20th Annual Gemstone Honors Program Thesis Conference

Friday, April 12, 2019
University of Maryland, College Park
Samuel Riggs IV Alumni Center

Gemstone Staff

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

Please join us…

You are cordially invited to attend

The 20th Annual
Gemstone Citation Ceremony
Tuesday, May 21, 2019
7:00 PM

University of Maryland Memorial Chapel
College Park, Maryland

Thesis Conference Schedule

Time	Team	Room
1:30-2:15 PM	DIVA	Ballroom A
	MICRO	Doetsch (B)
	Pressure	Heise (C)
2:45-3:30 PM	Oysters	Ballroom A
	SPACE	Doetsch (B)
	VOLTAGE	Heise (C)
4:00-4:45 PM	CARDIO	Ballroom A
	OMEGA	Doetsch (B)
	Purify	Heise (C)
5:15-6:00 PM	MELTS	Doestch (B)
	META	Heise (C)

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

CARDIO: Prototyping a piezoelectric energy-harvesting system from the simulated mechanical pulsation of a 3D-printed heart model

Research Team
Sarah H. Asfari, Bioengineering
Aishwarrya Jayapal, Physiology & Neurobiology and Psychology
Sahith Mukku, Physiology & Neurobiology
Bareera Qamar, Physiology & Neurobiology
Divyam Satyarthi, Physiology & Neurobiology
Cristina Tous, Bioengineering

Faculty Mentor
Dr. Robert Newcomb, Professor, Department of Electrical and Computer Engineering, UMD

Librarian
Mr. Jordan Sly, University Libraries, UMD

Discussants
Mr. Dhineshvikram Krishnamurthy, Software Engineer, Children's National Health System
Dr. Gowri Manickam, Research Fellow, Food and Drug Administration
Mr. Preston Tobery, Coordinator, Maker Technologies, University of Maryland Libraries
Dr. Ahmed Zidan, Senior Staff Fellow, Food and Drug Administration

Research Description
Roughly six million individuals live with cardiac pacemakers worldwide. Currently, pacemaker batteries must be replaced every 7-8 years, and the associated surgery often leads to life threatening complications such as sepsis, blood clots, stroke, and even death. Pacemakers are powered by lithium ion batteries, which have a lifespan of seven years. As a result, individuals have to frequently undergo surgery over the course of their life, which increases the chance of surgical complications. A system was developed for an alternative energy source for cardiac pacemaker technology. We aimed to capture energy from the mechanical pulsation of a 3D-printed synthetic heart using several different types of piezoelectric material including polyvinylidene fluoride piezo cables and polymethyl methacrylate transducers. The captured mechanical energy was then converted and stored in a rechargeable battery. Several tests were conducted to evaluate the maximum voltage that the piezoelectric membrane was able to capture from our pulsatile cardiac simulation. Initial tests generated a sufficient amount of energy to power a pacemaker, suggesting that piezoelectric material is a viable alternative energy source for cardiac pacemakers. Troubleshooting and future testing will aim to optimize the electrical and mechanical parameters of our system, laying the foundation for the development of a "heart-powered pacemaker." This could potentially alleviate the number of surgical complications and post surgical deaths in patients who rely on cardiac pacemakers for heart rate stabilization and regulation.

Acknowledgements
We would like to give a big thank you to our dear mentor, Dr. Robert Newcomb, for supporting us throughout our Gemstone journey. We would also like to thank Dr. Frank Coale, Dr. Kristan Skendall, Ms. Leah Tobin, and our librarian Mr. Jordan Sly. Additionally, we would like to extend our gratitude to Ms. Vickie Hill for facilitating all of our team purchases, and Vijay Kowtha for helping our team attend the Sigma Xi conference in San Francisco to present our research.

DIVA: An Immersive Experience: Visualizing Large-Scale Climate Data Using Virtual Reality and Infrared Hand-Tracking Technology

Research Team

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Kevin J. Ho, Electrical Engineering
Austin S. Hom, Applied Mathematics & Operations Management and Business Analytics
Mughilan Muthupari, Computer Science and Statistics
Justin E. Pan, Computer Science and Electrical Engineering
Justin M. Shen, Computer Science; Statistics minor

Faculty Mentor

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Librarian

Dr. Kelley O'Neal, University Libraries, UMD

Discussants

Dr. Anna Borovikov, Research Scientist, NASA Global Modeling and Assimilation Office
Dr. Timothy Canty, Associate Research Professor, Dept. of Atmospheric & Oceanic Sciences, UMD
Dr. Tse-Chun Chen, Postdoctoral Associate, Dept. of Atmospheric & Oceanic Sciences, UMD
Mr. Oscar Hendrick, Support Scientist Associate, NASA
Mr. Jeffrey Henrikson, Faculty Specialist, Dept. of Atmospheric & Oceanic Sciences, UMD
Mr. Patrick Meyers, Senior Faculty Specialist, Earth System Science Interdisciplinary Center, UMD
Dr. Mason Quick, Researcher, ESSIC

Research Description

Recently, interest in understanding Earth's climate has risen in light of anthropogenic climate change. However, while climate data resources have dramatically increased over this time, effective climate data visualization tools remain largely absent. Thus, the general public does not have the opportunity to engage with scientific data, and climate scientists end up using outdated software with limited interactivity and plotting capabilities. We visualized data for both the regional and global climate, with the regional view focused on the Chesapeake Bay and a comprehensive global visualization for our proof-of-concept. The regional view provides a close-up of the Chesapeake Bay, surrounded by topographic data in one cohesive, high-fidelity visualization. Our global view transformed climate data from a standard format into a perceptually-uniform color texture, and applied this to a virtual globe. We added a three-dimensional and animated particle field to visualize the magnitude, direction, and movement of vectorized wind field data by interpolating the two-dimensional grid onto a sphere. We used a Leap Motion Controller to facilitate interaction with the visualizations through hand gestures. We also developed a menu allowing users to control visualization factors, such as globe rotation speed, with a touch of a fingertip. Through a focus group, we gained valuable insights from experts about their use of visualization tools and their experience interacting with our prototype. Overall, participants found that three-dimensional visualizations were more intuitive than two-dimensional visualizations. Results from this focus group motivated the addition of new user interactions to our prototype..

Acknowledgements

Our project could not have been possible without the help of various individuals; we must take the time to thank them all. The first is Dr. Stephen Penny, our mentor, whose vision inspired our project and whose insights paved our way forward. He provided us with helpful suggestions week-to-week on immediate steps in our project. Next is our librarian, Dr. Kelley O'Neal - she had immeasurable impact over our papers, posters, and presentations. We would like to thank our discussants, whose voices have greatly shaped our project. We would also like to thank FedCentric and UMD Libraries for providing us resources with which we could develop. Additionally, we would like to thank Jill Smith, our GEMS104 mentor, for her great advice on team dynamics and internal goals. Finally, we would like to thank the entire Gemstone staff, especially Dr. Frank Coale, Dr. Kristan Skendall, and Dr. Vickie Hill, for making this experience possible.

MELTS: Sustainable Low Energy Desalination of Road Salt Runoff Using Ion Exchange Resins

Research Team

Surjo Bandyopadhyay, Physiology & Neurobiology
Danielle Firer, Bioengineering and Computer Science
Amanda Hamilton, Environmental Science and Chemical & Biomolecular Engineering
Greg Krasnoff, Civil & Environmental Engineering
Harrison Kraus, Chemical & Biomolecular Engineering
Eric McKenna, Civil & Environmental Engineering
Evan Quartner, Biochemistry
Soma Umeozulu, Chemistry

Faculty Mentor

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Librarian

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Discussants

Dr. Jeffrey Davis, Assistant Professor, Department of Chemistry, UMD
Dr. Allen Davis, Professor, Dept. of Civil and Environmental Engineering, UMD
Dr. Amy J. Karlsson, Assistant Professor, Department of Chemical and Biomolecular Engineering, UMD
Dr. Joel Moore, Associate Professor, Towson Geosciences

Research Description

Sodium chloride (in the form of rock salt) is used as a deicer to make roadways safer during the onset of winter storms. However, its application has detrimental environmental effects due to saline roadside runoff. Several preventative approaches exist to reduce the amount of salt used, such as using a brine solution or alternative substances, however not many reactionary approaches are used. For this project, a reactionary approach was undertaken, seeking to remove sodium chloride from road salt runoff before it results in widespread damage. Strong acid cation and strong base anion exchange resins with exchangeable H^+ and OH^- anions, respectively, were tested using gravity flow through columns to determine their efficiency in removing Na+ and Cl- ions from increasing concentrations of saline solutions. pH measurements were used to determine the cumulative moles removed per volume of resin as well as removal efficiency. The ion exchange resins are capable of removing the Na^+ and Cl^- ions and do offer some desalination potential. The cation exchange resins seem to be more effective than the anion exchange resins. Further research should be conducted in order to confirm the current findings, test for possible regeneration of the ion exchange resins, and determine their efficacy under environmental conditions.

Acknowledgements

We would like to thank our mentor, Dr. Brubaker, for her support these last few years. Thank you to the Sustainability Fund and our donors in the Launch UMD campaign- our research would not have been possible without you. We would also like to thank the UMD libraries for their unwavering support through the Library Award and our librarian, Ms. Kelsey Corlett-Rivera. Lastly, we are so grateful to the Sita Lab and Torrents Lab for generously providing us with lab space and to Kätchen and Marya- without your all of your assistance, this process would have been much more difficult.

META: Design and Fabrication of a Photonic Memristor

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Dr. Min Ouyang, Professor, Department of Physics, UMD

Research Description

A memristor is a nonlinear circuit element whose impedance depends on the history of current through the device. Photonic circuits are analogous to electronic circuits, but use photons rather than electrons to transfer signals. Circuit elements in conventional circuits, then, carry over to photonic circuits. With this in mind, we designed and constructed the analogue of a memristor for use in a photonic circuit, in the visible regime. We constructed a five-by-five array of nanorods, each with height 3.5 μm and pitch 3 μm, and coated in 100 nm of gold. We then immersed the array in a 10% by weight solution of Poly(N-isopropylacrylamide) (PNIPAM) dissolved in D2O. We chose to use PNIPAM as it expands with increasing temperature around 32 degrees celcius, so as to increase the pitch of the array. According to our simulations, changes in the pitch modify the transmittance of visible-regime light. We tested these effects by heating the structure with a ceramic element, and measuring the transmission of visible light. Future directions should move away from the use of an external heating source, so as to be useful in photonic circuits.

Acknowledgements
We would like to that everyone who has supported and provided guidance to us throughout our project. First, we would like to thank Dr. Min Ouyang for his lasting support for our team research and individual endeavors. Next, we would like to thank the Gemstone staff, including Dr. Frank Coale, Dr. Kristan Skendall, Vickie Hill, and the rest of the support staff, who provided us with the opportunity to conduct research under the Gemstone Program. Additionally, we would like to thank our team librarian, Nevenka Zdravkovska, as well as our discussants Dr. Marina Leite, Dr. Anil Deane and Dr. Steven Anlage for guidance in analysis of our data and ideas. Finally, we would like to thank our friends and families for supporting us.

MICRO: Variable Fenestration of a 3D Nanoprinted Liver Sinusoid on a Chip

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Dr. Bhushan Mahadik, Assistant Director, National Institute of Health (NIH) Center for Engineering Complex Tissues
Dr. Margaret Scull, Assistant Professor, Department of Cell Biology and Molecular Genetics, UMD

Research Description
Here we report a novel strategy for engineering liver sinusoids with designed fenestrae that yield near uniform microfluidic flow conditions along the length of the microstructure – capabilities enabled by the use two-photon direct laser writing (DLW). To better model organ systems, researchers have increasingly investigated the use of DLW as a promising means for mimicking both architectures and length scales of physiological components. DLW-based approaches could enable liver sinusoids to be recreated in vitro; however, recent efforts to construct permeated tubules exhibit dramatic decreases in fluid flow through the pores downstream. To overcome such issues, here we applied microfluidic circuit theory and in-situ DLW (isDLW) to manufacture liver sinusoids that included fenestrae with distinct sizes to better maintain a consistent fenestra-specific flow profile. Specifically, fenestrae radii were increased from 0.75 µm to 2.01 µm over the length of a 510-µm sinusoid. Theoretical results revealed that the flow rate through the fenestrae could be more maintained along the length of the optimized sinusoid versus the unoptimized sinusoid with uniform fenestrae which results in inconsistent fluid flow. Preliminary results revealed successful isDLW fabrication of the optimized sinusoid, with proof-of-concept microfluidic flow demonstrations that suggest that the presented strategy could benefit numerous biomedical applications. These results suggest the potential of this design strategy for liver on-a-chip modeling, and given the numerous anatomical structures similar to the presented fenestrated sinusoid, this approach could be extended to model additional organ systems of the body for disease modeling and drug screening.

Acknowledgements
We would like to acknowledge the assistance from the following people and organizations; the Bioinspired Additive Manufacturing (BAM) Laboratory members Andrew Lamont, Abdullah Alsharhan, and Michael Restaino, FabLab staff members including Mark Lecates and John Abraham, as well as Terrapin Works especially Caroline McCue. Finally, we would especially like to thank Dr. Frank Coale, Dr. Kristan Skendall, and all of the Gemstone staff for their assistance with our team development over the past four years.

OMEGA: Genetic modification of probiotic E. Coli to produce Omega-3 fatty acids

Research Team

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Research Description

Omega-3 fatty acids are an essential component of the human diet. omega-3 fatty acids have been linked to reduced risk of both neurological and cardiovascular diseases in humans. Although fatty fish contain gut symbionts that produce omega-3, such as Shewanella baltica (S. baltica), many of these fish are expensive and inaccessible to most of the population. To address this, probiotic bacteria will be modulated to produce omega-3, which can then be applied to various food products. The bacteria will be modulated by 1) isolating the omega-3 producing gene cluster from S. baltica and inserting the cluster into lab grade Escherichia coli; 2) transferring the genes to a probiotic, food-safe strain, E. coli Nissle; and 3) measuring omega-3 production in the bacteria through high-performance liquid chromatography (HPLC). If the genes are successfully transferred to E. coli Nissle, then the HPLC should indicate omega-3 production. This bacteria can be applied to fermented foods like yogurt with other probiotics. This new application would not only increase access to omega-3, but also provide a significant environmental benefit through reduced overfishing currently caused by the mass production of fish products for their omega-3 benefits.

Acknowledgements

First we would like to acknowledge our mentor, Dr. Biswas, and all of the members of Dr. Biswas's lab including Jungsoo Joo, Zajeba Tabashum, and Vinod Nagarajan. We would also like to thank Mark Stewart and the Sustainability Office for their generous funding and Stephanie Ritchie, our librarian, for her assistance with drafting our literature review and commentary on our proposal defense. Finally, we would like thank our friends and family for their support as well as Dr. Skendall and Dr. Coale and the rest of the Gemstone staff.

Oysters: Alternative substrates for restoration of the Chesapeake Bay's eastern oyster, *Crassostrea virginica*: An evaluation using additive manufacturing and electrolysis mineral accretion

Research Team
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Research Description
Over the past century, the population of the Chesapeake Bay's eastern oyster, *Crassostrea virginica*, has collapsed dramatically, endangering the ecology of the bay and economy of the surrounding area. Declining shell numbers limit the growth of current oyster populations and have led to the use of alternative substrate material as a method for oyster restoration. Motivated by successful coral reef restoration efforts and the emerging field of additive manufacturing, we tested the use of electrolysis mineral accretion and Fused Deposition Modeling (FDM) to create artificial substrate for oyster spat settlement and survival. To start, we employed electrolysis mineral accretion with the goal of creating a sustainable and adequate amount of calcium carbonate ($CaCO_3$) substrate. Mineral accretion rates were restrictive in our closed system, and we were unable to create sufficient substrate to test settlement. Second, we used 3D scanning and FDM to print artificial oyster shells identical to their natural counterparts, using a filament containing $CaCO_3$. Using 3D printed oyster shells, we tested the importance of physical structure versus the presence of intrinsic biochemical cues in oyster settlement rates. Our results indicated that the oyster spat did not achieve significant survival on the printed material. Similarly, the use of the biochemical cue L-DOPA was insufficient in encouraging larval settlement on printed shells, indicating the significant role played by the underlying shell composition. The results indicate that the biochemical properties of the substrate take precedence over the geometric similarity to natural shells, a finding which should guide future methodology in oyster restoration.

Acknowledgements
We would like to express our sincere appreciation to our advisor, Dr. Kennedy Paynter, for his constant support, knowledge, and enthusiasm for our project. We are grateful for the assistance of the Paynter Lab, Horn Point Oyster Hatchery, and VIMS Eastern Shore Laboratory. We appreciate the guidance and hard work of Preston Tobery with our 3D printing endeavors. We are also thankful for the access we have as students to 3D printing technology at the John and Stella Graves Makerspace and Terrapin Works. We also wish to thank our librarian, Stephanie Ritchie. We would like to thank the incredible Gemstone faculty and staff including Dr. Frank Coale, Dr. Kristan Skendall, Vickie Hill, Leah Tobin, and Jessica Lee for a remarkable four years. Finally, we are indebted to our loving families for their support throughout our undergraduate careers.

Pressure: Investigating Methods of Blood Pressure Measurement

Research Team
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Eric S. Murray, Finance and Operations Management & Business Analytics
Jonathan A. Sandoval, Aerospace Engineering
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Librarian
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Discussants
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Dr. Sandra Saperstein, Lecturer, School of Public Health, UMD
Dr. Bao Yang, Professor, Department of Mechanical Engineering, UMD

Research Description
Currently, one in three American adults suffer from high blood pressure, a condition known as hypertension. Our team has spent the past few years exploring methods of continuous blood pressure measurement. Using various methods to fluctuate blood pressure, we have gathered blood pressure data from 35 healthy adult participants. This data will be useful in measuring pulse transit time and determining optimal locations for biosensor placement. We also surveyed participants to collect public opinion on health monitoring devices. Furthermore, our team has explored the potential of using mobile device applications as an alternative method of retrieving signals and calculating blood pressure. The results from our research project have the potential to inform future studies that are focused on monitoring blood pressure.

Acknowledgements
We would like to express our gratitude towards our mentor, Dr. Jin-Oh Hahn, for his unwavering support throughout our collegiate careers. His expertise has been instrumental in guiding the trajectory of our research project and ensuring the success of our team. Furthermore, we would like to recognize the Gemstone staff for providing us with this unique opportunity that enabled us to explore the research process. Their investment into this program is much appreciated. We would also like to express our thanks to Dr. Gimer Blankenship and Dr. Thomas Murphy for providing advice during the early stages of our project development.

Purify: Sustainable Greywater Filtration on a Residential Scale

Research Team
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Dr. Lora Harris, Associate Professor, Center for Environmental Science, UMD
Mr. Bryan Quinn, Director of Technical Operations at Institute for Research in Electronics and Applied Physics (IREAP), UMD

Research Description

We have designed, prototyped, and integrated a non-portable, residential-scale greywater filtration system into a house. The system pulled greywater from a collection reservoir and supplied treated water for irrigation, car washing, and clothes washing. In conventional wastewater treatment, greywater and blackwater are mixed together in domestic sewage systems. Because of the clean nature of greywater relative to blackwater, we built a filtration system which separated these streams in order to gain additional efficiency. The system was built with components which were less likely to corrode over time and could be recycled for reuse. It used a variety of filtration methods incorporating micron filters, ceramic filtration, mineral sand filtration, activated carbon filtration, and ultraviolet filtration. We have conducted multi-phase water testing on the following parameters: chemical oxygen demand, biochemical oxygen demand, pH, total and fecal coliforms, turbidity, total organic carbon and total organic nitrogen. Although pilot scale systems have been created for the recycling of greywater, application on the household scale remained unexplored. On such a small scale, treatment options are limited, and economic potential is negatively affected. Nevertheless, our engineering prototype proved capable of functioning in a real-world setting, filtering water to meet non-potable urban reuse standards, thus reducing demand for water filtered to drinking water standards.

Acknowledgements
We would like to thank our team mentor Dr. Ray Adomaitis as well as Dr. Skendall and Dr. Coale. We appreciate support from the Solar Decathlon team, Fred Werth, and Emily Goo. We would also like to thank the Sustainability Fund for the financial support.

SPACE: Development of Additively Manufactured Rigid Spacesuit Components for Long Duration Missions

Research Team

Harrison Troy Bartlett, Aerospace Engineering
Joseph Nicholas Bowser, Electrical Engineering
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Mr. Andrew Lamont, PhD Candidate, Bioinspired Advanced Manufacturing Lab, UMD
Mr. Michael Restaino, PhD Candidate, Bioinspired Advanced Manufacturing Lab, UMD

Research Description

Long duration human exploration of Mars will pose new demands on spacesuits that current designs are unable to overcome, including the need for in-situ replacement and repair of suit components. While this cannot be accomplished with the “soft goods” traditionally used to make spacesuits, recent advancements in additive manufacturing (AM) technologies provide a wealth of capabilities to repair or replace rigid pressure garments on-site and on-need. “Hard suits” utilize sealed rotary bearings for mobility and a rigid body which maintains a constant pressure and volume, reducing the energy demands on the astronaut operating the suit. This thesis focuses on the first steps towards verifying in-situ hard suit manufacturing: the integration of additively manufactured suit components into a functional arm segment. We conducted tensile and hydrostatic tests on printing materials and selected the top-candidate for the development of rigid wedge elements. AM bearing configurations were tested under nominal operational loads, and seals were incorporated to allow for pressure retention. Selected components were integrated into a full-scale hard suit arm, that was compared in performance to a state-of-the-art EMU arm through human tests in a pressurized glove-box. Our results indicated that further refinement of hard suits has the potential to match the performance of operational EMU models while reducing the logistical issues associated with current spacesuits in long term missions.

Acknowledgements

We would like to offer an enormous thank you to Dr. David Akin for his guidance and support throughout this four-year process, we could not have done it without him! Additionally, we would like to thank Dr. Mary Bowden, Dr. Andrew Becnel, Lemuel Carpenter, Andrew Lamont, and Michael Restaino for serving as discussants for our thesis. Lemuel Carpenter and Dr. Andrew Becnel also provided us with advice and assistance that we are extremely grateful for. Thank you also to Dr. Sarah Over and Elizabeth Soergel for their guidance as our team librarians. We would also like to acknowledge Tracie Prater and the NASA personnel who provided us with support throughout the 2017 X-Hab Academic Challenge. Finally, we would like to thank the Gemstone Honors Program staff - Dr. Frank Coale, Dr. Kristan Skendall, Dr. Vickie Hill, Leah Tobin, and Jessica Lee - for providing the opportunity to engage in an extensive interdisciplinary research project as undergraduate students

VOLTAGE: Modeling for Power Consumption and Operation in a Bistable Electrowetting-Based Display

Research Team
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Dr. Gradimir Georgevich, Principal, BioNanoServe Consulting

Research Description
Team VOLTAGE is an undergraduate research team based in the University of Maryland's Gemstone research program. Their objective to advance research related to modeling e-paper technologies. Experimentation with electrowetting display fabrication techniques, followed by modeling based on measured parameters is performed. Both numerical and circuit-based simulations are performed. The resulting power consumption characteristics are presented and discussed.

Acknowledgements
We would like to thank the numerous individuals who contributed to our research. Thank you to each of our Launch UMD donors. We would also like to thank the many researchers who aided us in our pursuit of knowledge: Dr. Kristin Charipar and the Naval Research Laboratory, Dr. Matthew Hagedon and the Johns Hopkins Applied Physics Lab, and University of Maryland FabLab. We are incredibly grateful for the support of our mentor, Dr. Pamela Abshire, and our librarian, Ms. Celina McDonald. We would also like to thank Dr. Sangwook Chu for his guidance. And of course, we would like to thank the Gemstone staff and the Gemstone community for their unwavering friendship and support. Thank you.

GEMSTONE
Honors College
University of Maryland

CLASS OF 2020: 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 17, 2020!

JUNIOR POSTER ABSTRACTS

ART: Augmented Reality Technology

Team Members: Christine Bailey, Jacqueline Deprey, Abdulfatai Fakoya, John "Jack" Nolan, Ivan Quiles, Cameron Soderberg, Junie Wu, Richard Yu
Faculty Mentor: Dr. Matthias Zwicker, Reginald Allan Hahne Endowed E-Nnovate Professor in Computer Science, UMD
Librarian: Dr. Nevanka Zdrakovska, University Libraries, UMD

Research Description
Individuals with learning disabilities drop out of school at a rate twice that of their general education peers. Dyslexia, a disorder which affects one's ability to read and write, is among the most common of these learning disabilities affecting one in five people worldwide. As members of Team ART, we aim to explore the use of augmented reality (AR) as an assistive device platform for people with dyslexia. We first began our project by surveying the dyslexic community to determine the most helpful features and user interface for an application that provides real time handwriting correction for people with dyslexia. The feedback from the dyslexic community and interviews with members of the Special Education Department at University of Maryland facilitated the ideation of our design which iteratively evolved into our prototype application. Now that prototype-development phase is complete, we are beginning to perform controlled tests to determine the efficacy of the application in improving the dyslexic population's writing abilities and increasing their motivation to learn. Through our research, we hope to create a learning environment where students of all abilities can succeed!

CAPTURE: Functionalization of Consumer Grade Fabric for Atmospheric Carbon Capture

Team Members: Sean Cook, Pablo Dean, Eli Fastow, Patrick Ott, Jonathan Wilson, Hojin Yoon
Faculty Mentor: Dr. Mohamad Al-Sheikhly, Professor, Department of Materials Science and Engineering, UMD
Librarian: Mr. Jordan Sly, University Libraries, UMD

Research Description
Primary amines form a key component of a well studied mechanism for capturing carbon dioxide (CO_2) from the atmosphere. Our study is comprised of a single step synthesis of a novel sorbent for CO_2 by grafting monomers rich in primary amines to three commercial grade fabrics: polyethylene terephthalate, high density polyethylene, and nylon 6. Initial evaluation of the chosen monomers', allylamine and butenylamine, sorbency qualitatively confirmed their ability to extract CO_2 from the atmosphere. Six novel copolymers, comprised of each of the three fabrics grafted with one of each monomer, were synthesized using radiation induced graft copolymerization through electron beam irradiation. All fabrics achieved greater grafting with butenylamine as compared to allylamine, likely given the closer proximity of the primary amine to the radical on the latter's structure. Primary amines can stabilize radicals, preventing copolymerization reactions. Characterization of sorbency revealed that the majority of the grafted amines likely reacted to adsorb CO_2. Therefore, the amount of amine grafted comprises the primary limiting factor on the sorbents' CO_2 capacity.

JUNIOR POSTER ABSTRACTS

COR: Cardiovascular Oriented Research

Team Members: Tiffany Cao, Victoria Haass, Tom Kariyil, Samantha Kennedy, Carly Rosenfeld, Matthew Sandruck, Aza Shiao, Madina Smagulova, Margo Sybert, Syona Tuladhar, Justin Wu
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Librarian: Ms. Nedelina Tchangalova, University Libraries, UMD

Research Description
The goal of this study was to explore the atherosclerotic pathway and the prevention of arterial plaque buildup using microRNA (miRNA) delivered in rHDL particles. Research shows that individual miRNA can interrupt the formation of protein receptors on macrophages, which prevents macrophages from taking up oxidized low-density lipoproteins (oxLDL) and forming arterial plaques. After a thorough literature review, the most promising gene to target was LOX-1 because it encodes for receptor protein LOX-1 which plays a major role in atherogenesis- the progression of atherosclerosis. For our research, we have decided to deliver a single type of miRNA in reconstituted HDL (rHDL) to a macrophage cell line. The purpose of this study was to inhibit the expression of oxLDL receptor LOX-1 with miRNA let-7g, delivered in an rHDL particle, in order to diminish the amount of oxLDL taken up into macrophage cells.

E-JUSTICE: Investigating Environmental Justice in Maryland

Team Members: Maud Acheampong, Candela Cerpa, Anna Cheng, Nicolette Corrao, Audrey Krimm, Shifali Mathews, Haley Mullen, Olasunbo Salami, Lynne Zhang, Jaclyn Zidar
Faculty Mentor: Joanna Goger, J. D., Associate Professor, Department of Environmental Science & Policy, UMD
Librarian: Dr. Kelley O'Neal and Judy Markowitz, University Libraries, UMD

Research Description
By understanding the implications of environmental justice, our team seeks to research the disparity between exposure to environmental hazards between different socioeconomic and racial groups in the context of flood risk caused by sea level rise and major storm events. Our research has identified areas of Maryland with high socio-economic vulnerability, flood risk, and environmental risk and to assess whether emergency preparedness policies in these areas are effective in ensuring the fair treatment and meaningful involvement of vulnerable populations. We have characterized this injustice based on a review of flood policies in areas of Maryland that are susceptible to flood risk. Two phases of research are conducted, with the first determining which counties meet our criteria of containing low-income, minority populations, and being subject to flood risk. This phase takes into account demographic information and flood risk, as well as the locations of Superfund sites and other environmentally hazardous sites. With the use of GIS technology to visualize risk factors, we have chosen various counties in Maryland on which to use as our focus of comparison. The second phase involves analyzing the policies of the selected counties at the local, state, and federal levels. We are also interviewing individuals involved in the emergency preparedness policies and practices to gain a better understanding of the reality of their implementation. We expect to expose a disconnect between written policy and what is being implemented.

JUNIOR POSTER ABSTRACTS

FEELS: Tactile Feedback for Less Invasive Surgery

Team Members: Sophie Darwin, Salma Ghorab, Priya Kulkarni, Melika Marani, Emma Margolis, Priya Mittu, Sara Pohland, Rachel Wills
Faculty Mentors: Dr. Bao Yang, Professor, Department of Mechanical Engineering, UMD
Librarian: Ms. Stephanie Richie, University Libraries, UMD

Research Description
Robotic-Assisted Surgery (RAS) improves upon traditional minimally invasive (MIS) and open surgical techniques by maintaining the benefits of MIS while also providing surgeons with a wider range of motion, increased depth perception and control for tremors. However, inherent limitations of the technology mean that surgeons performing RAS must rely solely on visual feedback. This creates a steep learning curve for the technique. Previous literature and results from our own survey (n = 15) of robotic surgeons suggested that the introduction of haptic feedback to RAS will improve overall patient outcomes as well as decrease error rates and operating times for surgeons. Our survey indicated that information about tissue firmness would be the most helpful feedback for surgeons. To address this issue, we proposed a proof-of-concept addition to RAS systems that relays the firmness of soft tissue to surgeons. This prototype consists of a three-part system involving a sensor apparatus, relay system, and novel feedback mechanism. We constructed a probe containing a piezovibrative sensor to collect information on silicone samples of known varying firmness. This information was relayed to an arduino microcontroller, from which we generated a current that was amplified into a solenoid actuator. As the current varies based on the firmness of the material, the user will feel a different force from the actuator. For enhanced feedback, we created an encasement for the actuator system using silicone, a known tissue-mimicking material. Further research will be done to integrate the components and test the system with participants

LYTIC: Therapeutic Use of Bacteriophage Cocktails for the Treatment of Antibiotic Resistant Acinetobacter baumannii Infections

Team Members: Kierstin Acuña, Mariama Barrie, Madeline Beaudry, Rory Cooley, Colin Fields, Spencer Grissom, Zachery Keepers, Anna Lavrentieva, Hannah Sutton, Timothy Walsh, Natalie Wittick
Faculty Mentors: Mr. Kevin Knapstein, Manager of Bioprocess Scale-Up Facility
Librarian: Ms. Zaida Diaz, University Libraries, UMD

Research Description
Widespread use of antibiotics has enriched global bacteria populations for strains possessing antibiotic resistance (AR) genes. Proliferation of AR genes and mechanisms have resulted in numerous multidrug resistant (MDR) infections for which there are no effective treatments. *Acinetobacter baumannii* is a major cause of hospital acquired (nosocomial) infections, and is associated with outbreaks of MDR infections. Since the emergence of AR, *A. baumannii* has been declared an ESKAPE organism. Virulent bacteriophages (phages) present a way to remedy bacterial infections, while also having built in mechanisms to prevent resistance. This proposed study aims to develop a cocktail of phages targeting antibiotic resistant *A. baumannii* by deriving phages from parent lineages and testing them both individually and in combination to characterize their bactericidal activity. To prove this concept, the effectiveness of phages will be shown used in conjunction with standard antibiotics and *Bdellovibrio bacteriovorus* bacteria, as well as stand-alone phage cocktails.

JUNIOR POSTER ABSTRACTS

OPTIC: Building an Underwater Optical Wireless Communications System

Team Members: Arjun Agarwal, Andrew Chen, Thomas Good, Miles Grissom, Daniel Klawson, Jacob Levit, William Nix, Michael Piqué, Edward Salvatierra, Nicholas Zhao
Faculty Mentor: Dr. Ashok Agrawala, Director of the Maryland Information and Network Dynamics (MIND) Lab, College of Computer Mathematics and Natural Sciences (CMNS), UMD
Librarian: Ms. Nevenka Zdravkovska, University Libraries, UMD

Research Description
Team OPTIC is a Junior Gemstone team, mentored by Dr. Ashok Agrawala, investigating the use of optical wireless communication for transmitting and receiving data underwater at ranges suitable for scuba diving applications. The current methods of communication for scuba divers are limited to hand signals and acoustic communication; hand signals communicate very little information, and acoustic systems are power inefficient and unsuitable for higher data rates. An optical wireless communication system using unfocused blue light is proposed due to its lower power consumption and higher data rates underwater. We designed the hardware for the optical transmitter as well as the receiver to send and receive signals in the kHz frequency range. Additionally, software was developed to encode and decode data packets sent via the optical link using the Manchester encoding scheme. We also worked on designs for attaching the transmitter/receiver combination to the scuba diver and constructed a test rig to run experiments on the system underwater. We have gradually increased the data rates and distance at which we can transmit and aim to use the hardware and software we created to transmit audio and sensor data underwater. Our future plans include incorporating a star network structure, or a network where each scuba diver transmits to a central node that processes each message and relays communications to the other scuba divers. We also aim to test this technology in a variety of environmental conditions that affect the transmission and absorption of the optical signal.

PROCESS: A Data-Driven Approach to NBA Team Building

Team Members: Hyunsoo Chun, David Creegan, William Disher, Olivia Majedi, Matthew Moore, Daniel Smolyak, Brian Valcarcel
Faculty Mentor: Dr. Sean Barnes, Assistant Professor of Operations Management, R.H. Smith School of Business, UMD; Dr. Margaret Bjarnadottir, Assistant Professor of Management Science and Statistics, R.H.Smith School of Business, UMD
Librarian: Dr. Susan Wiesner, University Libraries, UMD

Research Description
In the National Basketball Association (NBA), it has historically been difficult to build and sustain a team that can consistently compete for championships. Given this challenge, we have developed a framework to support NBA teams make data-driven decisions to improve their chances for success. As such, we have collected data that includes team and individual player statistics, transactions, salaries, and regular season and playoff results since 1980, which coincides with the introduction of the 3-point field goal. Using this data, we have developed a set of analyses that capture several facets related to the construction of NBA rosters and their performance. In our analysis of on-court performance, we have used clustering algorithms to classify both teams and players in terms of playstyle, and determined which team and individual playstyles tend to lead to success. In our analysis of roster construction and transactions, we have analyzed the relative value of draft picks and the impact of trades involving draft picks, as well as analyzed the effect of roster continuity (i.e. maintaining the same players across seasons) on team success. Additionally, we have developed a model for predicting player contract values and performance versus contract value, which will help teams in identifying the most cost-effective players to acquire. Ultimately, this assembly of analyses, in conjunction, can be used to inform any NBA team’s decisions in its pursuit of success.

JUNIOR POSTER ABSTRACTS

SWARM-AI: Rapid Terrain Mapping Using a Simple Swarming Approach

Team Members: Sara Celidonio, Nathan Hoffman, Helen Kent, Paul Motter, Matt Patsy, Kevin Postlethwait, Henry Tuit Farquhar
Faculty Mentors: Dr. Anil Deane, Affiliate Associate Research Scientist, UMD
Librarian: Celina McDonald, University Libraries, UMD

Research Description
Even experienced users of aerial drones often find it difficult to integrate the various technologies needed to create a drone swarm. Our team reviewed the available technologies and programs needed to create a drone swarm and designed a platform that would make it easier for users implement their own swarming methods to achieve a desired mission. The platform simplifies the process by including built in calculations, and programs that are necessary for all swarming approaches. To test our platform, we designed a mission wherein four drones would use an explicit swarming approach to map a previously defined area using a Raspberry Pi camera. In order to set-up the mission our team developed adjustable field of view calculations for the camera, as well as algorithms responsible for partitioning, waypoint creation, and path planning for each drone. Our team then created a simulation of the mission in Gazebo to test the viability of our set-up. Finally, the four drones completed the designated mission in an enclosed flight facility, and data was taken to determine the drone's efficiency and accuracy. The data collected demonstrates the efficiency of completing tasks while using a swarming approach, and the necessity of making its technology more widely accessible.

TISSUE: Cryogenic 3D Printing of Collagen-Based Hydrogels

Team Members: Yahya Cheema, Kunal Dharmadhikari, Michael Hildreth, Neal Kewalramani, Catherine Liu, Alexi Rodriguez, Danielle Sidelnikov, Pavan Vemulakonda, Linnea Warburton
Faculty Mentor: Dr. Lester Schultheis, Director of Food and Drug Administration Regulatory Science and Innovation Initiative
Librarian: Dr. Sarah Over, University Libraries, UMD

Research Description
Our goal was to evaluate the performance of 3D hydrogel prints fabricated on a cryogenic build platform compared with those fabricated at room temperature. Early work reveals that 3D printed hydrogel lattices tended to lose geometrical definition immediately. Because of prior research, we hypothesized that rapid cooling during deposition would improve print resolution, maintain definition and allow for taller, more detailed prints. CELLINK Bioink was 3D printed in rectangular lattices on glass coverslips in an Inkredible+ 3D printer with a 30 gauge nozzle. The temperature of the build platform was controlled to be either room temperature (23 C) or cryogenic temperature (0 C) using a custom Peltier junction system. Controlled cooling of the build platform was managed after calibration with a K-type thermocouple (Omega SA1XL-K-120), custom analog electronics, and LabView sampled data acquisition system. Layers were cooled to approximate build platform temperature before apposition of a new layer. The print resolution determined by the size of the rectangular areas of lattice structures constructed cryogenically, was compared to prints made at room temperature. Smaller sized lattice openings are ideals as they indicate higher resolution of the print because more detail was preserved. Geometrical resolution of 14 lattices fabricated at room temperature (23 C) were compared to 15 lattices built at cryogenically (0 C). The following images reflect the typical differences associated with build temperature.

JUNIOR POSTER ABSTRACTS

VISOR: Developing an Integrated Heads Up Display for Astronauts

Team Members: Katheryn Fox, Radhika Karsalia, Jillian Kunze, Christoph Neisess, Zachary Peters, Roshan Rao, Brady Sack, Matthew Sieh, Ryan Skoletsky, Shelly Szanto, Matthew Wilkin
Faculty Mentor: Dr. David Akin, Associate Professor, Director of Space Systems Laboratory, Department of Aerospace Engineering, UMD
Librarian: Lindsay Inge, University Libraries, UMD

Research Description
Spacesuits impose a significant burden on the wearer in terms of isolation and lack of dexterity. This difficulty will be increasingly significant in future space exploration missions, where time delays or lack of line-of-sight to Earth will effectively isolate the astronauts. To address this problem, we have been investigating options to enhance data presentation to spacesuited crew through the development of helmet-mounted, non-obstructive, visual overlays. Previous research has focused on the provision of head-mounted displays for one or both eyes that could pivot up onto the forehead when not in use. This proved cumbersome, so we are proceeding with two current efforts in parallel. In the first, we have developed a display for the Microsoft HoloLens. This display provides a high-resolution visual display that does not obstruct the actual visual field; however, the HoloLens has a very small field of view. Therefore, our parallel effort is focused on a helmet specifically designed to incorporate an internal projecting system and optics to provide an overlay on an external visor assembly, which can be adjusted as needed.

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