsiness detection. We used two electroencephalography (EEG) devices, which are head-mounted and measure brain waves. We tested a one-electrode and 14-electrode device. We also tested a head-mounted gyroscope and head-mounted web camera. Devices were evaluated using the following criteria: time needed to achieve accurate reading, accuracy of prediction and ergonomics and portability. We had several important conclusions: we can successfully determine drowsiness after three minutes of data collection using both devices. The one-electrode device is the most cost-effective with successful detection at $130. The 14-electrode device was useful for research but most uncomfortable. Other cheaper techniques such as web camera eye-tracking and gyroscope head nodding detection were ineffective at detecting drowsiness. This research will contribute to the field of drowsy driving detection, help improve detection devices and reduce the number of future accidents due to drowsy driving.

Acknowledgements
Team umdRoute would like to thank Dr. Srinivasan for being extremely supportive of our team through all that we've been through. Thank you for sharing with us your expertise. Without your guidance, our team would not be where we are today. We would also like to thank our discussants for their time and knowledge: Dr. Bill Gasarch, Dr. Siddharth Potbhare, Dr. Jim Purtilo and Dr. Gang Qu. Finally, we would like to thank the Gemstone Program and staff for their help and support throughout the last four years.

JUNIOR POSTER ABSTRACTS

The Gemstone Honors Program is excited to share the work of the junior class. Attendees are encouraged to view the posters in the hallway outside of the presentation rooms. We hope to see you at next year's Thesis Conference on Friday, April 21, 2017.

CATTAILS: Cattail Applicability to Toxin Adsorption in Lakes and Seas

Team Members: Shlomit Chelst, Uva Dayalan, Belton DeLaine-Facey, Sophia Hull, Delaney Jordan, James Maher, Victoria Monsaint-Queeney, Mitul Patel, Aayush Thapa, Jennifer Wall, Debra Yee, Michael Xu
Faculty Mentor: Dr. Joe Sullivan, Professor, Department of Plant Science and Landscape Architecture; Interim Director, Environmental Science and Policy Program, UMD
Librarian: Kelley O'Neal, University Libraries, UMD

Research Description
Oil spills are an issue that affects wild plants, animals, and aquatic ecosystems, as well as human health, tourism, fishing, and economies. Many current methods lack sustainability, cause further environmental damage, or fail to effectively remove oil from the water column. We have researched cattails, otherwise known as typha, and their effectiveness in cleaning up oil spills. Cattails are resilient plants that grow abundantly in the wild and thus are a sustainable alternative to other natural sorbents, like cotton, which require more resources to produce. In our research we have compared cattails and cotton in oil, water, and a mixture of the two. We also are in the process of testing the effects of different environmental factors, such as wave movement, temperature, and salinity on the adsorption capacities of cattails and cotton. In simulating real-world factors, we hope to learn more about the properties of cattail and we hope to prove its viability as a renewable and energy-efficient form of oil spill cleanup.

DIRE: Dark Internet Research Exploration

Team Members: Jeremy Foust, Chariah Ghee, Matthew Hartung, Kathleen Hynes, Chong Li, Patricia Mandrich, Kymberlee McMaster, Jared Reibel, Nathan Samson, Kamilah Tadlock
Faculty Mentor: Jon Hoffman, Lecturer, Department of Communication, UMD
Librarian: Eric Cartier, University Libraries, UMD

Research Description
Team DIRE's research investigated the socio-cultural interactions of various sectors of the Dark Internet. Our research aimed to demonstrate the applicability of Dark Internet markets and currency to the world marketplace. Also, we provided a collection of current information about the Dark Internet that has been gathered in order to justify the need for further research and expansion upon the relatively small assemblage that exists thus far. Specifically utilizing the Tor Browser, Team DIRE studied this correlation by analyzing overlapping subjects of marketplace consumer experience and marketplace communication trends during key moments and times of normalcy. Our overarching goal was to develop new knowledge about the unique culture and community of marketplaces of the Dark Internet.

DREAM: Degeneration Research Engaging Alzheimer's Models

Team Members Laurel Gordon, Alice Lu, Melinda Matos, Se Yeon Seo, Yi Yeon Seo
Faculty Mentor: Dr. Ricardo Araneda, Associate Professor, Department of Biology, UMD
Librarian: Dr. Svetla Baykoucheva, University Libraries, UMD

Research Description
Previous research on Alzheimer's Disease (AD) showed a potential link between omega-3 fatty acids and neurogenesis, the formation of new neurons. Our study aimed to use omega-3 fatty acid through dietary supplementation in normal and transgenic mouse models, in order to determine the relationship between omega-3 fatty acids and neurogenesis. We measured neurogenesis through changes in cell proliferation and apoptosis in the olfactory bulb by labeling the newly generated neurons with specific antibodies and observing them under fluorescent light using immunohistochemistry and confocal microscopy. In addition, we utilized behavioral tests to assess whether there is a significant change in cognitive function between normal and transgenic mouse models. Due to previous results, we expected to find increased cognitive activity in the mice groups with omega-3 dietary supplementation and determined this change in AD and wild-type mice.

INJECT: Investigation of Nanoliposomes Jointly Encapsulating Curcumin for Therapeutics

Team Members: Sriramya Ayyagari, Haris Dar, Vivian Morton, Kevin Moy, Chadni Patel, Lalithasri Ramasubramanian, Nivetita Ravi, Samantha Wood, Andrew Zhao, Melanie Zheng, Kiet Zhou
Faculty Mentor: Dr. Jose Helim Aranda-Espinoza, Associate Professor, Fischell Department of Bioengineering, UMD
Librarian: Eileen Harrington, University Libraries, UMD

Research Description
Age-related macular degeneration (AMD), the most common cause of vision loss for people age 50 and over, is a disease characterized by the buildup of oxidative stress in the back of the eye. Current remedies are limited to intravitreal injections that only target the more severe 'wet' form; the common 'dry' form has no pharmaceutical solution. Curcumin, a natural antioxidant, has shown potential in combating inflammatory diseases like AMD; however, the molecule also demonstrates poor bioavailability. Team INJECT synthesized, characterized, and tested a liposomal complex encapsulating curcumin to improve its delivery to dry AMD-affected retinal cells via noninvasive methods. This project studied the complex's potential to protect retinal pigment cells from damage and its ability to permeate the layers of the eye in order to prevent or delay the onset of dry AMD.

MagNET: Magnetic Non-mechanical Energy Transfer

Team Members: Samer Abousaleh, Nikhil Badami, James Foote, Adam Hurwitz, Alexander Johnson, David Kessler, Jose Lamas, Jesse Lynch, Robin McFaul, Thomas Ogden, Shawn Rosofsky, Noah Wichrowski, Chungho Woo
Faculty Mentors: Dr. Frank Coale, Professor, Department of Environmental Science and Technology, UMD
Librarian: Nevenka Zdravkovska, University Libraries, UMD

Research Description
We have been working to create and test a digital magnetic stabilization device. Previously, magnetic stabilization systems have been passive, implementing only analog feedback components with zero user control. Analog systems have a limited, and often singular, functionality due to the static nature of an assembled circuit board. We aim to improve upon previous machines by creating a microcontroller-based system, allowing for real-time user manipulation via data processing software. Our first step in approaching this issue was dismantling an existing passive system in order to ascertain the general design layout and determine which components must be modified for dynamic control. We scanned and mapped magnetic fields to gather data, improving our knowledge base while preparing to prototype a dynamic system. The mapped data was compressed into a set of several equations that will be implemented into our code. We have started to complete the initial setup of our microprocessor and are currently working on developing an algorithm with a feedback system that can manipulate a levitating object. We hypothesize that this new approach will make stable, three-dimensional object manipulation possible. By introducing this new technology, innovative applications which were previously unattainable can now be realized. For example, the dynamic magnetic stabilization that this system will provide is applicable to structural stabilization, particularly mitigation of seismic damage resulting from earthquakes.

MORALS: Morality and Observations and Research in American Law and Society

Team Members: Diana Curtis, Natalie Dagher, Sudipta Das, Brian Frey, Lara Fu, Pablo Goldschtein, Katrina Haas, Elfadil Osman, Shai Weener
Faculty Mentor: Dr. Susan Dwyer, Executive Director, Honors College and Associate Professor, Philosophy, UMD
Librarian: Judy Markowitz and Eric Lindquist, University Libraries, UMD

Research Description
The formulation of major morality policies about abortion, capital punishment, gun control, and same-sex marriage often require that contemporary American ideals be reconciled with the founding principles of the United States. Research has attempted to understand the tensions that arise between these ideals and principles by pushing below surface-level demographic analyses to discover the extent to which such tensions are the result of a more fundamental conflict between individuals' interpretations of key values that underpin American ideals. We aim to extend this research by examining how a representative sample of the United States of America define, rank, and apply values and their moral and policy stances on the four types of aforementioned morality policies. We hypothesize that how an individual defines a value influences his/her hierarchical ranking of that value, which subsequently affects his/her stances on an issue where that value is evoked. We hope that our research will contribute to understanding the role of values in these types of decision-making.

MTB: Mycobacterium Tuberculosis

Team Members: Paige Chan, Grace Chun, Elizabeth Corley, Isaac Jeong, Christopher Kim, Carolyn Lane, Ari Mandler, Nathaniel Nenortas, Michelle Nguyen, Pradip Ramamurti, Ian Qian, James Tuo, Jimmy Zhang
Faculty Mentor: Dr. Volker Briken, Associate Professor, Department of Cell Biology and Molecular Genetics, UMD
Librarian: Dr. Svetla Baykoucheva, University Libraries, UMD

Research Description
The bacterium Mycobacterium tuberculosis (Mtb) is the main causative agent of human tuberculosis (TB). Mtb is transmitted between humans through aerosol droplets released when an infected individual coughs or expels fluid from their lungs. It is estimated that one in every three people in the world is infected with some form of the disease and 1.5 million people die annually from TB. Many of these people are located in developing countries and mortality rate is higher in immunocompromised communities. If a TB infection progresses to the active disease, the patient will require treatment, of which few viable options currently exist. Furthermore, the emergence of multi-drug resistant strains of the pathogen has rendered some current treatments increasingly less effective. The mycobacterial protein fragment complementation (M-PFC) assay has been shown to be an accurate method to quantify the degree of interaction between a specific pair of proteins in Mtb. Using the M-PFC assay, a drug panel can be screened to identify inhibitors of protein-protein interactions important to virulence. By inhibiting these specific interactions, a possible new treatment for TB can be identified. This new treatment will have the potential to advance to clinical trials and eventually to patient treatment.

NATURE: Nanopaper Applications to Universalize Renewable Electronics

Team Members: Karenna Buco, Eddie Chang, Parisa Davoodi, Julia Downing, Delena Ganey, Brandon Green, Jonathan Kagan, Sachi Khemka, Erik Larmore, Hannah Russell, Tom Schmitt, Luke Travisano, Jeannette Van Sickle, Stacy Wang
Faculty Mentor: Dr. Liangbing Hu, Professor, Department of Materials Science and Engineering, Energy Research Center, UMD
Librarian: Nevenka Zdravkovska, University Libraries, UMD

Research Description
The enormous amount of pollution from the fossil fuel-powered production of these plastics presents a serious threat to the planet's environmental health. We found cellulose nanopaper (CNP) to be an abundant, organic, and "green" potential alternative, but some key properties needed improvement for functional implementation. Although CNP has exhibited remarkable optical transparency, porosity and stiffness that are critical in thin films, photovoltaics and flexible electronics, we identified the need for improvement in its chemical and electrical properties. Team NATURE formed to determine and implement the most effective treatment(s) to increase CNP's functionality by altering the paper through several individual processing experiments. These treatments included altering the source of cellulose for the paper, performing atomic layer deposition (ALD), conducting surface esterification reactions, and applying transparent, conductive coatings of carbon nanotubes to the base CNP. We have implemented three out of these four treatments thus far, and our preliminary results have largely contributed to refinement of our experimental technique, and indicated the potential for conclusive results. We hope to have completed all four treatments, performed numerous characterization techniques, and analyzed our data to draw meaningful conclusions about the future of CNP's viability in novel, flexible electronics.

Piezo: Piezoelectric Sensing and Energy Harvesting in Touchscreens

Team Members: Jacob Bremerman, Steven Bronocco, Brenden Caffey, Teresa Kent, Eric Lee, Rounak Mukhapodhyay, Anand Patel, Emily Reed, Christopher Rother, Adam Stambouli, Erin Verni, Torrance Wang
Faculty Mentor: Dr. Bao Yang, Associate Professor, Department of Mechanical Engineering, UMD
Librarian: Jim Miller, University Libraries, UMD

Research Description
Team Piezo is investigating the answers to the following questions: How can we employ a piezoelectric device in a touchscreen to detect the location of applied pressure on the screen, and how can we harvest energy from taps on the screen to extend cell phone battery life? Using the energy from the forces exerted on an electronic device to power its battery would change the technology industry. One of the biggest benefits would be an emergency source of energy after a user has depleted a battery's power supply. With a piezoelectric film, someone tapping their screen repeatedly could recharge the battery. By performing experiments and administering surveys, Team Piezo will evaluate the feasibility of piezoelectric films as sensors and design a system for optimal implementation. This project includes enhancing the energy storage from piezoelectric films in non-resonant conditions and creating an electrical network that both detects location and stores excess energy generated. In addition, the surveys provide a view of the general effects that our technology could have based on data regarding average phone usage. Team Piezo hopes that our work will lead to the widespread use of piezoelectric technology in future research.

SCOPE: Sensory Computing and Object Processing Entity

Team Members: John Bachkosky, Alexandra Boukhvalova, Kevin Chou, William Gunnarsson, James Ledwell, Rayna Qian, Nick Rodgers, John Shi, Brendan McTaggart, Jason Yon
Faculty Mentor: Dr. Anil Deane, Research Associate Professor, Institute for Physical Science and Technology
Librarian: Elizabeth Soergel, University Libraries, UMD

Research Description
Developments in the fields of Visual Object Recognition (VOR) and Natural Language Processing (NLP) continue to further assistive robotics capabilities. VOR and NLP are components of artificial intelligence with applications in healthcare including optimizing data mining of health records, increasing capabilities of surgical procedures, and increasing accuracy of diagnosis (Luxton, 2015). Within the current realm of healthcare robotics, VOR is employed in technologies to aid medical professionals with tracking and sorting tasks such as in surgical robots that recognize and sort surgical tools (Ashrafian et al., 2015). NLP is used to expedite the process of searching through years of health records to provide more accurate diagnoses and validation behind prescription safety such as in data mining software that minimizes adverse effects of drug cocktails with records of drug-drug interactions (Tan et al., 2015). While both of these fields are increasing healthcare capabilities, there is limited work on medical robots incorporating both VOR and NLP. Team SCOPE has created the Auditory Learning and Visual Object Recognition System (ALVORES) which will integrate VOR and NLP applications on a mobile platform for assistive healthcare services. The main goal of ALVORES is to make routine tasks as well as complex diagnoses of doctors and nurses easier, which will be tested with experiments verifying task performance and accuracy of responses to diagnostic inquiries based on case studies.

STRIDE: Subsecond Testing: Research and Investigation in Dopamine and Empathy

Team Members: Surya Chappa, Henok Girma, Elizabeth Green, Shir Kantor, Anuj Lagowala, Matt Myers, Eric Mellinger, Meredith Pecukonis, Danielle Potemri, Robel Tesfay, Steven Walters
Faculty Mentor: Dr. Matthew Roesch, Associate Professor, Department of Psychology, UMD
Librarian: Nedelina Tchangalova, University Libraries, UMD

Research Description
Several mental disorders are characterized by abnormal cognitive empathetic behavior, such as antisocial personality disorder, autism spectrum disorder, and schizophrenia. Abnormal cognitive empathetic behavior is distinguished by a dysfunction in the neurotransmitters dopamine and oxytocin. We are investigating the roles of these neurotransmitters in a behaving rat model with two experimental paradigms. In the first paradigm, we use FSCV to measure subsecond dopamine release in a Pavlovian association task where treatments are alternated between the recording rat and a conspecific. In the second, oxytocin is administered intranasally prior to a decision task with similar treatments. Data from the first experiment shows that, contrary to previous findings, rats appear to be more selfish than empathetic. However, preliminary data from the second experiment suggests that oxytocin treatment may modulate empathetic behavior.

VESSEL: Vascular ElectroSpun Silk Engineered Linings

Team Members: Mina Al-Salihi, Adam Berger, Megan Dang, Irene Jones, Moli Karsalia, Casey Lim, Sherin Menachery, Glory Mgboji, Angelina Nou, Marquise Singleterry, Devayani Srinivasan, Phillip Tran, Amy Zhou
Faculty Mentor: Dr. Adam Hsieh, Associate Professor, Fischell Department of Bioengineering, UMD
Librarian: Eileen Harrington, University Libraries, UMD

Research Description
Peripheral arterial disease is a major health concern around the world today. Typically, autologous grafts are harvested from the patient and used in bypass surgery, redirecting blood flow around the diseased area. Unfortunately, in many cases the tissue quality is not high enough to use an autologous graft. While biomaterials have been used for large-diameter synthetic grafts, issues arise when the grafts are used for small diameter applications in the peripheral vasculature. Our research aims to address the biocompatibility and mechanical failures of current synthetic vascular grafts for small diameter use.

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