THE UNIVERSITY OF RHODE ISLAND

COLLEGE OF ENGINEERING

e-Week

RESEARCH SHOWCASE

APRIL 21, 2025

THE UNIVERSITY OF RHODE ISLAND
COLLEGE OF ENGINEERING

e-Week 2025

Welcome to the 2025 Engineering Week Research Showcase.

This showcase highlights the innovative and impactful research being carried out by our students across all levels from high school, undergraduate, to graduate. Each project represents a commitment to curiosity, creativity, and the desire to solve real-world problems. From renewable energy systems and nanomaterials to water treatment, biomedical devices, and AI, the work in this research showcase here reflects the wide range of research happening in our college.

We are especially proud to feature participants from the Rhode Island Nano-Bio Engineering Academy, whose posters mark the culmination of an eight-week collaboration between URI faculty, graduate students, and local high schools. This spirit of mentorship and hands-on learning continues through the afternoon with undergraduate and graduate student presentations.

As you explore the posters and speak with presenters, I hope you are inspired by their dedication and the exciting possibilities their work represents.

SCHEDULE

Rhode Island Nano-Bio Engineering Academy
10:30 am -12:00 pm., Toray Commons, Fascitelli Center for Advanced Engineering

Undergraduate Student Posters
Toray Commons, Fascitelli Center for Advanced Engineering
1:30 pm – 2:30 pm. Session A (Posters # 1 – 33)
2:30 pm - 3:30 pm. Session B (Posters # 34 – 65)

Plenary Lecture
4:00 pm – 5:00 pm. Professor Haibo He, Robert Haas Endowed Professor in the Department of Electrical, Computer and Biomedical Engineering. Title "*Integrated Neural Network and Reinforcement Learning for Decision Making*"

Graduate Students Posters and Reception
Toray Commons, Fascitelli Center for Advanced Engineering
5:00 pm – 6:00 pm. Session A (Posters # 1 – 22)
6:00 pm – 7:00 pm. Session B (Posters # 23 – 44)

THE UNIVERSITY OF RHODE ISLAND
COLLEGE OF ENGINEERING

e-Week 2025

List of Undergraduate Posters Presenting on Session A

Poster #, Title, Presenter

2. Evaluating Plastic Degradation in Simulated Wastewater. *Presenter: Kendrick Beaubrun*
3. Isolated LLC Resonant DC-DC Converter with Hybrid Control for Fast Transient Response and Low Noise. *Presenter: Gianni Smith*
4. High-Efficiency Wireless Power Transfer (WPT) System for Autonomous Underwater Vehicles (AUVs). *Presenter: Patrick Feliz*
5. Smartphone App Development for Water and Health Humanitarian Emergencies*Presenter: Jacob Silva.*
6. The effect of rigid and flexible vegetation on waves, and sediment transportation in a sloped beach environment. *Presenter: Heather Palardy*
7. Investigation of the Effect of Bio-Inspired Leading-Edge Tubercles on Hydrokinetic Turbine Performance. *Presenter: Ryan Cassin*
8. Classification of DNA Sequences Using Pytorch. *Presenter: Kaitlyn Lum*
9. Modeling the Mechanical Impact of REOB in Asphalt Through Molecular Dynamics Simulations. *Presenter: Aaron Iwanski*
10. Financial Advisor AI: An Intelligent Investment Assistant Leveraging LLMs and Real-Time Market Data. *Presenter: Jack DeMarinis*
11. Generative AI. *Presenter: Jack DeMarinis*
12. Undergraduate Research Assistant. *Presenter: Marcus Orr*
13. characterizing marine bacteria growth conditions. *Presenter: Liam Earley*
14. Noise in the Vote-by-Mail Tabulation Process. *Presenter: Cristian Varela*
15. Modeling the Mechanical Impact of REOB in Asphalt Through Molecular Dynamics Simulations. *Presenter: Devon Wakelin*
16. ECBE Department Chatbot. *Presenter: Zachary Notarianni*
17. Dynamics of Grafted Nanoparticle Solutions. *Presenter: David Amirsadri*
18. Covalent modification of carbon nanotube surface via a peroxide-mediated reduction of aryl diazonium salts to enhance near-infrared fluorescence. *Presenter: Jayden St. Louis*
19. From Election Day to Warehouse Facilities: Determining Spatial Requirements for the Storage of Voting Equipment. *Presenter: Grace Marrier*
20. Analysis of Vote-by-Mail Ballot Opening and Extraction Process Variations. *Presenter: Juan Zubieta*
21. Quantifying Artificial Intelligence's Energy Footprints. *Presenter: Oluwatosin Okele*
22. Evaluation of occupational exposure to nanoparticles through magnetic aerosol quantification. *Presenter: Maria Mozeleski*
23. Research Assistant in Generative AI. *Presenter: Richard Buckley*

24. Advancing Neurorehabilitation With a Modular Platform for Reach-to-Grasp Task Analysis. *Presenter: Luci Schneider*

25. Characterizing Error of Wearable Inertial Measurement Units (IMUs) Computing 2D Wrist Kinematics during Activities of Daily Living. *Presenter: Maria Morrow*

26. Retrieval Augmented Generation Optimization for LLMs. *Presenter: Garrett Kemper*

27. MINDER EDA Wearable. *Presenter: Ben Annicelli*

28. Fast Fourier Accelerator for Space Bourne Instruments. *Presenter: O'Malley Sherlock*

29. Analyzing the Reuse of Plastic Waste for Building Materials. *Presenter: Trinity Saab*

30. Optimizing Cold Storage Conditions for Lipid Nanoparticles. *Presenter: Maya Sheridan*

31. Paper or Ballot Marking Device? Simulating the Future of Georgia's In-Person Voting. *Presenter: Melany Tabares*

32. Synthesis of Polyethylene Glycol Coated Magnetic Nanoparticles for Biomedical Applications. *Presenter: Anna Erb*

33. Predicting Vertical Wave Forces on Elevated Coastal Structures. *Presenter: Aiden Sylvestre*

List of Undergraduate Posters Presenting on Session B

Poster #, Title, Presenter

34. Smartphone App Development for Water and Health Humanitarian Emergencies. *Presenter: Aryana Sadr*

35. Vertical Forces in Waves on Coastal Structures. *Presenter: Bailey Bolton*

37. Methods In Analyzing Axial Loading In Piles Within Offshore Wind Turbine Jacket Structures. *Presenter: Samantha Kipper*

38. Conductive Liquid-Crystal Elastomers for Soft Actutors*Presenter: Liam Kennings*

39. Development and Characterization of Paclitaxel and Iron Oxide-Loaded PEGylated Nanocomposite Microparticles via Spray Drying for Synergistic Pulmonary Chemotherapy and Hyperthermia. *Presenter: Savanna Sheffield*

40. High-Efficiency Wide-Range DC-DC Converter with Fast Transient Response and Low Noise. *Presenter: William Lucas*

41. Single Particle Tracking for Sensing Intracellular Cell Properties. *Presenter: Hayden Reilly*

42. Gesture & Object Recognition in Large Language Models (LLMs) for Robotic Arm-Assisted Rehabilitation. *Presenter: Arouney Sithtaphone*

43. Researcher. *Presenter: Andrew Delano*

44. Computational Study of Ship Maneuvering in Bidirectional Seaways. *Presenter: Xavier Morrissey*

45. Applications of GPR on a Fairing for Bubble Mitigation. *Presenter: Deirdrah Urban*

46. The effect of rigid and flexible vegetation on waves, and sediment transportation in a sloped beach environment. *Presenter: Kitara Pottebaum*

47. Development of Optical Strain Sensing â€œSmart Textileâ€ for Non-contact Monitoring of Strain. *Presenter: Emily Grevell*

48. Multi-Planar CFD Analysis of Axial and Lateral Force Dynamics in Tumblehome Hull Propulsion and Maneuvering Systems. *Presenter: Harrison Schmidt*.

49. Best Practices For Sterile Mammalian Cell Culture For Use With Single-Walled Carbon Nanotube Uptake Investigations. *Presenter: Eryn Wale*

50. Developing Biocompatible Single-Walled Carbon Nanotubes for Intracellular Fluorescence-Based Biosensing. *Presenter: Eryn Wale*

51. Wearable Inertial Measurement Units versus Optical Motion Capture: Characterizing IMU Error Computing 2D Wrist Kinematics during Activities of Daily Living. *Presenter: Katelyn Daniewicz*

52. Establishing a Neonicotinoid Monitoring Program Across Audubon Society of Rhode Island Wildlife Refuges. *Presenter: Justin Evans*

53. Synthesis, Characterization, and Analysis of Magnetic Nanoparticles for Targeting Bacterial Marine Biofilms. *Presenter: Franny Duong*

54. Iron oxide magnetic nanoparticles for bacterial biofilm removal. *Presenter: Caroline Forrest*

55. Magnetic biofouling release in polymer composites. *Presenter: Ethan Marchetti*

56. Undergraduate Researcher. *Presenter: Shaily Quiroa Gamez*

57. The effect of rigid and flexible vegetation on waves, and sediment transportation in a sloped beach environment. *Presenter: Christopher Hankins*

58. The effect of rigid and flexible vegetation on waves, and sediment transportation in a sloped beach environment. *Presenter: Alexandra Hilbert*

59. The effect of rigid and flexible vegetation on waves, and sediment transportation in a sloped beach environment. *Presenter: Eleni Mouyos*

60. Magnetic filtration for water reuse in Mars. *Presenter: Matewos Ashenafi*

61. Purification of Biosynthesized Manganese Oxide Nanoparticles Used to Enhance Agricultural Production. *Presenter: Wyanet Sanchez*

62. Development of a Device for The Application of a Rotating Magnetic Field. *Presenter: Crawford Phillips*.

63. Readout Electronics for Large-Scale Superconductor Detectors. *Presenter: Henry Cheng,Nathan Vierkant*

64. Recycling Plastic Waste into Building Materials: Creep Testing of Plastic-Sand Composite Blocks. *Presenter: Giovanni Benevides*

65. Aggregation of polymer-functionalized emulsion droplets. *Presenter: Daniele Russo*

List of Graduate Posters Presenting on Session A

Poster #, Title, Presenter

1. Building new Power Electronic Power Distribution Systems(PEPDS). Presenter: Sooan Pack, Electrical, Computer, and Biomedical Engineering 30

2. Computational Efficiency Versus Accuracy: Evaluating Multi-fidelity CFD Approaches for Predicting Hydrokinetic Turbine Performance in Sheared Inflow. Presenter: Yavar Mohammadi , PhD Graduate Student, Ocean Engineering

3. Realtime nonlinear model predictive control for roll motion attenuation of barge in regular and irregular waves. Presenter: Callum Robbins, MS Graduate Student, Ocean Engineering

4. Searching the Cure - Ballot Rejections Reasons in the Vote-by-Mail Process. Presenter: Leonie Otte, PhD Graduate Student, Mechanical, Industrial and Systems Engineering

5. Self-assembled cysteamine reporter ligands for SERS nitrate detection in continuous flow. Presenter: Katie Terceiro, PhD Graduate Student, Chemical Engineering.

6. Predicting the state of health of Li-ion Batteries. Presenter: Matthew O'Donnell, MS Graduate Student, Chemical Engineering.

7. Micro- and Nano- Plastics Accumulation in the Sea Surface Microlayer and its Impact on the Growth of Cobetia marina. Presenter: Lauren Lamothe, MS Graduate Student, Chemical Engineering

8. Hybrid Polymer Electrolyte Design for Enhanced Energy Utilization in Solid State Lithium-ion Battery Cells. Presenter: Michael Jones, PhD Graduate Student, Chemical Engineering

9. Polymer Linked Emulsion. Presenter: Sabirul Khan Priyo, PhD Graduate Student, Chemical Engineering

10. SWCNTs transport faster than expected in polymer solutions. Presenter: Sepehr Yari, PhD Graduate Student, Chemical Engineering

11. Establishing a Neonicotinoid Monitoring Program Across Audubon Society of Rhode Island Wildlife Refuges. Presenter: Alexandra Russo, MS Graduate Student, Civil and Environmental Engineering

12. Assessing Micro- and Nanoscale Emissions During the Extrusion of Recycled Plastic-Sand Bricks . Presenter: Sirri Akongnwi Neba Nforsoh, PhD Graduate Student, Civil and Environmental Engineering

13. Influence of Ratiometric Dosing on Intracellular Fluorescence of DNA-SWCNTs. Presenter: Raodatullah Abodunrin, PhD Graduate Student, Chemical Engineering

14. Nanotube Spectra Fingerprinting and Machine Learning for Optimized Bioimaging/Sensing and ALS Disease Detection Applications. Presenter: Roy Monroy, MS Graduate Student, Chemical Engineering

15. Behavior of microplastics in wastewater treatment using Microalgae-Bacteria Consortia. Presenter: Valeria Brito, MS Graduate Student, Civil and Environmental Engineering

16. Development of Optical Strain Sensing “Smart Textile” for Non-contact Monitoring of Strain. Presenter: Melissa Schneider, MS Graduate Student, Chemical Engineering

17. Biosynthesis of Manganese Oxide Nanoparticle for Agricultural Fertilization Application. Presenter: Nicoly Welter, PhD Graduate Student, Civil and Environmental Engineering

18. Tunable clustering of Magnetic Nanoparticles by Utilizing Poly(amino acid) Corrals for Improved r2 Relaxation. Presenter: Mohamed Kabil, PhD Graduate Student, Chemical Engineering

19. Magnetically enhanced treatment for water reuse on Mars. Presenter: Caitlin Murray, MS Graduate Student, Civil and Environmental Engineering

20. Spectral fingerprinting of SWCNTs as a Method of Cancer Detection in live Cells. Presenter: Maryam Rahmani, PhD Graduate Student, Chemical Engineering

21. Rechargeable Magnesium Batteries with Carbon Based Cathode Materials. Presenter: Lauren Rainone, PhD Graduate Student, Chemical Engineering

22. An ESS-extendable Converter with Energy Management Control Empowering Electric Mobility. Presenter: Xueshen Zhang, PhD Graduate Student, Electrical, Computer, and Biomedical Engineering

List of Graduate Posters Presenting on Session B

Poster #, Title, Presenter

23. Compact Frequency Comb Generator Implementation on RFSoC for MKIDs. Presenter: Frank Danso, MS Graduate Student, Electrical, Computer, and Biomedical Engineering

24. A Review of Evacuations Challenges for Vulnerable Populations at Short-Notice Disaster in Mixed Traffic Flow. Presenter: Arome Ozigagu, PhD Graduate Student, Civil and Environmental Engineering

25. Novel Power Conversion System and Power Management Control for Water monitoring Stations. Presenter: Changseok Kim, PhD Graduate Student, Electrical, Computer, and Biomedical Engineering

26. Anomalous aggregation in suspensions of polymer-grafted nanoparticles. Presenter: Masoud Abdi, PhD Graduate Student, Chemical Engineering

27. Aging in natural gas activates the relaxations of polymer melts. Presenter: Mohammadjavad Hajirezaei, PhD Graduate Student, Chemical Engineering

28. Graduate Research Assistant. Presenter: Isaac Salazar, MS Graduate Student, Ocean Engineering

29. Targeting Bacterial Biofilms with Magnetic Nanoparticles. Presenter: Mastoureh Shirjandi, PhD Graduate Student, Chemical Engineering

30. Cooperative Deterministic Learning-Based Formation Control for a Group of Nonlinear Mechanical Systems Under Complete Uncertainty. Presenter: Maryam Norouzi, PhD Graduate Student, Mechanical, Industrial and Systems Engineering

31. Breaking biofilms: Magnetic Nanoparticles for Cleaning Surfaces in Marine Environments. Presenter: Payel Biswas, PhD Graduate Student, Chemical Engineering

32. Novel Strategy for Dissipating Energy Released from Underwater Collapse of Structures. Presenter: Victoria Reilly, PhD Graduate Student, Mechanical, Industrial and Systems Engineering

33. Curve Sandwich Composite Panels Subject to a Near-Field Underwater Explosion. Presenter: Siddharth Jain, PhD Graduate Student, Mechanical, Industrial and Systems Engineering

34. Machine Learning-driven Optical Microfiltration Device for Improved Nanoplastic Sampling and Detection in Water Systems. Presenter: Liyuan Gong, PhD Graduate Student, Mechanical, Industrial and Systems Engineering

35. Reducing Stormwater Pollution through Enhanced Street Sweeping. Presenter: Andrew Sheerin, PhD Graduate Student, Civil and Environmental Engineering

36. Estimation of Rayleigh Wave Phase Velocities and Attenuation Coefficients Using Three-Component Ambient Noise Beamforming. Presenter: Mojgan Gharakhanlou, PhD Graduate Student, Ocean Engineering

37. Rapidly Deployable Coastal Observatory Enabled with Distributed Sensing. Presenter: Katie Burrows, PhD Graduate Student, Ocean Engineering

38 HELICSAuto: Automating the Development of Cyber-Physical Co-Simulation Framework for Smart Grids. *Presenter: Sayeb Tadvin, PhD Graduate Student, Electrical, Computer, and Biomedical Engineering*

39. Sanitizing Neurons: Pruning-based Backdoor Mitigation via Progressive Neuron Ranking using Adversarial Proxies. *Presenter: Abdullah Arafat Miah, PhD Graduate Student, Electrical, Computer, and Biomedical Engineering*

40. Integrating Data Imputation and Augmentation with Interpretable Machine Learning for Efficient Strength Prediction of Environment-friendly Fly Ash-Based Alkali-Activated Concretes. *Presenter: Nausad Miyan, PhD Graduate Student, Civil and Environmental Engineering*

41. STRATEGIC REINFORCEMENT OF WIND TURBINE BLADE TRAILING EDGES: IMPROVING BUCKLING RESISTANCE USING 3D PRINTED AUXETIC LATTICES. *Presenter: Raffaele Cuorvo, MSC Graduate Student, Mechanical, Industrial and Systems Engineering*

42. Meso-structural Degradation and Mechanical Property Evolution in Cementitious Mortars Containing Microencapsulated Phase Change Materials under Extended Freeze-Thaw Cycles. *Presenter: Rakesh Paswan, PhD Graduate Student, Civil and Environmental Engineering*

43. Integrating Experiments, Finite Element Analysis, and Interpretable Machine Learning to Evaluate the Auxetic Response of 3D Printed Re-entrant Metamaterials. *Presenter: Bolaji Oladipo, PhD Graduate Student, Mechanical, Industrial and Systems Engineering*

44. Evaluating the Adhesion Response of Acrylonitrile-butadiene-styrene (ABS)/Thermoplastic polyurethane (TPU) Fused Interface using Multiscale Simulation and Experiments. *Presenter: Jonathan Villada, PhD Graduate Student, Civil and Environmental Engineering*

Rhode Island Nano-Bio Engineering Academy

Poster session: 10:30 – 12:00 pm. Toray Commons Fascitelli Center for Advanced Engineering.

The **R**hode **I**sland **N**ano-**B**io Engineering (**RINBE**) Academy is a collaboration between the University of Rhode Island Colleges of Engineering and Pharmacy, the Narragansett High School, and the North Kingstown High School. Since 2019, this annual 8-week program occurring in URI's spring semester features in-person lectures and workshops by URI faculty and graduate students at the Narragansett High School in addition to an all-day research laboratory experience at URI. For 2025, the program included the Roxbury lab (CBME), the Andreu lab (CBME), and the Fischer lab (BPS). Today marks the culmination of the program, where 22 high school students present their research posters that they have prepared.

Narragansett High School

Mr. Adam Reis (*program coordinator*)

Abigail Blair
Ava Bockoven
Drew Bockoven
Nicholas Bridges
Taylah Cranton
Sofia DiBiasio
Hadrian Duncan
Anthony Insana
Sierra Keilty
Amber Leonard
Lennon Meyer
Owen Schneider
Ethan Smith
Connor Valois
Abigail Zelenak

North Kingstown High School

Mrs. Susan Eriksen (*program coordinator*)

John Couturier
Alice Dunning
Luke Labriola
Sadie McCann
Kyle McManus
Haley Votta
Jason Wahl

University of Rhode Island

Dr. Daniel Roxbury (*program director*)
Dr. Irene Andreu (*faculty sponsor*)
Dr. Fabian Fischer (*faculty sponsor*)
Raodah Abodunrin (*Roxbury lab graduate student*)
Maryam Rahmani (*Roxbury lab graduate student*)
Melissa Schneider (*Roxbury lab graduate student*)
Sepehr Yari (*Roxbury lab graduate student*)
Payel Biswas (*Andreu lab graduate student*)
Mastoureh Shirjandi (*Andreu lab graduate student*)
Juliana Gaudio (*Fischer lab graduate student*)
Olga Skende (*Fischer lab graduate student*)

THE UNIVERSITY OF RHODE ISLAND
COLLEGE OF ENGINEERING

e-Week 2025

Undergraduate Student Posters

Poster session: 1:30 – 3:30 pm. Toray Commons Fascitelli Center for Advanced Engineering.

2. Evaluating Plastic Degradation in Simulated Wastewater

Presenter: Kendrick Beaubrun

Advisor: Dr. Irene Andreu Blanco

In this work, we evaluate the role of particle-particle collisions in microplastic physicochemical properties. Microplastics originate from the release of micron-sized particles (primary microplastics) in consumer products or by the degradation of larger pieces littered into the environment (secondary microplastics). The role of particle-particle collisions in microplastic generation has been scarcely investigated. To study the generation of secondary microplastics through particle-particle collisions, we performed experiments in conditions reproducing wastewater treatment. We used polyethylene terephthalate platelet microparticles ranging from 350 to 1500 micrometers as our primary microplastics. The microplastics were stirred at the same particle number concentration in a simulated wastewater solution. Suspended particles were collected in filters at select time points. Light microscopy was used to observe and quantify the generated secondary microplastics. Primary microplastic degradation, in the form of delamination and cracking, was observed, while the formation of smaller secondary microplastic particles was detectable even after 1 week. The obtained results indicate that particle-particle collisions can be a relevant mechanism for microplastic generation, and even of nanoplastics, particularly when the concentration of microplastics is high.

Research supported by: URISE program, URI Plastics Initiative, and NOAA grant number NA22NOS4690221

3. Isolated LLC Resonant DC-DC Converter with Hybrid Control for Fast Transient Response and Low Noise

Presenter: Gianni Smith

Advisor: Dr. Yeonho Jeong

The proposed design presents a high-efficiency full-bridge LLC resonant DC-DC converter for wide-range operation with an input voltage of 400V and an output voltage adjustable between 20V and 150V. The design ensures a maximum output current of 10A and achieves power levels up to 1.5kW while maintaining high conversion efficiency and power density above 1.6 W/cmÂ³. A hybrid control strategy is employed, utilizing phase shift control for voltages â‰¤80V and frequency modulation for voltages â‰¥80V to enhance efficiency across the entire operating range. Compared to the phase-shift full-bridge topology, the LLC converter reduces switching losses through zero-voltage switching (ZVS) and mitigates conduction losses, enabling better performance. The proposed system is validated through design analysis, simulations, and experimental verification, ensuring its feasibility for high-performance power conversion applications.

Research supported by: unfunded

4. High-Efficiency Wireless Power Transfer (WPT) System for Autonomous Underwater Vehicles (AUVs)

Presenter: Patrick Feliz

Advisor: Dr. Yeonho Jeong

Autonomous Underwater Vehicles (AUVs) have emerged as vital tools for various underwater applications, including marine exploration, environmental monitoring, and offshore infrastructure inspection. However, their capabilities are severely hindered by the energy storage limitations of rechargeable batteries. Wireless Power Transfer (WPT) via an underwater system powered by renewable energy sources would enable AUVs to recharge autonomously while submerged and yield benefits such as extended mission durations, reduced downtime, and the possibility for long term autonomous deployment.

Research supported by: NDEP/NIUVT

5. Smartphone App Development for Water and Health Humanitarian Emergencies

Presenter: Jacob Silva

Advisor: Dr. Ali Akanda

Cholera is a major threat to people that live in countries with poor sanitation infrastructure. While information about outbreaks and safety measures exist, it's hard for the people who are affected to receive this information. Mobile applications offer a way to deliver critical information directly to those at risk. To address this we have been developing a mobile app using Flutter in Android Studio. The app displays local cholera risk levels and provides users with guidance on how to stay safe. Our focus has been creating an accessible app for users with limited technical proficiency.

Research supported by: unfunded

6. The effect of rigid and flexible vegetation on waves, and sediment transportation in a sloped beach environment.

Presenter: Heather Palardy

Advisor: Dr. Che-Wei Chang

Abstract:

The increase in global temperatures has significantly impacted our coastlines, contributing to rising sea levels, more intense storm surges, and heightened flooding. To address these challenges, two primary approaches have emerged: man-made structures and nature-based solutions. While man-made structures have been widely used, nature-based solutions show greater promise as a sustainable, eco-friendly strategy to combat climate change. Understanding the properties of coastal vegetation is essential for engineering nature-based solutions for coastal resilience. Our lab explores the effects of various model vegetation on wave attenuation by recording parameters such as wave amplitude, sediment displacement, and wave velocity.

Research supported by: URI start-up funds (Dr. Chang)

7. Investigation of the Effect of Bio-Inspired Leading-Edge Tubercles on Hydrokinetic Turbine Performance

Presenter: Ryan Cassin

Advisor: Dr. Bradford Knight

Tidal energy is a highly predictable and consistent source of renewable energy with strong potential to contribute to the transition toward carbon-free energy generation technologies. However, its widespread adoption is limited by geography, as grid-scale deployment is only feasible in regions with significant tidal ranges and strong tidal currents. As such, optimizing the performance of tidal energy systems is critical to maximizing energy output and overall impact. In this work, data from previous experimental studies are used to evaluate the accuracy of numerical and computational fluid dynamics (CFD) modeling methods. Based on this analysis, a CFD study is conducted to investigate the performance of a hydrokinetic turbine equipped with bio-inspired leading-edge tubercles. The results of this simulation are then compared to those of a previous CFD study of an identical turbine without tubercles. This comparison enables conclusions to be drawn regarding potential performance enhancements resulting from the addition of leading-edge tubercles on hydrokinetic turbines.

Research supported by: URISE - URI College of Engineering

8. Classification of DNA Sequences Using Pytorch

Presenter: Kaitlyn Lum

Advisor: Dr. Drew Zhang, Dr. Ying Zhang, Cecile Cres

Accurately classifying long DNA sequences is crucial to help scientists analyze genetic information. Proper DNA classification is vital in identifying genetic variations, understanding complex diseases, and tracking evolutionary patterns. There has been a significant amount of research on classifying short DNA sequences, but by focusing on long DNA sequences, there can be more resources for disease detection, prevention, and treatment. The model can improve the patientâ€™s outcomes and reduce healthcare costs. This research aims to develop a machine learning-based tool to classify long DNA sequences and provide an efficient and accurate approach to genomic analysis. By utilizing machine learning techniques, the tool can automatically and accurately identify patterns within complex genetic data. The developed model is intended to work in conjunction with researchers. Throughout this study, a BERT model was created to read a fastq file. A Bidirectional Encoder Representations from Transformers (BERT) model is a computational model that can understand language. It reads a sentence before and after a word to figure out the definition of that word. For example, â€œbarkâ€□ can mean either the wood from a tree or the noise from a dog. The model takes the context from the sentence to figure out what the word â€œbarkâ€□ means in the phrase. A fastq file is a text file for the BERT model to read from. Python code was developed to classify long DNA sequences. The code begins by opening the fastq file and reading the lines of each section. Each section contains a sequence number and DNA sequence. The code is written to go through each section to find the sequence key and DNA sequence. It then reads the sequence key as the label and the corresponding DNA sequence as the key. The resulting label and key for each section are printed in the terminal for a simple extraction.

Research supported by: URIse

9. Modeling the Mechanical Impact of REOB in Asphalt Through Molecular Dynamics Simulations

Presenter: Aaron Iwanski

Advisor: Dr. Michael Greenfield

Asphalt is a common material used mostly in roadways and sidewalks, and specific engineering specifications must be met to address important factors regarding performance. These factors heavily involve mechanical properties, all of which must be considered in ranges of hot and cold temperatures. The extremities of these temperatures can be simplified to the upper and lower limits of the local climate in which the material resides. Some of these qualifications can be measured through polymer rheology to assess the mechanical structure, with heavy emphasis on the complex modulus.

Oftentimes, additives are used to influence the complex modulus at these temperature limits, and this can present issues. â€œRecycled engine oil bottomsâ€ (REOB), a byproduct of unvaporized residue generated through distillation of used motor oil for extraction of lubricants, is a recent example. REOB includes nonvolatile engine oil additives and metal debris from engine wear that survive lengthy timescales in a vehicle. Originally, the use of REOB in asphalt seemed encouraging, but some believed that it causes degradation and premature cracking, causing concern when using this material in highway and sidewalk maintenance.

In an attempt to further understand the interactions present in REOB when added to asphalt, molecular dynamics (MD) simulations were conducted on a sample of oligomeric poly(isobutylene) (PIB) consisting of 20 repeating monomer units as an example of an integrated additive. The asphalt model is a 12-component system previously seen to show mechanical relaxations through MD simulations, mimicking those found in real asphalt. This new process involving the REOB compound implemented a multi-step compression/decompression cycle, where pressure and timestep parameters were altered to observe a system equilibrium and resulting mechanisms through completing molecular dynamics simulations over longer than 10 nanosecond timescales. Through computing the fluctuations in stress and relaxation of REOB at equilibrium, the complex modulus can be analyzed, allowing for the estimation of behaviors for storage modulus and loss modulus. The differences between the results of complex modulus for asphalt and the REOB compound show the effect of these additives on the changes of the storage and loss modulus.

Research supported by: Funded by: USDOT FHWA University Transportation Center TIDC "Transportation Infrastructure Durability Center", Univ of Maine; for-credit

10. Financial Advisor AI: An Intelligent Investment Assistant Leveraging LLMs and Real-Time Market Data

Presenter: Jack DeMarinis

Advisor: Dr. Resit Sendag

The Financial Advisor AI explores the intersection of artificial intelligence and financial technology by developing a personalized investment assistant that uses Large Language Models (LLMs) in conjunction with live market data to deliver data-driven, adaptive financial recommendations. The tool addresses common challenges in personal investing, including emotional bias, limited access to analytics, and risk mismanagement.

The system integrates APIs from Alpaca, Alpha Vantage, and Finnhub to gather real-time and historical market information. These data streams feed into a backend that enables intelligent decision-making, portfolio tracking, risk control, and trade simulations. The assistant uses GPT models to interpret this data in the context of user-defined strategies, providing actionable investment insights along with explanations and performance forecasts. The modular Python-based architecture, along with a local SQLite database, ensures portability and scalability.

By automating key aspects of investment analysis and decision-making, this project lowers the barrier to entry for new investors and offers a practical use case for AI in a real-world setting. I look forward to the opportunity to share this work during the undergraduate poster session and contribute to the showcase of innovation and research happening within the College of Engineering.

Research supported by: URIs

11. Generative AI

Presenter: Jack DeMarinis

Advisor: Dr. Resit Sendag

This research explores the integration of cloud-based and locally hosted large language models (LLMs) within a multi-agent generative AI framework. By combining OpenAI's ChatGPT-4.1, known for its extensive context handling and instruction adherence, with the locally deployed Qwen Multimodal model, which offers advanced multimodal processing capabilities, we aim to harness the strengths of both platforms. The system employs a modular architecture where specialized agentsâ€"such as planners, retrievers, and evaluatorsâ€"collaborate to perform complex tasks, including multimodal reasoning and tool utilization. This hybrid approach facilitates efficient task delegation and enhances the system's adaptability to diverse applications. Our findings indicate that such a configuration not only improves performance in tasks requiring multimodal inputs but also offers a scalable solution adaptable to various domains, from education to enterprise applications. This study contributes to the evolving landscape of multi-agent systems by demonstrating the practical benefits of integrating diverse LLMs to achieve more robust and versatile AI solutions.

Research supported by: URI

12. Undergraduate Research Assistant

Presenter: Marcus Orr

Advisor: Dr. Geoffrey Bothun

Surface enhanced Raman Scattering (SERS) is a highly sensitive spectroscopy technique capable of single molecule detection under ideal conditions. Raman scattering is the inelastic scattering of light where roughly 1 in 10^8 photons loses some of its kinetic energy by changing the vibrational state of a given analyte. Performing Raman scattering on gold or silver coated nanostructures takes advantage of plasmon resonance, attracting analytes to the surface and greatly increasing their Raman signal. Our research group aims to develop and implement continuous flow SERS devices for environmental analyte detection, namely . Continuous measurement offers the advantage of real-time analyte sensing, enabling the observation of time-dependent behaviors such as analyte adsorption and desorption rates. Consequently, device design plays a critical role. After multiple iterations, the current device achieves complete sealing for continuous-flow measurements, improved usability for more consistent results, and integrated electrical contacts to enable SERS analysis under an applied electric field. Previous designs will also be presented along with relevant discoveries related to each.

Research supported by: NSF Grant

13. characterizing marine bacteria growth conditions

Presenter: Liam Earley

Advisor: Dr. Irene Andreu Blanco, Payel Biswas

Marine biofouling, the growth of micro- and macroogranisms on underwater surfaces, is a problem affecting the blue economy due to structure damage and increased vessel fuel consumption, among others. Marine biofouling starts with the formation of bacterial biofilm on surfaces as primers for larger organisms like algae and mollusks. Bacterial biofilm formation and properties depend on the physiology of the bacteria which is affected by their nutrient environment. In this project, I systematically studied the growth of a marine biofilm-forming model microorganism, Cobetia marina, in different growth media commonly used in the literature. Bacterial growth was monitored during 24 h using the optical density of the suspension at 600 nm as the metric. With this study, we will be able to determine the optimal growth conditions for C. marina growth. Future steps will be the analysis of biofilm morphology and mechanical properties for the optimal growth conditions.

Research supported by: NSF ERI #2301790

14. Noise in the Vote-by-Mail Tabulation Process

Presenter: Cristian Varela

Advisor: Dr. Gretchen Macht, Leonie Otte

Noise-induced health problems can cause various long term issues, such as hearing loss and tinnitus, as well as secondary symptoms like sleep disturbance, increased stress, and even stress-related cardiovascular disorders, depending on the noise level and the length of time someone is exposed. To mitigate these risks, personal protective equipment (PPE) like industrial earmuffs, earplugs, and canal caps are effective forms of hearing protection. Institutions like the U.S. Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH) each have their recommendations and guidelines for workers; OSHA recommends PPE when noise exceeds 90 dB(A), while NIOSH recommends PPE when it exceeds 85 dB(A) for an eight-hour workday.

An emerging field that carries these risks is elections, particularly in the Vote-by-Mail (VBM) process. The VBM processâ€™ increasing popularity and increased ballot volume have resulted in the implementation of industrial machines for tasks like tabulation and sorting that emit constant noise to the environment. This study compares the noise levels produced by three types of VBM machines against both OSHA and NIOSH thresholds, highlighting the conditions under which noise levels exceed safety limit threshold standards and suggests possible mitigation strategies to ensure worker safety.

Data was collected on the noise output over time in five different counties in Colorado and California. The Total Noise Level (TNL) of operating multiple machines simultaneously and the Time-Weighted Average (TWA) are calculated to compare the noise levels to the threshold standards. For all three machines, instances occurred where noise levels exceeded the NIOSH and OSHA guidelines, especially during operations like cutting and when multiple machines were running at once. This study found that noise levels from VBM machines can exceed the standard safety thresholds, especially without proper mitigation like PPE. Utilization of proper PPE and worker training can help ensure safer working conditions for election staff

Research supported by: Democracy Fund and PLEJ

15. Modeling the Mechanical Impact of REOB in Asphalt Through Molecular Dynamics Simulations

Presenter: Devon Wakelin

Advisor: Dr. Michael Greenfield

Asphalt is a common material used mostly in roadways and sidewalks, and specific engineering specifications must be met to address important factors regarding performance. These factors heavily involve mechanical properties, all of which must be considered in ranges of hot and cold temperatures. The extremities of these temperatures can be simplified to the upper and lower limits of the local climate in which the material resides. Some of these qualifications can be measured through polymer rheology to assess the mechanical structure, with heavy emphasis on the complex modulus.

Oftentimes, additives are used to influence the complex modulus at these temperature limits, and this can present issues. â€œRecycled engine oil bottomsâ€□ (REOB), a byproduct of unvaporized residue generated through distillation of used motor oil for extraction of lubricants, is a recent example. REOB includes nonvolatile engine oil additives and metal debris from engine wear that survive lengthy timescales in a vehicle. Originally, the use of REOB in asphalt seemed encouraging, but some believed that it causes degradation and premature cracking, causing concern when using this material in highway and sidewalk maintenance.

In an attempt to further understand the interactions present in REOB when added to asphalt, molecular dynamics (MD) simulations were conducted on a sample of oligomeric poly(isobutylene) (PIB) consisting of 20 repeating monomer units as an example of an integrated additive. The asphalt model is a 12-component system previously seen to show mechanical relaxations through MD simulations, mimicking those found in real asphalt. This new process involving the REOB compound implemented a multi-step compression/decompression cycle, where pressure and timestep parameters were altered to observe a system equilibrium and resulting mechanisms through completing molecular dynamics simulations over longer than 10 nanosecond timescales. Through computing the fluctuations in stress and relaxation of REOB at equilibrium, the complex modulus can be analyzed, allowing for the estimation of behaviors for storage modulus and loss modulus. The differences between the results of complex modulus for asphalt and the REOB compound show the effect of these additives on the changes of the storage and loss modulus.

Research supported by: Funded by USDOT FHWA University Transportation Center TIDC "Transportation Infrastructure Durability Center", Univ of Maine; for credit

16. ECBE Department Chatbot

Presenter: Zachary Notarianni

Advisor: Dr. Resit Sendag

We present an LLM-powered automation agent capable of autonomously interacting with a computer system by leveraging large language models (LLMs) to interpret user intent and execute tasks in a human-like manner. The agent operates by evaluating high-level natural language commands, taking periodic screenshots to assess screen state, and dynamically generating actions such as mouse movements, clicks, and keyboard input. This enables seamless control of GUI-based applications without hard-coded scripts or specific UI bindings. The system incorporates feedback loops for validating outcomes and can adapt its behavior based on visual changes, providing a robust framework for intelligent web scraping, form automation, and general-purpose desktop interaction.

Research supported by: not applicable

17. Dynamics of Grafted Nanoparticle Solutions

Presenter: David Amirsadri

Advisor: Dr. Ryan Poling-Skutvik

Polymer-grafted gold nanoparticles (AuNPs) represent a widely studied class of materials that integrate polymer and colloidal physics. Gold nanoparticles provide structural integrity and impart desirable optical properties, while polymers grafted to the nanoparticle surface enhance stability in colloidal suspension. Their unique physical properties lead to a broad range of applications, including drug delivery and catalysis. This poster explores the dynamics of polymer-grafted nanoparticle suspensions by investigating the impact of molecular weight on the colloidal stability of AuNP solutions. We modulate the rate of aggregation using a grafting-to procedure and characterize the aggregation kinetics in solution through dynamic light scattering. We examine how different polymer molecular weights affect structural hysteresis in the relationship between particle size and temperature. Additionally, a DLS temperature ramp is performed to investigate aggregation and dispersion behavior. DLS reveals a kinetic effect from slow aggregation in rods functionalized with a 57 kDa thiolated polystyrene and spheres functionalized with a 233 kDa polystyrene. Currently, AuNPs are grafted with a 20:1 molar ratio of low (5.3 kDa) to high (233 kDa) molecular weight polystyrene to assess the impact on aggregation and dispersion behavior. Future work will focus on characterizing the effect of different molar ratios of polymers on the aggregation behavior of the nanoparticles in solution. Additionally, measurements will evaluate how varying temperature affects the absorbance of UV light by the particles, aiming to tailor the aggregation kinetics to optimize aggregation in the presence of environmental contaminants and develop a novel class of nanoparticle-based sensors.

Research supported by: RI INBRE, US Geological Survey, National Science Foundation, Rhode Island Foundation

18. Covalent modification of carbon nanotube surface via a peroxide-mediated reduction of aryl diazonium salts to enhance near-infrared fluorescence

Presenter: Jayden St. Louis

Advisor: Dr. Daniel Roxbury

Single-walled carbon nanotubes (SWCNTs) have emerged as promising materials for biomedical applications due to their unique fluorescence properties and sensitivity to environmental changes, making them highly effective for bio-sensing. Conventional covalent functionalization using aryl diazonium salts typically requires harsh conditions, limiting biocompatibility and scalability. Utilizing single-stranded DNA-wrapped SWCNTs and hydrogen peroxide as a mild reducing agent addresses these issues, offering real-time fluorescence monitoring, scalability, and enhanced biocompatibility. The creation of quantum well (sp3) defects on SWCNT surfaces during this reaction introduces a new fluorescence peak (E11*) compared to intrinsic E11 peak emission. Increased E11* intensity indicates ongoing defect formation, enhancing fluorescence-based sensing and allowing for lower nanotube concentrations. This reduction is particularly beneficial in wearable textile sensors and intracellular biosensors, minimizing cytotoxicity and nanotube aggregation. Additionally, introducing sp3 defects provides further opportunities to customize SWCNT sensors. Future directions involve attaching biological sensing units to these defect sites for analyte-specific detection, expanding SWCNT biosensors' precision and practical applications.

Research supported by: Taking research for credit. Additionally funded on Undergraduate Research Grant

19. From Election Day to Warehouse Facilities: Determining Spatial Requirements for the Storage of Voting Equipment

Presenter: Grace Marrier

Advisor: Dr. Gretchen Macht, Sara Nunes

Election officials in every state must store equipment, materials, and documentation for elections in designated storage facilities. To support this requirement, the Engineering for Democracy Institute is collaborating with the Partnership for Large Election Jurisdictions to develop the Warehouse Space Requirement Calculator (WSRC), which will provide election officials with quantifiable data to assist in determining the amount of space necessary to store election-related supplies. This research aims to contribute to the WSRC by focusing on the storage requirements of the most commonly used in-person voting equipment. Based on where it is utilized in the voting process, in-person voting equipment can be classified into three main categories: check-in, ballot marking, and ballot scanning. The pieces of equipment deemed to impact a prominent number of voters were evaluated for each category based on their use during the November 2024 Presidential Election. Using this evaluation, the dimensions of the respective equipment, when in use or when packaged for long-term storage, were researched. This information will be applied to the WSRC to provide a pre-programmed list of equipment to select from when using the application, allowing election officials to customize the equipment list to reflect current inventory. By using the parameters found in this work, the outputs from the WSRC will aid in the decision-making processes related to warehouse space planning and requirements.

Research supported by: Partnership for Large Election Jurisdictions, Undergraduate Research in Science and Engineering Program, Engineering for Democracy Institute

20. Analysis of Vote-by-Mail Ballot Opening and Extraction Process Variations

Presenter: Juan Zubieta

Advisor: Dr. Gretchen Macht, Leonie Otte

Vote-by-Mail (VBM) has been an efficient alternative for United States citizens to practice their right to vote in a convenient way from any place. The VBM system has evolved over the years, and each county implements it slightly differently based on their available investment, regulations and laws, or preferences. The VBM tabulation process can include the following steps: verification of signature, ballot opening and extraction, ballot flattening, and the total ballot count. The only consistent step in the process is the opening of envelopes and extraction of the ballot, during which the returned envelope is opened, the ballot is extracted, and then flattened for counting. This research focuses on the opening and extraction procedures in different counties across the United States to explore the variation in time between the processes. Opening, extraction, and flattening processing times are collected from pre-recorded videos from two different counties across the United States during two different elections, each using a different process variation. To compare these processes, statistical analysis and a discrete-event simulation were performed to determine which opening and extraction method is the most time-efficient. This research helps election officials and administrators improve their counties' VBM tabulation process

Research supported by: PLEJ, Democracy Fund, Undergraduate Research in Science and Engineering (URISE) , and Engineering for Democracy Institute.

21. Quantifying Artificial Intelligence's Energy Footprints

Presenter: Oluwatosin Okele

Advisor: Dr. Hui Lin

There are many opportunities and applications of artificial intelligence (AI). Within the CYPHER Lab at URI, efforts focus on utilizing machine learning, artificial intelligenceâ€”and the relevant hardwareâ€"to enhance the resilience of power systems, ensuring that critical infrastructures are protected from malicious actors. As research continues to explore the potential and resilience offered by artificial intelligence, it is equally important to examine the social and environmental costs associated with such technology. While users often think of artificial intelligence as a cloud service, every interaction with AI requires physical computation, drawing energy from data centers and contributing to real-world resource consumption. To that end, an analysis of the energy consumption required for various inference tasks was conducted. For the scope of this semester, two tasks were examined: image classification using the Microsoft ResNet-50 model and CIFAR-10 dataset, and image generation using the Stable Diffusion v1-5 model and DiffusionDB dataset. This exploration aimed to validate the findings of Luccioni et al. in their published work, "Power Hungry Processing: Watts Driving the Cost of AI Deployment?" Regarding the scope of this research, the image classification model was reinitialized and retrained, whereas the image generation model was not. Future research efforts could further examine and validate Luccioni et al.'s assessment on additional AI-driven tasks, such as question answering, summarization, and text generationâ€"widely used applications of artificial intelligence

Research supported by: URISE

22. Evaluation of occupational exposure to nanoparticles through magnetic aerosol quantification

Presenter: Maria Mozeleski

Advisor: Dr. Irene Andreu Blanco

Nanoparticles, due to their small size, have the potential to become airborne and remain in aerosol suspension for extended periods. This poses a potential occupational exposure risk to personnel working with engineered nanomaterials, particularly in research and industrial settings. The health effects of unintended nanoparticle exposure remain insufficiently understood and are dependent on the physical and chemical properties of the particles. In this study, we evaluate and quantify the unintentional generation of magnetic nanoparticle aerosols in a laboratory environment. Airborne nanoparticle samples are collected using specialized nanoscale filtration devices and equipment, and subsequently analyzed through magnetic characterization and elemental analysis through X-ray fluorescence. The results of this study will provide insight into the extent of nanoparticle aerosol formation and contribute to a better understanding of potential exposure risks associated with magnetic nanoparticles in workplace settings.

Research supported by: for-credit (CHE492)

23. Research Assistant in Generative AI

Presenter: Richard Buckley

Advisor: Dr. Resit Sendag

The adoption of large language models (LLMs) for information retrieval is rapidly growing. Major search engines now integrate LLM generated summaries in order to maintain their market share. While these models provide broadly useful insights, they often struggle to accurately retrieve or recall niche and specialized information, particularly when data is absent from their training sets (e.g. due to it being current news, or it being sensitive information).

To address this challenge, techniques such as Retrieval-Augmented Generation (RAG) and Cache-Augmented Generation (CAG) have been proposed. However, an issue remains: how can we effectively retrieve the most relevant information to answer a user query?

A common approach is to represent both queries (user questions) and documents (holding the answer to the user's query) in a vector space (via an embedding model) and retrieve the K-nearest neighbors (KNN). Some methods extend this by leveraging sparse embeddings, which improve keyword matching and relevance. However, further improvements are needed to enhance retrieval effectiveness in specialized domains.

Research supported by: URISE

24. Advancing Neurorehabilitation With a Modular Platform for Reach-to-Grasp Task Analysis

Presenter: Luci Schneider

Advisor: Dr. Reza Abiri

Upper-limb disabilities among stroke patients and individuals with spinal cord injuries can have lifelong impacts on motor control and quality of life. Studies in restoration of hand dexterity are a crucial part to improving outcomes of these populations. While there are existing assistive devices and patented neural technologies aimed to support these individuals, they lack generalizability, modularity, and are cost inefficient. This research proposes the development of a dynamic platform that will include a modular turntable that presents either 2, 4, or 8 objects to a participant. The platform will allow for improvements in precision and efficiency of data collection during studies that aim to advance current assistive and neural rehabilitative technologies. Future implementation of the platform will involve reach-to-grasp experiments, in which participants interact with objects displayed by the turntable. An algorithm will then be developed to predict planned grasp types and different preshaping actions based on electroencephalogram (EEG) recordings. Investigating EEG signals may help address the limitations that restrict interaction between neurorehabilitation devices and physical objects. This study combines an innovative experimental setup with prior knowledge of EEG analysis and classification to enable cleaner data acquisition. It aims to advance the understanding of upper-limb visuomotor coordination to improve current assistive and neural rehabilitative technologies.

Research supported by: URISE grant

25. Characterizing Error of Wearable Inertial Measurement Units (IMUs) Computing 2D Wrist Kinematics during Activities of Daily Living

Presenter: Maria Morrow

Advisor: Dr. Ryan Chapman

Wrist range of motion (ROM) is well-established in clinical and laboratory settings. This metric, along with frequency of motion (FOM) are critical for understanding both typical and atypical movement patterns (e.g.

wrist arthritis). However, there is limited information regarding wrist ROM and (FOM) outside of well-controlled laboratory/clinical settings. This may be one factor affecting the adoption of and success of certain clinical interventions like total wrist arthroplasty (TWA), the terminal treatment for wrist arthritis. Currently, the best technology for quantifying joint kinematics outside of laboratory settings for extended durations are wearable inertial measurement units (IMUs). Wearable IMUs are portable, wireless sensors capable of quantifying long duration joint kinematics of a variety of joints. However, no known validation studies exist assessing the error of IMUs quantifying 2D wrist kinematics. As such, we conducted a study to calculate the error of wearable IMUs compared to gold-standard optical motion capture (MOCAP) measurements for evaluating 2D (sagittal, frontal planes) wrist kinematics. Optical MOCAP reflective markers and IMUs were attached to participantâ€™s bilateral upper extremities and torso prior to completing three trials of six upper extremity tasks: 1) sagittal plane flexion/extension, 2) frontal plane radial/ulnar deviation, 3) circumduction, 4) reaching to and turning a doorknob, 5) pouring water from a pitcher, and 6) performing the dart-throwerâ€™s motion. We hypothesized wrist flexion/extension and radial/ulnar deviation would be within Â±5Â° throughout all activities. Overall, wearable IMUs are a convenient method for determining wrist biomechanics within a non-extreme range of motion. The collected data will progress development of preclinical guidelines for evaluating wrist implants as well as assessing a patientâ€™s wrist ROM and FOM before and after TWA.

Research supported by: URISE

26. Retrieval Augmented Generation Optimization for LLMs

Presenter: Garrett Kemper

Advisor: Dr. Resit Sendag

The adoption of large language models (LLMs) for information retrieval is rapidly growing. Major search engines now integrate LLM generated summaries in order to maintain their market share. While these models provide broadly useful insights, they often struggle to accurately retrieve or recall niche and specialized information, particularly when data is absent from their training sets (e.g. due to it being current news, or it being sensitive information).

To address this challenge, techniques such as Retrieval-Augmented Generation (RAG) and Cache-Augmented Generation (CAG) have been proposed. However, a critical issue remains: how can we effectively retrieve the most relevant information to answer a user query?

A common approach is to represent both queries (user questions) and documents (holding the answer to the user's query) in a vector space (via an embedding model) and retrieve the K-nearest neighbors (KNN). Some methods extend this by leveraging sparse embeddings, which improve keyword matching and relevance. However, further improvements are needed to enhance retrieval effectiveness in specialized domains.

Research supported by: URISE

27. MINDER EDA Wearable

Presenter: Ben Annicelli

Advisor: Dr. Solanki, Vignesh Ravichandran

The goal of my research this semester was to create a companion wearable to the main MINDER system that collects Electrodermal Activity (EDA) signals. This wearable is worn on the wrist and uses two gel electrodes attached to the fingers. The wearable itself is composed of an AD8604 op amp chip, which is an op amp chip that contains 4 separate op amps. The circuit uses only 3 of these op amps, and is split into 3 phases. The first phase is a virtual ground phase which is comprised of a voltage divider that provides a constant voltage of half of the source. The virtual ground must provide half of the source voltage since EDA signals have a negative component that can't be directly measured due to the systemâ€™s single-supply configuration. The half source voltage acts as ground and any signal less than the half source voltage is counted as negative. The second phase is the data collection phase. This phase takes in the signal from the electrodes and amplifies them to make them visible as EDA signals are typically low in amplitude and have to be amplified for accurate detection. The final phase is a third-order low pass filter with a cutoff frequency of 1.5 Hz. This phase exists to limit high frequency noise which is especially important when recording EDA signals since signal noise has a greater impact on the data. This design enables reliable, real-time acquisition of EDA data which will then be compared to the BioDAQ system for validation.

Research supported by: This research was supported by the National Institutes of Health (NIH)'s National Institute of Biomedical Imaging and Bioengineering (NIBIB), grant # 1R01EB033581-01A1.

28. Fast Fourier Accelerator for Space Bourne Instruments

Presenter: O'Malley Sherlock

Advisor: Dr. Sungho Kim

The Fast Fourier Transform (FFT) is arguably the most essential algorithm in digital signal processing, widely used across most engineering fields. Despite this, challenges in optimising the trade-offs between resolution, throughput, and power consumption for high-resolution, high-throughput hardware implementations of the algorithm remain. In this project, we aim to gain deeper insight into these challenges by implementing two different Cooley-Tukey FFT architectures on a Xilinx RFSoC board. Through these implementations, we identified key bottlenecks of limited DSP slices and complexity of inter-stage storage and routing. These limitations significantly impacted stage-wise parallelism, resolution scalability, and latency. We will use these findings to assist in designing an ASIC-based FFT solution that will minimize these trade-offs.

Research supported by: Office of Naval Research (ONR)

29. Analyzing the Reuse of Plastic Waste for Building Materials

Presenter: Trinity Saab

Advisor: Dr. Vinka Craver

The growth of plastic production is prevalent in the 20th century, and its build up in landfills is a concern that forces us to find sustainable alternatives. One is the integration of recycled plastic waste into bricks for construction. This poster will analyze the process and methodology of doing so, and briefly touch upon its importance and environmental impacts. Reviewing existing relevant studies and lab experience, the main focus will be an in depth review of the processes and steps, from plastic bottles to small-scale building bricks. The task of turning recycled plastics into building bricks, consists of material collections and sorting, washing and drying, shredding, melting and mixing, molding and cooling. While reusing plastics to make bricks for building is seen as a sustainable alternative, the manufacturing brings upon potential environmental pollutants. In multiple phases of the manufacturing, potential pollutants are relevant and with more future research, those specific pollutants can be identified and explored in depth.

Research supported by: URISE

30. Optimizing Cold Storage Conditions for Lipid Nanoparticles

Presenter: Maya Sheridan

Advisor: Dr.Ting-Yu Shih

Lipid nanoparticles (LNPs) are one of the most commonly used delivery platforms for mRNA vaccines and therapeutics, but their physical stability during storage remains a key limitation to their widespread application.

The goal of this study was to evaluate the stability of LNPs which have been previously optimized for vaccination under different storage conditions over time. Our hypothesis was that increasing the concentration of sucrose cryoprotectant would improve the physical stability of LNPs during cold storage at âˆ’20Â°C.

Blank LNPs were formulated using 50 mol% SM-102, 10 mol% DOPE, 38.5 mol% cholesterol, and 1.5 mol% DMG-PEG2K. The LNPs were dialyzed overnight and distributed into five storage groups: 4Â°C without sucrose, and âˆ’20Â°C with 0%, 5%, 10%, and 15% sucrose. Samples were analyzed by dynamic light scattering (DLS) on day 0, 1, 3, 7, and 14 to monitor changes in LNP size and polydispersity index (PDI).

While storage at 4Â°C maintained size near 200 nm through Day 14, PDI increased sharply by Day 3 (~0.55) before gradually stabilizing near 0.45. In contrast, cold samples without cryoprotectant experienced severe instability, with size exceeding 500 nm and PDI reaching ~0.8 by Day 14. Increasing sucrose concentration at âˆ’20Â°C provided a protective effect, with 15% sucrose yielding the most stable condition overall: size remained under 360 nm and PDI stayed below 0.5 throughout the study.

These findings demonstrate that 15% sucrose at âˆ’20Â°C provides the best preservation of both LNP size and uniformity, even compared to 4Â°C storage. This study provides a preliminary guide to long term LNP storage and that helps maintain stability of LNP-based RNA vaccines and therapeutics.

Research supported by: For-credit and URI COP faculty start up funds

31. Paper or Ballot Marking Device? Simulating the Future of Georgiaâ€™s In-Person Voting

Presenter: Melany Tabares

Advisor: Dr. Gretchen Macht, Gianna Wadowski

The introduction of electronic voting technologies has transformed in-person voting, offering potential improvements in accessibility and efficiency. Yet, questions remain about their impact on long Election Day wait times. Georgiaâ€™s current voting system relies on ballot marking devices as its primary ballot marking method. However, recent legislative comments have introduced the concept of allowing voters to choose between marking their ballot digitally or with paper ballots. This choice has the potential to greatly impact voter wait times and influence polling place operations. This study employs discrete-event simulation to model the effects of voterâ€™s choices between ballot marking devices and paper ballots on voter wait times, considering factors such as the number of available voting stations and resource utilization. Using observational time studies from two elections, this work models multiple scenarios to assess how different conditions influence the voting process. By simulating these conditions, this research seeks to identify potential challenges and opportunities associated with multiple methods of ballot marking. This research aims to provide insights into how equipment choice impacts polling place efficiency, helping election officials improve resource distribution and decrease voter wait times. By understanding these factors, election officials can make informed decisions to enhance the overall voting experience.

Research supported by: Democracy Fund and Engineering for Democracy Institute

32. Synthesis of Polyethylene Glycol Coated Magnetic Nanoparticles for Biomedical Applications

Presenter: Anna Erb

Advisor: Dr. Irene Andreu Blanco

Iron oxide magnetic nanoparticles are commonly used for biomedical applications such as drug delivery. A problem that arises in the synthesis of these particles is their tendency to aggregate, making them unstable in solution. PEGylation -the coating of particles with biocompatible polymer polyethylene glycol (PEG)- can help increase their stability as they circulate through the bloodstream. The outstanding stealth properties of PEG make it an ideal biocompatible polymer to be used for this purpose. However, it is challenging to attach PEG to magnetic nanoparticles, and cannot be accomplished using a single reaction. In this project, we are demonstrating and optimizing a multi-step synthesis method to achieve PEG-functionalized magnetic nanoparticles. We use the polyol synthesis method to make magnetic spherical iron oxide nanoparticles, with tetraethylene glycol (TEG) acting as a solvent, capping and reducing agent. The iron oxide nanoparticles are then coated with an amine-terminated catechole molecule (3,4 - dihydroxybenzylamine hydrobromide). The catechol side of the molecule binds strongly to iron oxide, while the amine group provides anchoring functional groups to attach carboxylic acid-terminated PEG through simple chemical couplings performed at room temperature. The colloidal and magnetic properties of the nanoparticles are tested after each synthesis and functionalization step, with the goal of creating enhanced stability and improved circulation within the bloodstream, while preserving strong magnetic response that can be leveraged for drug delivery.

Research supported by: URISE program, URI College of Engineering and Provost Office

33. Predicting Vertical Wave Forces on Elevated Coastal Structures

Presenter: Aiden Sylvestre

Advisor: Dr. Mehrshad Amini

There is currently no standardized formulas in the ASCE handbook to design structures around vertical wave forces and pressures. So based on an experiment preformed by Oregan State University to simulate a 1:10 length scale idealization of Hurricane Ike's impact on the Bolivar Peninsula, Texas data was recorded through load cells and pressure gauges. This data was posted under 'PRJ-2131Â Elevated Structure Investigation of Wave Pressures and Forces' on DesignSafe. All of this data was downloaded and imported to MATLAB where a variety of codes were made to sort through all the data and determine the maximum vertical and horizontal forces as well as vertical pressure. This data was then plotted and compared to existing theoretical equations to determine the level of accuracy those equations have and to set the ground to create an equation that better fits.

Still finalizing research before putting everything in the slideshow

This presentation isnt done but this is the link:

https://uri0-my.sharepoint.com/:p:/g/personal/sylvestreaiden_uri_edu/Ec3e_ZYuLwdNmeKBAwDy22YBkLNZRirh_ZIR-4M2-qTvgQ?e=EZphjD

Research supported by: Funded through URISE

34. Smartphone App Development for Water and Health Humanitarian Emergencies

Presenter: Aryana Sadr

Advisor: Dr. Ali Akanda

Cholera is a major threat to people that live in countries with poor sanitation infrastructure. While information about outbreaks and safety measures exist, it's hard for the people who are affected to receive this information. Mobile applications offer a way to deliver critical information directly to those at risk. To address this we have been developing a mobile app using Flutter in Android Studio. The app displays local cholera risk levels and provides users with guidance on how to stay safe. Our focus has been creating an accessible app for users with limited technical proficiency.

Research supported by: unfunded

35. Vertical Forces in Waves on Coastal Structures

Presenter: Bailey Bolton

Advisor: Dr. Mehrshad Amini

Elevated homes in coastal areas are impacted by storm surge. The objective of this work is to apply data from Experimental Modeling of horizontal and vertical wave forces on an elevated coastal structure by Park et al using vertical pressure and force equations in MatLab. Finding accurate vertical force and pressure equations allows engineers to design to a more accurate standard.

Research supported by: URISE

36. Methods In Analyzing Axial Loading In Piles Within Offshore Wind Turbine Jacket Structures

Presenter: Sam Kipper

Advisor: Dr. Christopher Baxter, Dr. Aaron Bradshaw

Offshore Wind Turbines (OWT) are designed to be able to withstand extreme environmental loads over the course of their lifespan. Continuous cyclic loadings from the offshore domain cause dynamic conditions (wind, waves, current, etc.) that the OWTâ€™s operate in, which results in major stresses on these structures (Hines et al, 2023). The objective of this research is to compare two methods of calculating axial loading, one method which relies only on strain gauges and another which relies on strain gauges and tilt, in order to analyze the structural health of the jacket structure used for Block Island Wind Farm (BIWF).

Research supported by: URISE

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Presenter: Samantha Kipper

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Research supported by: URISE

38. Conductive Liquid-Crystal Elastomers for Soft Actutors

Presenter: Liam Kennings

Advisor: Dr. Ryan Poling-Skutvik

Liquid crystal elastomers (LCEs) are shape-changing polymers uniquely suited for a broad range of soft matter applications, including use as soft actuators in prosthetic and therapeutic devices. In this project, we develop conductive LCEs using a thiol-acrylate Michael addition and thermal polymerization method, incorporating carbon black into the polymer matrix to allow for electrically conductive; resistive heating-based actuators. By utilizing resistive heating, we aim to change the external stimuli from thermal to electrical. This enables the creation of a more compact and integrated actuator system (compared to more traditional methods i.e. pneumatic or mechanical) while still being able to mimicking the mechanical behavior of the natural tendons/muscles.

Research supported by: RI-INBRE, URI^2 undergraduate research grant

39. Development and Characterization of Paclitaxel and Iron Oxide-Loaded PEGylated Nanocomposite Microparticles via Spray Drying for Synergistic Pulmonary Chemotherapy and Hyperthermia

Presenter: Savanna Sheffield

Advisor: Dr. Samantha Meenach

Lung cancer remains a leading cause of cancer-related death and is often treated with intravenous chemotherapy, which results in significant systemic toxicity and limited tumor targeting. Paclitaxel (PTX) is a widely used chemotherapeutic to treat lung cancer, but its intravenous (IV) delivery limits drug diffusion into the lungs and contributes to undesirable side effects. Iron oxide (IO) nanoparticles offer a promising strategy for localized hyperthermia therapy, as they generate heat under exposure to an alternating magnetic field (AMF). Combining hyperthermia with paclitaxel can enhance cancer cell death and improve chemotherapeutic outcomes. Pulmonary drug delivery offers a localized and non-invasive alternative to IV treatment, improving drug deposition in the lungs while minimizing systemic side effects. However, nanoparticle-based therapeutics often suffer from poor aerodynamic properties, reducing their efficiency for inhalation therapy. Nanocomposite microparticles (nCmPs) address this limitation by embedding nanoparticles within larger, respirable micro-carriers that improve dispersion and deep lung deposition. In this study, IO and PTX were co-encapsulated into nCmPs via spray drying to create an inhalable dry powder formulation for synergistic application of chemotherapy and hyperthermia treatment. The spray-dried nCmPs were tested for particle size, morphology, drug loading, aerosol dispersion, and magnetic heating capabilities. Ongoing work aims to optimize these formulations and assess their in vitro therapeutic efficacy.

Research supported by: For credit

40. High-Efficiency Wide-Range DC-DC Converter with Fast Transient Response and Low Noise

Presenter: William Lucas

Advisor: Dr. Yeonho Jeong

The goal of this project is to design and develop a high-efficiency isolated DC-DC converter capable of supporting a wide output voltage range (20 V to 150 V) with fast transient response and low noise. Applications include renewable energy systems, electric vehicles (EVs), and industrial power electronics where performance, reliability, and efficiency are key. This project was developed in response to the 2025 IEEE International Future Energy Challenge (IFEC), with a focus on innovation in power conversion technologies.

Research supported by: Our projects have been funded through grants in previous years. This year, we submitted a proposal for excess funding for our project and future competitions.

41. Single Particle Tracking for Sensing Intracellular Cell Properties

Presenter: Hayden Reilly

Advisor: Dr. Daniel Roxbury

Single-Walled Carbon Nanotubes (SWCNTs) have been investigated for their use in biosensing applications due to their distinctive optical properties. Due to their ability to be functionalized, SWCNTs are able to be used as biocompatible, long-term sensing devices. These unique characteristics of SWCNTs make them an ideal tool to track how nanomaterials can impact the environment and living organisms. This study proposes a method for detecting various cell-type dependent intracellular properties through the tracking of SWCNT movement within cells. GT-15 ssDNA-SWCNTs were first introduced into cells with differing intracellular conditions via the cell membrane where they entered the early endosomal pathways. Conditions included tumorigenic vs non-tumorigenic cells, and cells with induced osmotic stress. Using near-infrared (NIR) fluorescence spectral fingerprinting the ssDNA-SWCNTs were tracked as they moved inside of the cells. Particle tracking was done via MATLAB code that quantified the dynamics of the SWCNTs inside of the cells. Analysis was performed, and a statistical difference was determined between the SWCNTs in the various cells. These findings provide evidence that this method of single-particle tracking can be used as a sensor of the intracellular cell properties.

Research supported by: for-credit, EPSCoR C-AIM, and Undergraduate Research Grant

42. Gesture & Object Recognition in Large Language Models (LLMs) for Robotic Arm-Assisted Rehabilitation

Presenter: Arouney Sithtaphone

Advisor: Dr. Resit Sendag, Dr. Reza Abiri, Ali Rabiee

Assistive robotics have become an important tool for supporting patient recovery, particularly motor function training. However, most systems lack understanding of patient intent leading to non-personalized interactions. Recent advances in large language models (LLMs) offer an opportunity to enhance human-robot collaboration by enabling the interpretation of gestures and objects within context. This project explores the integration of LLMs with visual and gesture recognition systems to facilitate intelligent control of a robotic arm designed for rehabilitation and assistive robotics. One aspect explored was gesture/object detection with LLMs for intent interpretation. Gestures and objects were fed to an LLM which inferred user intent and suggested corresponding robotic arm commands. The system demonstrated accuracy in gesture/object recognition and the LLM successfully inferred appropriated intents. Integrating LLMs into robotic rehabilitation provides the potential to create scalable and personalized assistance. Future work will focus on personalization, natural language integration, and clinical validation.

Research supported by: URISE

43. Researcher

Presenter: Andrew Delano

Advisor: Dr. Bradford Knight

We used CFD to analyze a vessel's maneuvering motions in bidirectional sea waves, focusing on interactions like yaw, sway, and roll. Simulations were run in a Linux environment using open-source tools, highlighting how CFD and Linux skills were applied to study vessel-wave dynamics.

Research supported by: unfunded

44. Computational Study of Ship Maneuvering in Bidirectional Seaways

Presenter: Xavier Morrissey

Advisor: Dr. Bradford Knight

Using computational fluid dynamics to look at a vessel maneuvering and seakeeping in a bidirectional seaway, highlighting how we learned to use Linux and CFD

Research supported by: There are not grants supporting the project and I was payed through URISE

45. Applications of GPR on a Fairing for Bubble Mitigation

Presenter: Deirdrah Urban

Advisor: Dr. Bradford Knight

Bubbles underneath vessels interfere with instruments for collecting oceanographic data. Fairings can be an effective means of mitigating the effect of bubbles on data collection, but also lead to increased drag. The objective of the present work is to use Gaussian Process Regression (GPR) to model and predict the effect of fairings on drag and bubble mitigation. GPR models of the drag and effectiveness of bubble mitigation are generated using a MATLAB code. The GPR model is trained with data from CFD computations of different fairing geometries.

Research supported by: URISE

46. The effect of rigid and flexible vegetation on waves, and sediment transportation in a sloped beach environment.

Presenter: Kitara Pottebaum

Advisor: Dr. Che-Wei Chang

The increase in global temperatures has significantly impacted our coastlines, contributing to rising sea levels, more intense storm surges, and heightened flooding. To address these challenges, two primary approaches have emerged: man-made structures and nature-based solutions. While man-made structures have been widely used, nature-based solutions show greater promise as a sustainable, eco-friendly strategy to combat climate change. Understanding the properties of coastal vegetation is essential for engineering nature-based solutions for coastal resilience. Our lab explores the effects of various model vegetation on wave attenuation by recording parameters such as wave amplitude, sediment displacement, and wave velocity.

Research supported by: URISE program and URI start-up funds (Dr. Chang)

47. Development of Optical Strain Sensing â€œSmart Textileâ€□ for Non-contact Monitoring of Strain

Presenter: Emily Grevell

Advisor: Dr. Daniel Roxbury

Developing a Strain-sensing micro fibrous textile constructed via the core-shell electrospinning of polymers, in which the inner polymer consists of Single Walled Carbon Nanotubes (SWCNTs) whose generated optical fluorescence peaks shift in the presence of strain applied to the material in which they are embedded inside of.

Research supported by:

48. Multi-Planar CFD Analysis of Axial and Lateral Force Dynamics in Tumblehome Hull Propulsion and Maneuvering Systems

Presenter: Harrison Schmidt

Advisor: Dr. Bradford Knight

This research employs advanced computational fluid dynamics (CFD) to explore the hydrodynamic interactions in a tumblehome hull vesselâ€™s propulsion and maneuvering systems. By conducting a multi-planar fluid flow analysis, the study investigates how variations in rudder angle, oblique inflow angle, and forward velocity affect the axial and lateral forces exerted on the propeller and rudder. The project aims to uncover the underlying fluid dynamic mechanisms that govern thrust generation and maneuverability, providing insights that could drive innovations in naval vessel design and operational performance.

Research supported by: I have joint funding from URISE, and self support.

49. Best Practices For Sterile Mammalian Cell Culture For Use With Single-Walled Carbon Nanotube Uptake Investigations

Presenter: Eryn Wale

Advisor: Dr. Daniel Roxbury

It has been shown that single-walled carbon nanotubes (SWCNTs), once functionalized with DNA, have the ability to be uptaken into live cells through the endosomal pathway. In order to ensure accurate and reproducible data from experiments, sterile mammalian cell culture must be practiced and DNA-SWCNTs must be produced in alignment with standard protocols. Sterile mammalian cell culture techniques were developed and applied to RAW and Caco2 cell lines. These techniques incorporate the use of ethanol for sterilization as well as allocated phosphate buffered saline (PBS) reserves to prevent cross-contamination, all of which is performed within a fume hood. For DNA-SWCNT functionalization, treatment of the samples in a standardized sequence of ultra-sonication followed by ultracentrifugation. Successful samples of DNA wrapped SWCNTâ€™s are then analyzed using UV Vis spectrophotometry to characterize the different chiralities present in each sample. From these protocols, cell lines were successfully maintained and grown up for reliable usage in other experiments.

Research supported by: For-credit

50. Developing Biocompatible Single-Walled Carbon Nanotubes for Intracellular Fluorescence-Based Biosensing

Presenter: Eryn Wale

Advisor: Dr. Daniel Roxbury

It has been shown that single-walled carbon nanotubes (SWCNTs), once functionalized with DNA, have the ability to be internalized into live cells through the endosomal pathway. Once internalized, the SWCNTs have been used for various biosensing applications. In order to ensure accurate and reproducible data from in vitro experiments, sterile mammalian cell culture must be practiced and DNA-SWCNTs must be produced in alignment with standard protocols. Sterile mammalian cell culture techniques were developed and applied to RAW 264.7 and Caco-2 cell lines. These techniques incorporate the use of ethanol for sterilization as well as allocated sterile-filtered phosphate buffered saline (PBS) reserves to prevent cross-contamination, all of which is performed within a biosafety cabinet. For DNA-SWCNT functionalization, the samples are treated in a standardized sequence of probe-tip sonication followed by ultracentrifugation. Successful samples of DNA-wrapped SWCNTs are then analyzed using UV-Vis spectrophotometry to characterize the different chiralities present in each sample and determine SWCNT concentration. The DNA-SWCNTs are added to the various types of cells for predetermined periods of time, and internalization is confirmed with the use of near-infrared fluorescence microscopy.

Research supported by: for credit

51. Wearable Inertial Measurement Units versus Optical Motion Capture: Characterizing IMU Error Computing 2D Wrist Kinematics during Activities of Daily Living

Presenter: Katelyn Daniewicz

Advisor: Dr. Ryan Chapman

M.N. Morrow, K.M. Daniewicz, A.L. Hollingworth, N.M. Stone, J.J. Crisco, & R.M. Chapman

Wrist range of motion (ROM) is well-established in clinical and laboratory settings. This metric, along with frequency of motion (FOM) are critical for understanding both typical and atypical movement patterns (e.g. wrist arthritis). However, there is limited information regarding wrist ROM and FOM outside of well-controlled laboratory/clinical settings. This may be one factor affecting the adoption of and success of certain clinical interventions like total wrist arthroplasty (TWA), the terminal treatment for wrist arthritis. Currently, the best technology for quantifying joint kinematics outside of laboratory settings for extended durations are wearable inertial measurement units (IMUs). Wearable IMUs are portable, wireless sensors capable of quantifying long duration joint kinematics of a variety of joints. However, no known validation studies exist assessing the error of IMUs quantifying 2D wrist kinematics. As such, we conducted a study to calculate the error of wearable IMUs compared to gold-standard optical motion capture (MOCAP) measurements for evaluating 2D (sagittal, frontal planes) wrist kinematics. Optical MOCAP reflective markers and IMUs were attached to participantâ€™s bilateral upper extremities and torso prior to completing three trials of six upper extremity tasks: 1) sagittal plane flexion/extension, 2) frontal plane radial/ulnar deviation, 3) circumduction, 4) reaching to and turning a doorknob, 5) pouring water from a pitcher, and 6) performing the dart-throwerâ€™s motion. We hypothesized wrist flexion/extension and radial/ulnar deviation would be within Â±5Â° throughout all activities. Overall, wearable IMUs are a convenient method for determining wrist biomechanics within a non-extreme range of motion. The collected data will progress development of preclinical guidelines for evaluating wrist implants as well as assessing a patientâ€™s wrist ROM and FOM before and after TWA.

Research supported by: URISE

52. Establishing a Neonicotinoid Monitoring Program Across Audubon Society of Rhode Island Wildlife Refuges

Presenter: Justin Evans

Advisor: Dr. Vinka Craver. Alexandra Russo

Neonicotinoids are the most commonly used group of insecticides in the world. They work by targeting and disrupting neurological pathways primarily in insects. However, they have been found to move through ecosystems and become transmitted through entire food webs while having the proven potential to severely impact non-target species leading to ecosystem scale impact.

The Audubon Society of Rhode Island is collaborating with Water for the World to establish a monitoring program across its wildlife refuge complex and understand the capacity of these chemicals to infiltrate conservation land. The negative impacts of neonicotinoids to biota can undermine the potential of these areas to properly serve as refugia for birds, pollinating insects and other species.

The method first involves sampling optimization. This is for sampling locations that are most likely to have anthropogenic influence. The samples are then prepared and processed through LC-MS analysis where the presence and quantity of any neonicotinoid substances will be found. This information will be used to evaluate the risk of the chemicalâ€™s presence to species and the ecosystem. Program updates will be shared on the neonicotinoid monitoring program website to raise awareness of the impact of neonicotinoids.

Research supported by: Audubon Society of Rhode Island

53. Synthesis, Characterization, and Analysis of Magnetic Nanoparticles for Targeting Bacterial Marine Biofilms

Presenter: Franny Duong

Advisor: Dr. Irene Andreu Blanco

Marine biofilms, formed by the accumulation and growth of microorganisms on surfaces, are responsible for significant economic losses in industries such as shipping, aquaculture, and offshore engineering, due to their role in corrosion, fouling, and the increased energy required for vessel propulsion. This study investigates the use of polyethylenimine (PEI)-coated magnetic nanoparticles (MNPs) as a potential solution for biofilm removal.

PEI enhances the adsorption of MNPs to the negatively charged biofilm surface, promoting the physical disruption of bacterial clusters and inhibiting further biofilm formation. The magnetic properties of the nanoparticles also allow for targeted delivery and actuation to biofilms . In this project MNPs were synthesized through the hydrothermal method to eventually evaluate their effectiveness in disrupting Cobetia marina (C. marina) bacterial biofilms. We tested different synthesis conditions using different molecular weights of PEI and varying reaction times. The synthesized particles were then characterized using dynamic light scattering and dynamic susceptometry. MNP uptake in bacterial biofilms was evaluated using image analysis. These findings suggest that higher molecular weight PEI is more effective for creating MNPs suitable for biofilm disruption. Additionally, image analysis indicated that positively charged MNPs are also effective in targeting marine biofilms. Although the MNPs demonstrated promise for biofilm disruption in laboratory conditions, challenges remain in scaling the method for real-world applications, where environmental factors and biofilm heterogeneity may influence nanoparticle effectiveness. Future research could explore the effectiveness of MNPs on wild biofilms compared to laboratory-grown samples.

Research supported by: Hourly pay from the URISE Program

54. Iron oxide magnetic nanoparticles for bacterial biofilm removal

Presenter: Caroline Forrest

Advisor: Dr. Irene Andreu Blanco

Bacterial biofilms are complex communities of bacteria living on surfaces, held together by large biomolecules. Biofilms are key contributors to, for example, chronic infections and emergence of antibiotic resistance in human health, and fouling of boat hulls in marine transportation. Removal of biofilms is typically done by scraping them off surfaces or applying biocidal agents such as antibiotics. A potential novel method for removal of bacterial biofilms is using magnetic nanoparticles to disrupt the biofilm structure, eventually leading to bacterial removal and death. This research aims to study the synthesis of magnetic nanoparticles capable of disrupting biofilms. Iron oxide magnetic nanoparticles were synthesized through a hydrothermal method and capped with polyethylenimine, a positively charged polymer that has demonstrated biofilm penetration capabilities. We measured the relationship between the temperature and reaction time, on key nanoparticle parameters such as magnetic properties, particle sizes and pH stability. Initial results suggest that autoclaving at 134â„ƒ for 1 hour seems to work the best to create particles that have the optimal magnetic response.

Research supported by: URISE and the RI Foundation, Medical Seed Grant

55. Magnetic biofouling release in polymer composites

Presenter: Ethan Marchetti

Advisor: Dr. Irene Andreu Blanco

Unmanned underwater vehicles for seafloor exploration encounter issues after biofouling such as increased weight, changed hydrodynamics and polymer degradation. Cleaning processes typically involve removing the robot from the water and physically scrubbing it, or treating it with a biocidal agent. These cleaning processes lead to instrument downtime and allow the potential for further polymer degradation.

Within the past few years, novel strategies have been explored to combat these issues, employing mechanisms inspired by nature. However, these material solutions are often infused with intricate features, making it difficult to manufacture and implement. Here, we aim to refine this bioinspired architecture by fabricating a magnetic silicone composite that can be distally activated to induce surface movement. Our design combines a magnetically-generated undulatory motion with a functionalized surface micropatterning to induce an anti-biofouling response. Additionally, our fabrication methods require only a few steps to reproduce using commercially viable products. Using particle image velocimetry, we have demonstrated that actuation of the compositeâ€™s surface under the influence of a dynamic magnetic field leads to the generation of fluid vortices, with the possibility of preventing bacterial deposition. When taken in combination with the surface morphology, which acts as an intended bactericidal mechanism, these novel magnetoactive materials can prevent the need for traditional biofouling removal techniques.

Research supported by: This experience has been made possible by the URISE program (Undergraduate Research in Science and Engineering) to EM, generously funded by a corporate partner. This research was funded by the National Science Foundation Engineering Research Initiation (N

56. Undergraduate Researcher

Presenter: Shaily Quiroa Gamez

Advisor: Dr. Paolo Stegagno

Physical Human-Robot Interaction (PHRI) holds significant promise for advancing human-robot collaboration across various applications. While mobile robots and robotic arms have been extensively studied, the safe integration of unmanned aerial vehicles (UAVs) into PHRI remains underexplored due to safety challenges.

This research aims to develop a controlled simulation environment using the Robot Operating System (ROS) and Virtual Reality to facilitate safe human-drone interaction by creating a simulation environment in which a human subject can interact virtually with the real physical environment. Particularly, the human subject will wear a VR headset to interact with a simulated hovering drone while the real sense of haptic touch for such interaction will be provided and measured by a real physical robotic arm outside the proposed virtual environment. Our framework requires not only communication between the virtual reality and simulated drone, but also having the robotic arm be able to communicate with the drone within the simulation and vice versa.

At the current stage of development, we achieved ROS-enabled robotic simulations on Gazebo. Our framework enables real-time communication and position tracking between a simulated drone and a physical robotic arm (Sawyer Robotic Arm by Rethink Robotics). The robotic arm replicates the drone's pose within the Gazebo simulation, ensuring synchronized motion. Alternatively, the armâ€™s joints can be manually manipulated, with the drone replicating these movements in real time to ensure that while ROS controls the drone in the simulation, the arm performs the proper movements to imitate the drone trajectory.

Future work will incorporate a virtual reality Oculus headset, enabling users to interact directly with the simulation. Additionally, enhancements such as workspace-aware robotic arm behavior, an April Tag system for improved hand tracking, and haptic feedback will refine the setup. These advancements will pave the way for human subject experiments, advancing safe and effective PHRI with drones for applications such as surveillance, delivery, and inspection.

Research supported by: URI ESTEEMED (NIH)

57. The effect of rigid and flexible vegetation on waves, and sediment transportation in a sloped beach environment.

Presenter: Christopher Hankins

Advisor: Dr. Che-Wei Chang

The increase in global temperatures has significantly impacted our coastlines, contributing to rising sea levels, more intense storm surges, and heightened flooding. To address these challenges, two primary approaches have emerged: man-made structures and nature-based solutions. While man-made structures have been widely used, nature-based solutions show greater promise as a sustainable, eco-friendly strategy to combat climate change. Understanding the properties of coastal vegetation is essential for engineering nature-based solutions for coastal resilience. Our lab explores the effects of various model vegetation on wave attenuation by recording parameters such as wave amplitude, sediment displacement, and wave velocity.

Research supported by: URISE program and URI start-up funds

58. The effect of rigid and flexible vegetation on waves, and sediment transportation in a sloped beach environment

Presenter: Alexandra Hilbert

Advisor: Dr. Che-Wei Chang

The increase in global temperatures has significantly impacted our coastlines, contributing to rising sea levels, more intense storm surges, and heightened flooding. To address these challenges, two primary approaches have emerged: man-made structures and nature-based solutions. While man-made structures have been widely used, nature-based solutions show greater promise as a sustainable, eco-friendly strategy to combat climate change. Understanding the properties of coastal vegetation is essential for engineering nature-based solutions for coastal resilience. Our lab explores the effects of various model vegetation on wave attenuation by recording parameters such as wave amplitude, sediment displacement, and wave velocity.

Research supported by: URISE program and URI start-up funds (Dr. Chang)

59. The effect of rigid and flexible vegetation on waves, and sediment transportation in a sloped beach environment

Presenter: Eleni Mouyos

Advisor: Dr. Che-Wei Chang

The increase in global temperatures has significantly impacted our coastlines, contributing to rising sea levels, more intense storm surges, and heightened flooding. To address these challenges, two primary approaches have emerged: man-made structures and nature-based solutions. While man-made structures have been widely used, nature-based solutions show greater promise as a sustainable, eco-friendly strategy to combat climate change. Understanding the properties of coastal vegetation is essential for engineering nature-based solutions for coastal resilience. Our lab explores the effects of various model vegetation on wave attenuation by recording parameters such as wave amplitude, sediment displacement, and wave velocity.

Research supported by: URISE program and URI start-up funds (Dr. Chang)

60. Magnetic filtration for water reuse in Mars

Presenter: Matewos Ashenafi

Advisor: Dr. Irene Andreu Blanco

Inhabiting Mars by 2030 will require innovative technologies, especially for securing a sustainable water supply through reuse and low-power purification methods. Martian soil, which may contaminate water systems during Mars inhabitation, contains magnetic iron oxide that could be targeted for removal using magnetic filtration. This project explores the use of permanent magnets to create in-flow magnetic filters that are energy-efficient and resistant to clogging. By testing various filter designs and evaluating their effectiveness in removing particles and possibly organic matter, the study aims to identify optimal solutions for water purification on Mars. We have built a magnetic in-line filter combining a commercially-available filter housing and a strong NdFeB permanent magnet. A custom adapter was designed to hold the magnet in place and to maximize suspended particle exposure to strong magnetic field gradients, leading to increased magnetic particle removal.

Research supported by: URISE and NASA EPSCoR Seed Grant Program

61. Purification of Biosynthesized Manganese Oxide Nanoparticles Used to Enhance Agricultural Production

Presenter: Wyanet Sanchez

Advisor: Dr. Vinka Craver

Biosynthesized Fertilizers are a cleaner alternative as opposed to synthetic fertilizers. They have the potential to have greater nutritional yield while adopting a more sustainable approach. Moreover bacteria such as Pseudomonas putida GB-1, a strain isolated from a marine environment, has been proven to successfully biosynthesize Manganese Oxide Nanoparticles (MnONPs). This suggests a high potential to be adapted to an agricultural scale. However, there is a lack of a standardized method of purifying the MnONPs whilst achieving replicable and optimal results. This study investigates various cleaning procedures to find the most efficient and effective cleaning method of nanomaterials biosynthesized by the bacteria, Pseudomonas putida GB-1. A literature assessment regarding purification procedures of different nanoparticles after bacterial synthesis revealed similar techniques. The studies follow the structure of centrifuging the solution and washing the retrieved nanoparticles. Most studies wash the nanoparticles with water; however, a minority substitutes or supplements it with reactive chemical solutions. Thereafter, the nanoparticles are dried and characterized using either XRD (X-ray Diffraction) or EDS (Energy Dispersive Spectroscopy). The literature review corroborated with the cleaning method of nanoparticles chosen for this project. Here, we begin by incubating the bacteria culture (Pseudomonas putida GB-1) with the lept media for 24 hours at 30Â°C and 144 RPM. The bacteria media is then centrifuged for 10 min at 3000 RPM, where the supernatant is removed from the pellets (MnONPs). Subsequently, the pellets are soaked with pure ethanol for 10 minutes and centrifuged again with the same conditions. The nanoparticles are then left to air dry and will be later physically and chemically characterized. Based on the findings, it warrants the assessed purification procedure as a prospective protocol for the nanoparticles (MnONPs) biosynthesized by the bacteria, Pseudomonas putida GB-1.

Research supported by: URISE Program

62. Development of a Device for The Application of a Rotating Magnetic Field

Presenter: Crawford Phillips

Advisor: Dr. Irene Andreu Blanco

This ongoing project is evaluating if magnetic nanoparticles (MNPs) actuated by magnetic fields can affect bacterial biofilm. Under a rotating magnetic field, these particles can dissipate mechanical energy and heat. This work specifically supports investigating how elongated iron oxide MNPs can affect bacteria by dissipating mechanical energy when actuated by a low frequency, rotating magnetic field (LF RMF) . In order to test these samples, a LF RMF applicator is needed. This work is the outlines the development of this device.

Research supported by: This experience has been made possible to CP by the URISE program. This research was funded by NSF ERI #2301790.

63. Readout Electronics for Large-Scale Superconductor Detectors

Presenter: Henry Cheng,Nathan Vierkant

Advisor: Dr. Sungho Kim, Frank Danso

Superconductivity is an effect where certain materials exhibit zero electrical resistance and counteract any external magnetic force once reaching a critical point . This principle is governed by the Meissner effect and is the driving force behind technologies like magnetic resonance imaging (MRIs), magnetic levitation trains (Maglevs), and superconducting qubits. Because superconductors operate near absolute zero, superconductor-based electronics tend to benefit from minimal electrical noise, near-perfect energy conservation, and increased electron mobility. For this reason, superconductors are favorable for sensitive sensors used in submillimeter astronomy like microwave kinetic inductance detectors (MKIDs). MKIDs rely on the precise breaking of Cooper pairs upon interactions with photons, changing the superconducting filmâ€™s kinetic inductance in the process. A frequency resonator multiplexed to each detector will identify small shifts in a detectorâ€™s resonance frequency due to the kinetic inductance. When constructed into arrays, these individual shifts can meticulously record photon count, energy, and time of arrival. MKIDs can cover a broader electromagnetic spectrum (0.1-3mm) which is useful for distant galaxy and exoplanet detection. However, there exist no single commercial hardware capable of handling the high-channel readout for MKIDs.

A frequency comb generator, which is a component of the readout system, is responsible for generating the resonant frequencies of the various resonators in the MKID array. Due to the high frequency multiplexing capability of MKIDs, the implementation of a single channel MKID readout on a commercial FPGA implementation board consumes large amounts of resources. Hence, the implementation of a multi-channel readout system will need several commercial FPGA implementation boards which is not very practical. The Integrated Circuits Design Lab has developed a compact frequency comb generator for enhanced MKID operation. We are currently developing a custom FPGA implementation board capable of handling up to ten channels of the compact frequency comb generators for a readout with 1024 MKIDs in each array per channel.

Research supported by: Laboratory: Integrated Circuits Design Lab (ICDL), Funding: URISE

64. Recycling Plastic Waste into Building Materials: Creep Testing of Plastic-Sand Composite Blocks

Presenter: Giovanni Benevides

Advisor: Dr. Vinka Craver

Plastic waste is an important environmental issue, requiring innovative recycling solutions to reduce pollution and create sustainable materials. Recently, an increasing number of efforts have proposed repurposing plastic waste into durable construction blocks as an alternative building material. These blocks can be used for pedestrian and bike paths, parking lots, and other lightweight and low-traffic applications. However, the performance of these blocks has not been fully studied, and there is a lack of standard methods to assess their effectiveness. This study focuses on identifying appropriate conditions to measure creep over time in recycled plastic blocks. By performing creep tests, we aim to evaluate the materialâ€™s long-term strength and determine how well the blocks align with established benchmarks.

Plastic blocks were manufactured by collecting and melting plastic waste (pristine and recycled high-density polyethylene [HDPE], and pristine and recycled polypropylene [PP]), combined with sand. The blocks were produced using a ratio of 70% sand to 30% of the respective plastic type. Since standardized testing methods for plastic blocks do not currently exist, we addressed this gap by adapting existing standards with similar material properties. Creep testing was conducted in accordance with ASTM C512/C512M âˆ’ 15 standards at 15%, 30%, and 45% of the blockâ€™s maximum compressive strength (MCS).

The results showed a displacement of 1.3 mm and a strain of 2.01% at 15% MCS, 1.6 mm and 3.28% at 30% MSC, and 3.7 mm and 7.12% at 45% MSC. The material performed well under lower loads but exhibited greater deformation at higher levels of MSC, indicating potential structural limits. Continued testing can help enhance long-term performance. With further development, plastic-based blocks could become a sustainable and cost-effective building material. Future research may explore how environmental conditions and design modifications affect their strength and durability.

Research supported by: Hourly Pay

65. Aggregation of polymer-functionalized emulsion droplets

Presenter: Daniele Russo

Advisor: Dr. Ryan Poling-Skutvik

The formation and stability of emulsions at the nanoscale level are key for helping advance the research of cell replication in the medical world. In this research, I studied the formation of oil-in-water emulsions stabilized by a 4:1 ratio of Tween-20 and Span-20 surfactants. These emulsions were produced by ultrasonication and analyzed using dynamic light scattering (DLS) at 60Â°, 90Â°, and 120Â° to determine nanoparticle size. Following these measurements, poly-styrene with a polydispersity index (PDI) of 1.10 was introduced to test its effect on the particle size and stability of the emulsion. The sample then experienced a gradual temperature decrease in the DLS, recorded at 60Â°, 90Â°, and 120Â°, to discover how this polymer would react. As the temperature decreases, I expect the polymer to increase stability of the emulsion droplets, resulting in an increased change to particle size. Throughout this process, I analyzed the behavior of polymer chains and how they affect the stability and distribution of nanoparticles. With these findings, I can move on to the next step of the process and test different polymer chains and how they react in various temperature environments.

Research supported by: National Science foundation

Plenary Lecture

Professor Haibo He, Robert Haas Endowed Professor in the Department of Electrical, Computer and Biomedical Engineering

Talk Title: Integrated Neural Network and Reinforcement Learning for Decision Making

5:00 pm. Fascitelli Center for Advanced Engineering rooms 010/025

Haibo He is the Robert Haas Endowed Professor in the Department of Electrical, Computer and Biomedical Engineering at URI. His main research interests include neural networks and reinforcement learning, with their applications in power and energy systems. He has published numerous papers in the filed including several highly cited papers and best paper awards. He served numerous capacities at the professional societies, including the General Chair of the IEEE Symposium Series on Computational Intelligence (IEEE SSCI, Orlando, Florida) in 2014 and the Editor-in- Chief of the IEEE Transactions on Neural Networks and Learning Systems (IEEE TNNLS) from 2016 to 2021, a flagship journal of the IEEE Computational Intelligence Society (IEEE CIS). He is a Fellow of IEEE.

Graduate Students Posters

Poster session: 5:00 – 7:00 pm. Toray Commons Fascitelli Center for Advanced Engineering.

1. Building new Power Electronic Power Distribution Systems(PEPDS)

Presenter: Sooan Pack, Electrical, Computer, and Biomedical Engineering

Advisor: Yeonho Jeong

This project is developing a power electronic power distribution system (PEPDS) for Official Navy Research. In the power system, converters are needed to control the charging of the storage and the discharge of power to the load.

The integrated power electronics building blocks (iPEBB) is being introduced as a new integrated converter structure. While the current power system uses a Modular Multilevel Converter (MMC), the project aims to develop a new converter based on the CLLC resonant converter topology.

Real-time simulators are major tools for the design and development of power systems. The components of the CLLC resonant converter are modeled using conductance and parallel current source for the real-time simulation. The system is simulated using the Modified Nodal Analysis (MNA) method in MATLAB. Simulation results are then compared with those obtained from PSIM, with both tools showing closely matching results under ideal conditions.

Future work will focus on enhancing model accuracy by adding nonlinear characteristics into the simulation.

Research supported by: This project is supported by Official Navy Research.

2. Computational Efficiency Versus Accuracy: Evaluating Multi-fidelity CFD Approaches for Predicting Hydrokinetic Turbine Performance in Sheared Inflow

Presenter: Yavar Mohammadi , PhD Graduate Student, Ocean Engineering

Advisor: Professor Bradford Knight

Marine energy extraction through hydrokinetic turbines faces substantial operational challenges when deployed in natural environments characterized by velocity gradients and flow non-uniformities. These flow conditions generate cyclical loading variations that necessitate advanced computational methods for accurate prediction during design phases. This research evaluates the capabilities of three distinct numerical approaches in capturing performance and blade loading under non-uniform inflow conditions.

This investigation uses systematic methodology examining turbine performance under controlled velocity distributions, ranging from uniform flow to increasingly pronounced linear velocity gradients across the rotor plane. Computational approaches assessed include the computationally efficient Reynolds-Averaged Navier-Stokes with Blade Element Momentum Theory (RANS-BEMT), medium fidelity Unsteady Reynolds-Averaged Navier-Stokes (URANS), and high-fidelity Improved Delayed Detached Eddy Simulations (IDDES). For validation purposes, the moderate shear case undergoes comparative analysis using both URANS and IDDES approaches.

Analysis shows that RANS-BEMT delivers reasonably accurate predictions of key performance indicators despite requiring only 0.2% of the computational resources needed for the IDDES method, making it ideal for initial turbine design and parameter optimization. The consistent blade loading patterns observed between URANS and IDDES approaches show the reliability of URANS for detailed performance analysis and structural load assessment. However, IDDES demonstrates superior wake region resolution capabilities than other methods. This becomes important when the wake region analysis is critical for understanding downstream turbine interactions, turbulence recovery characteristics, and long-term environmental impacts in multi-turbine array configurations.

Research supported by: The authors acknowledge the financial support provided through a startup package from the University of Rhode Island. This research utilized computational resources from the URI Center for Computational Research, specifically the UMass-URI UNITY high-performance computing cluster. Additional computational resources were provided by the Texas A&M University FASTER system under allocation MCH240051 and the Purdue Anvil CPU system at Purdue University under allocation EES240051. These resources were made available through the Advanced Cyberinfrastructure Coordination Ecosystem: Services & Support (ACCESS) program, supported by the U.S. National Science Foundation under grants #2138259, #2138286, #2138307, #2137603, and #2138296.

3. Realtime nonlinear model predictive control for roll motion attenuation of barge in regular and irregular waves

Presenter: Callum Robbins, MS Graduate Student, Ocean Engineering

Advisor: Jason Dahl

Model predictive control (MPC) is a control method that can predict the future behavior of a system which is used to optimize the control response by minimizing a cost function. The future behavior of the system is estimated using a digital twin. Due to the optimal control response provided by the MPC, improved control of the system can be achieved when compared to conventional control schemes, such as proportional-integral-derivative control. In the presented research, MPC is used in realtime to minimize the roll of a scale model barge in beam sea conditions. The barge is fixed in all degrees of freedom except for heave and roll. This research also incorporates a wave reconstruction and prediction (WRP) algorithm that takes incoming wave information and predicts the surface elevation at a specific location downstream of the propagating waves faster than realtime. The combination of using MPC along with the WRP algorithm allows for optimal control responses of future wave events. Relevant applications of using MPC and forecasted wave elevations include floating offshore wind turbines as minimizing excess pitch and roll motion is important to structural health of the system. This research includes simulated MPC results of the real world scale model barge as well as preliminary experimental results of using the MPC scheme in real time.

Research supported by: grant

4. Searching the Cure - Ballot Rejections Reasons in the Vote-by-Mail Process

Presenter: Leonie Otte, PhD Graduate Student, Mechanical, Industrial and Systems Engineering

Advisor: Dr. Gretchen A. Macht

The three most common reasons a ballot may be rejected are: arrival after the acceptance deadline, failure of the voter to sign the return envelope, or the signature on the return envelope not being matched with previous voter signatures on file. Previous research primarily focused on the reason for signature discrepancies for ballot rejection, discussing demographic factors like age and race.

However, in every election, thousands of ballots go uncounted for various reasons, such as missing ballots, multiple ballots in a return envelope (in primary elections), or failing to provide ID when required. Some of these rejection reasons can be cured, like a missing or mismatched signature; however, the voter cannot cure other causes after submission, resulting in a lost vote.

Therefore, this research examines the proportion of each ballot rejection type based on whether they are curable or non-curable, along with changes over multiple days before and after Election Day, specifically for the state of California during the Presidential Preference Primary Election in 2024. The critical question is: are voters making more errors as Election Day approaches compared to the weeks leading up to it? This study aims to broaden the understanding of ballot rejection reasons and will assist election officials and administrators in making data-informed decisions for voter outreach activities.

Research supported by: URI Graduate School First-Year Doctoral Fellowship

5. Self-assembled cysteamine reporter ligands for SERS nitrate detection in continuous flow

Presenter: Katie Terceiro, PhD Graduate Student, Chemical Engineering

Advisor: Geoff Bothun

Elevated nitrate concentrations in aquatic environments can contribute to the formation of harmful algae blooms, which lead to eutrophication. In this work cysteamine self-assembled monolayers (SAMs) on two-dimensional gold nanostructured substrates were investigated for the capture and detection of nitrate anions by surface enhanced Raman scattering (SERS) under continuous fluid flow. An indirect detection strategy is demonstrated where cysteamine Raman activity and SAM reconfiguration change due to nitrate adsorption. Nitrate adsorption, as well as SAM reconfiguration based on the gauche to trans conformation ratio, were dependent upon the cysteamine protonation state. The terminating amine of cysteamine was Raman active when protonated near the expected SAM pKa and gold-thiol bond was increasingly Raman active above the expected pKa. Highly charged SAMs (pH 3) were not responsive to nitrate, suggesting that nitrate detection is reliant upon the dynamic interplay between protonation, charge state, and nitrate adsorption. Cysteamine SAMs responded to nitrate concentrations spanning 10^1 to 10^3 nanomolar (10^0 to 10^2 parts per billion), which are considerably lower than previously reported for direct detection of nitrate using cationic SAMs. This work demonstrates the potential for indirect SERS detection of anionic pollutants using rationally selected capture + reporter ligands.

Research supported by: NSF EPSCoR, RI Research Alliance STAC; I am on a TA right now

6. Predicting the state of health of Li-ion Batteries

Presenter: Matthew O'Donnell, MS Graduate Student, Chemical Engineering

Advisor: Dr. Arijit Bose

Lithium-ion batteries have become a staple in day-to-day applications because of their high performance and large energy density. As a result many different types of lithium-ion batteries reach the average consumer, among these the 18650 cylindrical cell are the most common. The 18650 cylindrical cells are named by their physical attributes, as they are 18 millimeters in diameter, 65 millimeters in height, and the ending 0 denotes its cylindrical shape. These 18650 batteries different environments can be used to train machine learning algorithms (MLA). MLA are a model that can analyze trends in a given data set to predict the performance of said system. These algorithms can be implemented in battery management systems to prevent cells that cannot efficiently charge and discharge, from negatively affecting other cells in the system. This leads to an improvement in the overall safety by predicting cell failures, such as thermal runaway, short circuits, and poor cell performance. This thesis aims to create a MLA that uses data from the performance of 18650 batteries under varying conditions. That is able to accurately predict the state of health (SOH), the dynamic status of the cell in correlation to the initial condition of the cell, of the cells with minimal input data.

Research supported by: [1] Office of Naval Research (ONR) funded National Institute for Undersea Vehicle Technology (NIUVT), [2] Naval Innovative Science and Engineering (NISE) Program, and [3] Naval Undersea Warfare Center (NUWC) Division Newport Part-Time Academic Degree Training Program (PTADTP)

7. Micro- and Nano- Plastics Accumulation in the Sea Surface Microlayer and its Impact on the Growth of Cobetia marina

Presenter: Lauren Lamothe, MS Graduate Student, Chemical Engineering

Advisor: Dr. Geoffrey Bothun

Oceans and coastal ecosystems are major sinks for plastic pollution. A critical component of oceans and a point of exposure to pollution are sea surface microlayers (SSMLs), which are ubiquitous globally and comprised of natural molecules, microorganisms, and particulate matter including microplastics (MPs) and nanoplastics (NPs). Macroplastics derived from consumer waste are broken down by chemical and physical degradation processes, resulting in MPs & NPs in the ocean environment. This size range of particles is the cause of significant environmental hazards, drawing much attention. Due to the increasing amount of plastic waste accumulating and negatively affecting marine life and ecosystems, it is imperative to understand the transformation and fate of the plastics. Their interactions with bacteria and other natural components are a large part of that. In this study, polystyrene was engineered into pristine and weathered MPs and NPs and then added in various concentrations to Cobetia marina bacteria cultures. The modified cultures and control cultures were monitored to determine the effects of plastics on the growth kinetics of the bacteria. Qualitative data was collected in the form of optical density and SEM imaging, indicating the growth or biofilm formation of bacteria in relation to the presence of plastics. Additional studies were done on the production of exopolysaccharides (EPS), as well as the chemical changes to those substances. FTIR analysis and protein assays were performed to obtain results on the EPS production. Our results provide physical and chemical trends of the impact of polystyrene on the growth of Cobetia marina.

Research supported by: NSF

8. Hybrid Polymer Electrolyte Design for Enhanced Energy Utilization in Solid State Lithium-ion Battery Cells

Presenter: Michael Jones, PhD Graduate Student, Chemical Engineering

Advisor: Prof. Arijit Bose

Standard Li-ion battery cells contain a flammable electrolyte, that poses intrinsic risk of thermal runaway; this risk limits Li-ion battery applications within safety-critical environments. The objective for solid state Lithium-ion (Li-ion) battery development, is to design inherently safer Li-ion cells, while maintaining the operational performance requirements of the end user. Polymer electrolytes often exhibit high impedance in comparison to standard liquid electrolytes, resulting in high polarization (waste heat) during cell charging/discharging. This polarization limits the amount of energy a Li-ion cell can provide on discharge to downstream users. This work demonstrates a hybrid polymer electrolyte design, wherein multi-phase tuning of polymer molecular weight and Li-salt concentration yields decreased cell impedance, as well as increased energy utilization and efficiency, with respect to conventional polymer electrolyte systems. For glimpse to the future, this work illustrates developmental progress on merging this novel electrolyte system with high voltage capability, by use of bi-polar configured electrode stacks.

Research supported by: [1] Office of Naval Research (ONR) funded National Institute for Undersea Vehicle Technology (NIUVT), [2] Naval Innovative Science and Engineering (NISE) Program, and [3] Naval Undersea Warfare Center (NUWC) Division Newport Part-Time Academic Degree Training Program (PTADTP)

9. Polymer Linked Emulsion

Presenter: Sabirul Khan Priyo, PhD Graduate Student, Chemical Engineering

Advisor: Dr. Ryan Poling-Skutvik

Think about any biological tissue, how complicated their structures are and how difficult it is to handle, transport and store them? So much, right? So how about we create a structure that looks and behaves and shows the properties of a biological tissue

My name is Sabirul Khan Priyo. I am currently a Ph.D student under Ryan Poling-Skutvic and my research is about “Polymer Linked Emulsions”. I synthesize triblock co polymer that has hydrophobic endblocks and hyrdrophilic midblocks. When added into oil in water emulsions consisting of decanol as dispersed phase (hydrophobic) and DI water as continuous phase (hydrophilic), they form a linked system by dissolving the endblocks of the polymer into the oil phase and mid block in the continuous phase. This structure makes the emulsion instantly more viscous and we get gel to more stiffer like materials. We add different weight percent of polymer to different size of emulsions and study their rheological properties. We are seeing very similar behavior as a growing brain tissue cells.

Our next goal is to prepare polymer that can attach itself to silica like solid stuffs and make different elastic networks and study new rheological properties.

Research supported by: TA+RA

10. SWCNTs transport faster than expected in polymer solutions

Presenter: Sepehr Yari, PhD Graduate Student, Chemical Engineering

Advisor: Dr. Poling-Skutvik and Dr. Roxbury

Particle tracking offers powerful insights into nanoparticle dynamics within complex environments. Single-walled carbon nanotubes (SWCNTs), owing to their intrinsic fluorescence in the near-infrared region and high aspect ratio, have become useful tools for studying local physical and chemical conditions. In this study, we leverage the particle tracking of SWCNTs to explore their transport behavior in viscoelastic media as a foundation for developing physical biosensors capable of detecting intracellular changes indicative of disease.

To test our hypothesis, we conducted a series of experiments aimed at understanding the coupling between the dynamics of SWCNTs and the structure and viscoelasticity of complex fluids. We prepared solutions of polyethylene oxide (PEO) with varying molecular weights at concentrations of 1, 3, 5, 10, 20, and 30 c*, where c* denotes the overlap concentration of polymer chains. Surfactant-functionalized SWCNTs were introduced into these solutions and imaged using near-infrared (NIR) fluorescence microscopy. To identify the effects of anisotropy, we compared these measurements to similar experiments performed using spherical nanoparticles with diameters of roughly 200 nm, similar to the hydrodynamic diameter of SWCNTs. We find significant deviations in the diffusivity of SWCNTs in high molecular weight PEO solutions, with SWCNTs diffusing up to 300 times faster than predicted by the Stokes-Einstein equation. By contrast, spherical nanoparticles exhibited diffusivities consistent with SE predictions across all molecular weights. This anomalous transport behavior of SWCNTs, which we hypothesize is caused by their anisotropic shape and their ability to rapidly navigate through the polymer mesh, indicates that SWCNTs exhibit a high sensitivity to variations in solution viscosity. Ongoing investigations aim to identify the specific factors influencing their motion to develop a predictive model. Upon establishing the correlation between SWCNT dynamics and medium properties, we will proceed to investigate how changes in these properties within the cellular environment affect SWCNT motion.

Research supported by: RA

11. Establishing a Neonicotinoid Monitoring Program Across Audubon Society of Rhode Island Wildlife Refuges

Presenter: Alexandra Russo, MS Graduate Student, Civil and Environmental Engineering

Advisor: Vinka Oyanedel Craver

Neonicotinoids are the most widely used insecticide. These insecticides disrupt neurological pathways, killing target pests when exposed. Neonicotinoids are highly effective and can be applied directly to the seed, using foliar sprays, or through soil applications. One advantage is their ability to remain effective for up to 3 years after application. In addition to target pests, non-target pollinators and pests are also exposed and ingest the insecticide at sublethal levels. This in turn can lead to the exposure of neonicotinoids to other consumers, opening a pathway for it to travel up a food web. Studies have found that they can move within ecosystems, and demonstrate a negative effect on vertebrates, such as birds. Suggesting that exposure to neonicotinoids at sublethal levels can disrupt species-specific phenology, including breeding and migration. The Audubon Society of Rhode Island & Water for the World Lab seek to establish a monitoring program across its wildlife refuges. To determine the amount of neonicotinoids present, surface water and feather samples will be collected and analyzed using solid phase extraction coupled with liquid chromatography tandem mass spectrometry (LC-MS/MS). Sampling will be optimized using a prioritization map that uses land use data to determine the most high risk refuges. Once processed the data collected for all samples will be made publicly accessible through a website. Quantifying the concentration present in the water and feather samples will aid in the understanding of the capacity of neonicotinoids to infiltrate conservation land.

Research supported by: Rhode Island Water Resources Center and the Audubon Society of Rhode Island

12. Assessing Micro- and Nanoscale Emissions During the Extrusion of Recycled Plastic-Sand Bricks

Presenter: Sirri Akongnwi Neba Nforsoh, PhD Graduate Student, Civil and Environmental Engineering

Advisor: Vinka Oynedel Craver

Recycling plastic waste into construction materials offers a promising solution for plastics deemed "unrecyclable" by traditional recycling methods. The production of plastic blocks has garnered significant attention, particularly in several countries of the global South. The blocks are produced from plastic waste and sand. The manufacturing process involves plastic collection, shredding, extrusion or melting of the plastic and sand, molding, and cooling. During extrusion, particulate emissions are generated, potentially impacting workers' health and occupational safety. This study investigates the release and characterization of particulates emitted during the extrusion process. Particulate samples were collected using a polycarbonate filter and a Tsai diffusion sampler. The collected samples were analyzed using a combination of microscopy, particle size analysis, and spectroscopic techniques. Scanning Electron Microscopy (SEM) was used for imaging, while elemental composition was determined by SEM-energy dispersive X-ray (SEM-EDX). Particle size analysis was conducted using FIJI (ImageJ) software. The results revealed that the particulates collected on the filter ranged from micro- to nanoscale, with diameters approximately between 0.04 µm and 25 µm. Elemental analysis identified the presence of silicon, aluminum, magnesium, iron, potassium, carbon, and oxygen. Nanoparticles, influenced by extrusion temperature and material composition, were found to contribute significantly to the overall particulate load. Understanding the formation and emission of these nano and micro-sized particles is critical for optimizing production processes and mitigating potential environmental and health risks. This research provides useful knowledge into controlling particulate emissions and enhancing the sustainability of plastic-based construction material manufacturing.

Research supported by: NOAA

13. Influence of Ratiometric Dosing on Intracellular Fluorescence of DNA-SWCNTs

Presenter: Raodatullah Abodunrin, PhD Graduate Student, Chemical Engineering

Advisor: Daniel Roxbury

It has been demonstrated that DNA-functionalized single-walled carbon nanotubes (DNA-SWCNTs) bind to cell surface receptors and are trafficked via the endosomal pathway into live cells. The time duration of this process varies depending on cell type and state. Preliminary findings suggest that dosing DNA-SWCNTs in vitro (i.e. into plated and cultured live cells) at a concentration of 1mg/L and incubated for 30 minutes has been shown to have minimal toxicity and adverse effects on cell viability and health. Here, we introduce a nanoparticle dosing parameter (NDP) in terms of concentration ´ time and propose to vary both concentration and time while maintaining a constant NDP (30 mg-minutes/L). By varying the concentration versus time ratio (i.e. NDP ratio) while keeping NDP constant, we investigate apparent brightness in terms of NIR fluorescence intensity per cell as well as absolute uptake, confirmed via hyperspectral NIR fluorescence and confocal Raman microscopies, respectively. We uncovered cell type-dependent NDP ratios for optimized cell internalization and bright NIR fluorescence while minimizing cytotoxicity from the exogenous nanomaterials. We envisioned that the results of this study can be extended to other types of nanoparticles as well as cell types. The inspiration behind ratiometric dosing lies in the well performing 1mg/L for 30 minutes standard. If the concentration and incubation times are scaled while maintaining the ratio, what impacts are had on fluorescence intensity, retention, and cell health and viability. We anticipated that stronger concentrations with short incubation times will have a rapid uptake of SWCNTs but low retention over time while lower concentrations with longer incubation times will have a greater long-term retention with a more heterogeneous distribution of internalized SWCNTs. Additionally, how do those changes hold true across cell types. We also expect to see the intrinsic traits of cells, such as phagocytic vs non phagocytic or cancerous vs noncancerous, will assist in highlighting considerations when determining a dosing strategy. Investigating this experimental setup can potentially describe themes of endosomal recycling, decreased cellular uptake specificity, and chirality dependent biosignaling.

Research supported by: Research Assistantship

14. Nanotube Spectral Fingreprinting and Machine Learning for Optimized Bioimaging/Sensing and ALS Disease Detection Applications.

Presenter: Roy Monroy, MS Graduate Student, Chemical Engineering

Advisor: Daniel Roxbury

Single-walled carbon nanotubes (SWCNTs) possess unique physicochemical and optical properties that make them ideal candidates for biomedical imaging, biosensing, and disease diagnostics. This thesis explores the potential of SWCNT-based spectral fingerprinting combined with ML algorithms to optimize bioimaging, disease detection and prediction, with a specific focus on differentiating between healthy and amyotrophic lateral sclerosis (ALS) lymphoblastic patient samples. By functionalizing SWCNTs with single-stranded DNA, we enhance their stability and target specificity, enabling their application in serum patient samples.

A comprehensive spectral analysis of DNA-SWCNTs was conducted using near-infrared fluorescence spectroscopy and other characterization techniques, including UV-Vis absorption spectroscopy. The spectral data obtained from healthy and ALS serum samples were processed using mathematical approaches, statistic methods and advanced ML algorithms to establish a nanotube spectral fingerprint, facilitating precise disease characterization and classification.

This work highlights the advantage of integrating SWCNT-based nanotechnology with computational methodologies to develop a novel, non-invasive specific diagnostic tool. The study demonstrates high sensitivity and specificity in differentiating Healthy and ALS patient serum lymphoblast samples, paving the way for enhanced early-stage neurological diagnostics. Furthermore, the findings contribute to the broader of nano biosensors and their applications in personalized medicine and point of care diagnostics.

The successful implementation of this approach could revolutionize bioimaging and sensing techniques, providing a rapid, reliable, and cost-effective platform for early disease detection and monitoring. Future research will focus on refining the SWCNT functionalization by expanding the sensors to different DNA strands, varying the processing of data and ML models, expanding the sample size, and investigating additional biomarker features to further validate and test the technique's clinical applicability for different neurological diseases.

Research supported by: Unfunded

15. Behavior of Microplastics in Wastewater Treatment using Microalgae-Bacteria Consortia

Presenter: Valeria Brito, MS Graduate Student, Civil and Environmental Engineering

Advisor: Vinka Oyanedel Craver

Including photosynthetic microorganisms in sanitation systems has the potential to transform the way water treatment is conventionally conceived, by using sunlight as an energy source driving the biological process. The combination of microalgae and bacteria in a single reactor provides the metabolisms required for efficient removal of organic matter and nutrients. This is the result of the ability of microalgae to assimilate nutrients, and the activity of nitrifying and heterotrophic bacteria, resulting in ammonia and organic matter transformation. As a result, they have been proposed as an affordable and sustainable solution with the potential to cope with future challenges of sanitation and water reclamation. The self-sufficient production of oxygen, provided by photosynthesis, reduces or eliminates the operational costs associated with aeration. Meanwhile, CO_2 is produced by HB, which is subsequently used as a carbon source by microalgae and NB. Capture of CO_2 by microalgae is expected to provide low greenhouse gases (GHG) emissions, when compared to traditional treatment processes. Moreover, the combined action of microalgae and bacteria could reach a low concentration of pollutants, compatible with reuse and irrigation standards. Moreover, some studies have observed an improvement in the removal of emerging contaminants, when compared with traditional systems.

One of the aspects still to be determined for microalgae-based sanitation systems is how microplastics behave in these systems. The subject has been studied and characterized in traditional activated sludge systems. However, this is not the case for microalga/bacteria systems, where conditions are different in terms of hydraulic retention time, shear forces and mixing. This research looks to fill that gap, identifying if microplastics present in the influent suffer any transformation, and how the interact with the developing biomass.

Research supported by: The thesis will be carried out within the framework of the proyects: FONDECYT 1230660 “Membrane assisted microalga/bacteria consortia as a tool for sustainable sanitation” and Anillo de Tecnología ACT240022, “Bioprocess for sustainable water reclamation”. I was supported by a fellowship.

16. Development of Optical Strain Sensing “Smart Textile” for Non-contact Monitoring of Strain

Presenter: Melissa Schneider, MS Graduate Student, Chemical Engineering

Advisor: Daniel Roxbury

Developing a Strain-sensing micro fibrous textile constructed via the core-shell electrospinning of polymers, in which the inner polymer consists of Single Walled Carbon Nanotubes (SWCNTs) whose generated optical fluorescence peaks shift in the presence of strain applied to the material in which they are embedded inside of.

Research supported by: NA

17. Biosynthesis of Manganese Oxide Nanoparticle for Agricultural Fertilization Application

Presenter: Nicoly Welter, PhD Graduate Student, Civil and Environmental Engineering

Advisor: Vinka Oyanedel-Craver

Green synthetized nanoparticles have been the object of study for their use as fertilizers in the agricultural field. Among them, manganese oxide nanoparticles (MnONPs) have been used to increase the growth and biomass of rice seedlings, mung bean, moringa plants, among others. In this work, we explore the biosynthesis and purification of MnONPs for this environmental applications, seeing as the biosynthesis of MnONPs consumes less thermal energy compared to chemical synthesis methods. In this study, MnONPs were biosynthesized using a strain derived from the marine environment, Pseudomonas putida GB-1. The bacteria were incubated in a batch system in Leptothorix media, enriched with MnCl2 as the manganese source, for 24 hours at 30 °C and 144 rpm, until the late stationary phase. During the incubation Pseudomonas putida GB-1 transforms aqueous Mn(II) to Mn(III/IV) particles. After 24 hours, the media was centrifuged at 3000 rpm for 10 minutes. The supernatant was collected and filtered for investigation using Inductively Coupled Plasma Mass Spectrometry (ICP-MS), while the MnONPs pellet was re-suspended and soaked in absolute ethanol for 10 minutes aiming the dissolution of organic remnants to obtain a high yield of reactive particles. The pellet was then left to air dry for 48h and then analyzed in the XRF (X-ray Fluorescence) to determine the elemental composition of the remaining solids. The results showed a significant decrease of Mn concentration in the supernatant media after incubation (2160 ppb to below detection limits), suggesting the transformation of MnCl2 into MnONPs by the bacteria. Moreover, the elemental analysis of the pellet showed a high percentage of Mn (52 %) in the remaining solids and possible formation of manganese and oxygen bonds (41%), suggesting once more the formation of MnONPs. The particles obtained will be further characterized using Fourier Transform Infrared Spectroscopy, Energy-Dispersive X-ray Spectroscopy, Transmission Electron Microscopy, X-ray Diffraction, Zeta Potential and Inductively Coupled Plasma Optical Emission Spectroscopy. Moreover, after characterized, the nanoparticles will later be used as fertilizers by foliar application to soybean plants.

Research supported by: Rhode Island Water Resources Center, US Department of Agriculture

18. Tunable clustering of Magnetic Nanoparticles by Utilizing Poly(amino acid) Corrals for Improved r2 Relaxation

Presenter: Mohamed Kabil, PhD Graduate Student, Chemical Engineering

Advisor: Geoffrey D. Bothun

Superparamagnetic iron oxide nanoparticle (SPION) clusters produce localized magnetic field inhomogeneities which could dramatically enhance magnetic relaxation rates important for magnetic resonance (MRI) and magnetic particle imaging (MPI). In this work, we report high and tunable r2 transverse relaxivity in hydrophobic SPION clusters self-assembled with amphiphilic polyethylene glycol-b-poly(L-Leucine) block copolymers, PEGm-b-p(L-Leu)n where the PEG chains were terminated by methoxy (CH3-O-PEGm) or hydroxyl groups (HO-PEGm). SPION cluster micelles exhibited sizes ranging from approximately 100-300 nm with the cluster diameter and interparticle SPION spacing influenced by the molecular weight or chain length of the hydrophobic p(L-Leu)n block. The r2 transverse relaxivity, determined from the dependence of the T2 relaxation rate on SPION concentration, of the assembled SPIONs increased with cluster diameter consistent with greater magnetic dipole-dipole interactions within larger clusters. Terminating the PEG segment with a hydroxyl group that has a high affinity for water resulted in SPION clusters having a higher r2 relaxivity compared to methoxy terminated PEG, as well as commercially available SPIONs-based MRI contrast agents. This work shows that the hydrophobic polymer block length and the terminating hydrophilic headgroup can be used to tune the magnetic dipolar behavior in self-assembled clusters.

Research supported by: CBET Grant No. 2305402

19. Magnetically enhanced treatment for water reuse on Mars

Presenter: Caitlin Murray, MS Graduate Student, Civil and Environmental Engineering

Advisor: Joseph Goodwill and Irene Andreu

As the prospect of human settlement on Mars becomes increasingly realistic, finding sustainable ways to maintain life with limited resources - particularly water – becomes crucial. A key challenge will be developing efficient ways recycle to water that require minimal equipment and do not rely on chemicals, both of which would be scarce in space. One of the conventional methods in wastewater treatment on Earth is to use gravitational settling [1], this is not ideal as gravity on Mars is roughly ⅓ that of what it is on Earth at 3.73 m/s2 [2]. Mars is a desert planet so it is assumed that any water used would then get dust particles in the water on top of the bacteria and waste. Martian regolith (loose rock, dust, and other materials [3]) is more magnetic than that of its Earthen counterpart [3][4], this can be used in conjunction with magnets to increase the speed of settling particles.

Theoretical models as well bench scale experiments are being performed.

Research supported by: NASA funded summer research but it has been unfunded for the academic year and I have been working on it for credit.

20. Spectral fingerprinting of SWCNTs as a Method of Cancer Detection in live Cells

Presenter: Maryam Rahmani, PhD Graduate Student, Chemical Engineering

Advisor: Prof. Daniel E. Roxbury

Detecting cancer at an early stage is a significant challenge because of its diverse forms and elusive nature. To overcome these challenges, this research examines the hypothesis that an innovative SWCNT spectral fingerprinting approach can enhance the in vitro detection of breast cancers more efficiently than conventional methods. The spectral fingerprinting technique utilizes near-infrared (NIR) fluorescence spectra of DNA-functionalized single-walled carbon nanotubes (SWCNTs) within cellular environments, in conjunction with a machine learning algorithm, to distinguish between cancerous and healthy cells. The NIR fluorescence spectra of SWCNTs within different cell-line types showed significant differences, in terms of emission peak intensities, center wavelengths, and peak intensity ratios, due to the variations in cellular uptake and biomolecular interactions. These features served as distinguishing markers for the detection of cancer cells. A support vector machine (SVM) model trained on SWCNT fluorescence data was used to classify cancerous and non-cancerous cells. Moreover, by using Raman microscopy, we statistically analyzed the uptake of SWCNTs in both cancerous and healthy cells. Insights from this research enhance the development of nanomaterial-based platforms for biosensing and provide potential for real-time monitoring of in vivo cellular differentiation. **Research supported by**: RA

21. Rechargeable Magnesium Batteries with Carbon Based Cathode Materials

Presenter: Lauren Rainone, PhD Graduate Student, Chemical Engineering

Advisor: Arijit Bose

As the need for alternative energy storage systems grows, more research is being done to find suitable cathode materials for rechargeable magnesium battery systems. Magnesium batteries are being explored as an alternative to lithium-ion batteries because magnesium is more abundant, offers improved safety features, and has a higher volumetric capacity (3833 mAh/cm^3 compared to lithium's 2061 mAh/cm^3). Compared to monovalent lithium ions, divalent magnesium ions possess a higher charge density, inducing strong interactions between magnesium ions and negatively charged transition metal oxide cathode materials. Fullerene, a carbon allotrope with covalently bonded carbon atoms forming a spherical cage-like structure, is investigated as a potential alternative cathode material due to its unique ability to distribute charges across multiple molecules. This has the potential to improve energy densities and diffusion rates, enhancing cycling capabilities. The compatibility of fullerene as an active material in rechargeable magnesium batteries is explored using galvanostatic cell cycling and surface microanalysis of cell components. Magnesium batteries with fullerene cathodes experience low initial capacities and have rapid capacity fade caused by material dissolution through the electrolyte. Additionally, the dispersion of C60 in the electrolyte is observed, indicated by reduced capacity loss at higher cycling rates, the detection of soft shorts during cycling, and the presence of C60 in the separator after cycling.

Research supported by: NIUVT RA and TA

22. An ESS-extendable Converter with Energy Management Control Empowering Electric Mobility

Presenter: Xueshen Zhang, PhD Graduate Student, Electrical, Computer, and Biomedical Engineering

Advisor: Yeonho Jeong

The hybrid energy system sourced from a fuel cell (FC) and energy storage systems (ESS), such as batteries and supercapacitors, has been considered to extend operation time and ensure long life cycles of ESSs in various electric mobility applications, such as unmanned aerial vehicles and electric vehicles. To enable the utilization of multiple inputs with a simple structure, a hybrid converter is promising, and its energy management control should be developed cooperatively to achieve optimal performance. However, if the desired system specification or configuration is changed, the hybrid converter and its energy management control must be modified, which requires significant effort and considerable delays in overall system redesign. To address this challenge, this paper proposes a scalable multi-input hybrid converter with its energy management capable of rapid adaptation to modified specifications, especially different numbers of ESSs, while realizing three crucial functions: 1) Output voltage regulation, 2) energy flow optimization, and 3) protection for all energy sources. The proposed converter has been validated by the experiment using 16.8 V and 400 W output and three input sources, 450 W FC, one 39.6-50.4 V Lithium battery, and a supercapacitor for the application of small unmanned aerial vehicles.

Research supported by: Dean's Fellowship

23. Compact Frequency Comb Generator Implementation on RFSoC for MKIDs

Presenter: Frank Danso, MS Graduate Student, Electrical, Computer, and Biomedical Engineering

Advisor: Dr. Sungho Kim

Microwave Kinetic Inductance Detectors (MKIDs) are superconducting detectors which are capable of single photon counting through the modulation of their kinetic inductance. Their high frequency multiplexing capability makes them suitable for most cryogenic applications, particularly in space observations. As the number of detectors in the MKID array increases, the significant challenges MKID readout systems face are high power consumption and high memory utilization. While prior approaches have attempted to reduce power consumption by optimizing readout system hardware, the fundamental challenges of memory and power efficiency in large MKID arrays remain inadequately addressed. A primary contributor to these challenges is the high resolution inverse fast Fourier transform (IFFT) engine found in the frequency comb generator of the readout system.

Our proposed frequency comb generation method addresses these issues through a grouping mechanism. By organizing frequency tones into smaller, manageable groups for processing and transmission, the method effectively increases the separation between adjacent tones within each group. This approach reduces the reliance on high-resolution IFFT engines by ensuring that frequency tones in a group remain sufficiently distinct for detection. Consequently, the need for power-intensive and resource-hungry high-resolution IFFT engines is eliminated while achieving 1.9kHz of the frequency bin resolution. Additionally, we reduce memory requirements for data storage by a factor of 20 by storing only the significant portions of resonant frequencies. We present a compact frequency generator capable of generating a large number of resonant frequencies for MKIDs with minimal resource utilization. Leveraging Xilinx's Zynq RFSoC ZCU111, the implementation was verified with 118 tones using measured S21 of MKIDs with the potential to generate more frequency tones without impacting resource utilization.

Research supported by: Research Assistantship

24. A Review of Evacuations Challenges for Vulnerable Populations at Short-Notice Disaster in Mixed Traffic Flow

Presenter: Arome Ozigagu, PhD Graduate Student, Civil and Environmental Engineering

Advisor: Dr. Natacha Thomas

Short-notice evacuations at disasters create acute challenges for vulnerable populations, such as low-income or non-motorized groups, and the elderly or institutionalized, due to their limited physical and material resources. In mixed traffic flow systems, where Connected and Autonomous Vehicles (CAVs) operate alongside Human-Driven Vehicles (HDVs), existing research has largely focused on CAV efficiency, overlooking equity, infrastructure resilience, and the behavioral dynamics that affect HDV-dependent individuals during emergencies. This review aims to evaluate the literature concerning short-notice evacuation challenges for vulnerable populations within mixed CAV-HDV traffic flows. The review specifically investigates research gaps related to equity across infrastructure resilience, behavioral dynamics, and Human-Machine Interface (HMI) designs. The analysis reveals a significant absence of equity-sensitive metrics in evacuation modelling, under-researched systemic risks for HDV-dependent users, and Human-Machine Interface (HMI) designs that intensify the digital divide. These deficiencies collectively risk further marginalizing vulnerable populations at emergency evacuations. Recommendations derived from this analysis call for the integration of comprehensive equity metrics into evacuation models, the recalibration of infrastructure investments to prioritize under-resourced communities, and the incorporation of behavioral dynamics into evacuation planning to mitigate decision-making disparities among vulnerable populations. Enhancing HMI designs to support multilingual interfaces, low-tech compatibility, and universal accessibility is essential to bridge the digital divide.

Research supported by: TA

25. Novel Power Conversion System and Power Management Control for Water monitoring Stations

Presenter: Changseok Kim, PhD Graduate Student, Electrical, Computer, and Biomedical Engineering

Advisor: Yeonho Jeong

Continuous data transmission is crucial for water monitoring stations. To prevent energy shortages due to insufficient solar power generation, batteries are used as a secondary energy source. A power conversion system is employed to manage the energy flow from both the PV panels and the battery to the load. Our objective is to develop a new power conversion system for water monitoring stations that achieves higher power density with fewer components compared to existing systems. We have completed battery modeling using parameter values extracted from the automated measurement system and are currently building a system for PV panel modeling. The project is currently in the simulation phase, and we plan to fabricate a prototype in the near future to validate its performance and conduct a comparative analysis with existing products.

Research supported by: USGS (United States Geological Survey), RA

26. Anomalous aggregation in suspensions of polymer-grafted nanoparticles

Presenter: Masoud Abdi, PhD Graduate Student, Chemical Engineering

Advisor: Ryan Poling-Skutvik and Irene Andreu

Polymer-grafted nanoparticles (PGNPs) exhibit phase behavior distinct from classical polymer and colloidal systems. Understanding these unique behaviors is essential for designing tunable nanomaterials with applications in drug delivery and sensing technologies. Here, we explore the stability and phase transitions of PGNPs. Notably, we assess functionalized gold nanoparticles (AuNPs) with polystyrene at different molecular weights ranging from 5 to 260 kDa. The graft thickness h follows a power-law dependence as a function of Mw with a larger exponent in solution compared to dry-state measurements, confirming the swollen conformation of the grafted polymer in solution. Temperature-dependent measurements indicate that the hydrodynamic diameter Dh of PGNPs decreases with decreasing temperature until we reach a critical temperature TUCST. Below this temperature, aggregation begins due to decreasing polymer-solvent interaction and increasing polymer-polymer interaction. Time-dependent aggregation studies confirm that PGNP aggregation follows diffusion-limited aggregation kinetics below TUCST, where the hydrodynamic size of the PGNP aggregates grows as a power law in time with an exponent $\alpha = 0.34 \pm 0.06$ independent of Mw. This exponent is dramatically different from the universal behavior of hard-sphere colloidal systems in which $\alpha = 0.55$. We hypothesize that this different rate results from a combination of long-range polymer-

polymer interactions and the viscoelastic relaxations of polymer grafted within the aggregate, allowing particles to rearrange. Furthermore, we observe that there is a significant reduction of TUCST compared to that of free polymers, which we attribute to the lower entropy of mixing of grafted polymer chains. Our findings establish PGNPs as hybrid materials in which their stability and phase behavior result from a combination of polymer thermodynamics and colloidal phenomena. Our investigation thereby provides crucial insights for designing nanomaterials with precise stability, self-assembly, and functionality.

Research supported by: This work was partially supported by the National Science Foundation.

27. Aging in natural gas activates the relaxations of polymer melts

Presenter: Mohammadjavad Hajirezaei, PhD Graduate Student, Chemical Engineering

Advisor: Dr. Ryan Poling-Skutvik

Although cast iron pipes carrying natural gas have been in service for several decades, they are prone to corrosion, cracks, and leaks. Polymeric materials such as polyethylene (PE), polyamide (PA) and polyvinylidene difluoride (PVDF) can serve as internal structural liners because of their high corrosion resistance, high strength-to-weight ratio, and impressive mechanical durability in hydrocarbon-rich and high-pressure environments. However, the impact of hydrocarbon environments on the properties of polymer liners is not yet fully understood. In this project, we characterize the properties of these materials after exposure to hydrocarbons at elevated temperatures and pressures, and over long periods of time to assess the stability of these liners in the presence of natural gas and contaminants. Dynamic mechanical analysis (DMA) and Fourier transform infrared spectroscopy (FTIR) were performed on both pre-aged and post-aged samples. Notably, the storage modulus indicates that the polymers generally maintain acceptable mechanical and chemical stability under typical natural gas compositions. However, using time-temperature superposition (TTS) indicates that hydrocarbon aging accelerates polymer relaxations and may lead to reduced mechanical performance. Thus, the activation energy governing polymer relaxation was identified as a sensitive indicator for benchmarking polymer performance and degradation. This minor change in polymer properties demonstrate that they are a viable alternative to cast iron for use as pipeline liners. However, hydrocarbon mixtures may contain reactive or corrosive contaminants. The next step of our study will focus on including these contaminants to observe their effects on mechanical and chemical properties and the activation energy.

Research supported by: grant

28. Graduate Research Assistant

Presenter: Isaac Salazar, MS Graduate Student, Ocean Engineering

Advisor: Lora Van Uffelen

Broadband acoustic transmissions from five moored transceivers were received by two autonomous Seagliders in August 2017 during the Canada Basin Acoustic Propagation

utilized in a least squares inversion to obtain subsurface position estimates. Acoustic sources in this experiment did not transmit simultaneously and in some cases, position estimates spanned larger distances during the reception period than expected given typical horizontal vehicle speeds. Horizontal speeds derived from vehicle measurements can be used to impose a physical limit on the position estimation. Here, three iterations of the least squares model, using increasingly more vehicle data, are presented for two example acoustic receptions received on a Seaglider. The final iteration demonstrates how in situ vehicle measurements can be used to refine position estimates from long-range acoustic data.

Research supported by: NIUVT Grant

29. Targeting Bacterial Biofilms with Magnetic Nanoparticles

Presenter: Mastoureh Shirjandi, PhD Graduate Student, Chemical Engineering

Advisor: Irene Andreu

Bacterial biofilms form protective barriers around bacteria, blocking antimicrobial agents and significantly hindering treatment efforts. These biofilms allow bacteria to grow and persist in hostile environments, contributing to chronic infections and increasing resistance to conventional therapies. Understanding the mechanisms behind biofilm formation and persistence is crucial for developing more effective therapeutic strategies. Magnetic nanoparticles (MNPs) have unique properties, such as generating heat under alternating magnetic fields, which have been extensively studied in cancer treatment for their ability to target and destroy cancer cells. However, the potential impact of MNPs on bacterial biofilms has not been thoroughly explored, presenting a promising area for research. This study aims to investigate the ability of MNPs to disrupt bacterial biofilms through localized temperature increases. The primary objectives are to evaluate the impact of MNP-induced hyperthermia on bacterial survival within biofilms and to explore the potential use of MNPs as a standalone treatment or in combination with existing antimicrobial therapies. This research could lead to innovative solutions for treating biofilm-related infections, improving patient outcomes, and addressing the growing concern of antimicrobial resistance.

Research supported by: NSF, RI Foundation

30. Cooperative Deterministic Learning-Based Formation Control for a Group of Nonlinear Mechanical Systems Under Complete Uncertainty

Presenter: Maryam Norouzi, PhD Graduate Student, Mechanical, Industrial and Systems Engineering

Advisor: Chengzhi Yuan

Over the past decades, multi-agent systems (MASs), due to their efficiency, scalability, and adaptability, have become a powerful approach for solving challenging real-world problems. MASs refer to systems consisting of multiple agents that collectively perform complex tasks. In many robotic applications, agents must adhere to a specific formation, requiring precise coordination, collision avoidance, and efficient navigation around obstacles. Formation control serves as a key approach to satisfying these requirements. Its goal is to regulate how agents move relative to each other while maintaining a specific formation pattern. Formation control algorithms are commonly categorized into three types. First, the behavioral approach, in which the formation task is divided into sub-problems with separate solutions. Second, the leader-following approach, in which agents follow a leader(s), making the system vulnerable to leader(s) faults. Finally, the virtual structure approach, in which agents follow a virtual leader, improving robustness. Each mentioned approach can operate in a centralized or decentralized schema. In a centralized approach, one unit controls the agents, while in a decentralized one, each agent communicates with the other agents and decides independently. In most leader-following formation control techniques, leader dynamics is linear time-invariant with no inputs, while the system's ability to handle more complex formation tracking tasks requires the implementation of diverse and sophisticated reference trajectories. In addition, challenges caused by dynamic variations in inertia remain unaddressed in cooperative control research and require further investigation.

To address the mentioned challenges, here we considered a more generalized leader dynamics model, where the virtual leader is a linear system subject to bounded time-varying external inputs and developed a novel cooperative deterministic learning-based adaptive formation control scheme to address the formation control problem for a group of general nonlinear mechanical systems with complete uncertain dynamics. Our control architecture framework consists of two layers. The first layer is a cooperative discontinuous nonlinear estimation protocol designed to estimate the states of a leader with linear time-variant dynamics, and the second layer introduces a novel cooperative deterministic learning-based formation control protocol to achieve formation tracking control and cooperative locally-accurate identification/learning of the completely uncertain nonlinear dynamics using radial basis function neural networks (RBF NNs). Numerical simulations have been conducted, and the results verify that the proposed formation control protocol can ensure formation tracking performance while enabling cooperative and accurate learning/identification of nonlinear uncertain system dynamics with guaranteed NN weight convergence and learning consensus performance.

Research supported by: This work was supported by the National Science Foundation under Grant CMMI-2154901.

31. Breaking biofilms: Magnetic Nanoparticles for Cleaning Surfaces in Marine Environments

Presenter: Payel Biswas, PhD Graduate Student, Chemical Engineering

Advisor: Irene Andreu

Marine biofilms, which are formed by the growth of various organisms, can significantly compromise underwater equipment, especially for devices like sensors and camera lenses, by obscuring sensor readings and camera clarity. They can also escalate fuel consumption and corrosion on ships by altering hydrodynamics. These persistent biofilms necessitate costly removal and maintenance, posing a challenge to marine operations. Removing bacterial biofilms early on can prevent the attachment of harmful macro-organisms. This project proposes using magnetic nanoparticles (MNPs) to remove marine biofilms under alternating magnetic fields. Spherical iron oxide MNPs (diameter ~20 nm) were synthesized by the hydrothermal method, and their morphology, crystallinity, and magnetic properties were evaluated by electron microscopy, X-ray diffraction, and static and dynamic magnetometry. The synthesized MNPs have a polyethyleneimine coating, a positively charged polymer with antimicrobial properties. The integrity of these coatings was verified and quantified using Fourier Transform Infrared Spectroscopy, Transmission Electron Microscopy (TEM), and Z-potential measurements. The MNPs were internalized within lab-grown C. marina biofilms and placed under alternating magnetic fields. Several high-frequency alternating magnetic fields in the hundreds of kHz range were tested. This frequency range is designed to promote MNP heating for the MNP morphology and composition. Also, the MNPs were placed in a low-frequency magnetic field, which caused the particles to rotate due to their interaction with the magnetic field. This rotation generates mechanical torque that can disrupt the biofilm physically, augmenting the MNP's ability to disturb and displace the biofilm matrix. The morphology of the biofilm and viability of the bacteria before and after alternating magnetic field treatment were evaluated by fluorescence microscopy and crystal violet absorbance. The study investigated the most effective MNP treatment regime and the effects of mechanical or thermal excitation on biofilm and bacterial physiology. The proposed research holds potential for providing an effective approach to addressing the problem of marine biofilms and could be used to treat biofilm caused by antibiotic-resistant bacteria strains.

Research supported by: NSF Engineering Research Initiation (grant # 2301790), Research Assistantship

32. Novel Strategy for Dissipating Energy Released from Underwater Collapse of Structures

Presenter: Victoria Reilly, PhD Graduate Student, Mechanical, Industrial and Systems Engineering

Advisor: Dr. Arun Shukla

An experimental study of the underwater collapse of shrouded cylindrical shells was conducted to mitigate the pressure pulses emitted. Each experiment involved a thin-walled metallic shroud with several small perforations placed concentric to a sealed implodable volume which was brought to instability hydrostatically within a pressure vessel, simulating a free-field environment. High-speed stereo photography coupled with 3D digital image correlation (DIC) provided full-field displacement histories of the shroud during the event. High frequency response dynamic pressure transducers placed at several locations around the shroud captured emitted pressure histories. The effects of varying perforation densities and perforation orientation of shrouds on the pressure signatures emitted by the implosion of thin metallic cylindrical shells were experimentally investigated. The shrouds mitigated the emitted pressure history by up to 90%. Two regimes of shroud behavior were observed, one in which the implodable underpressure is equalized primarily by shroud wall deformation and one where equalization occurs through fluid ingression via the shroud perforations. The perforation density directly determined the contribution from both of those two mechanisms. Research is ongoing to understand the fluid-structure interaction between an imploding volume and a deformable confining shroud along with impulse mitigation optimization.

Research supported by: ONR grant number: N00014-22-1-2295

33. Curve Sandwich Composite Panels Subjected to Near-Field Underwater Explosion.

Presenter: Siddharth Jain, PhD Graduate Student, Mechanical, Industrial and Systems Engineering

Advisor: Arun Shukla

Composite sandwich structures have emerged as promising systems for marine structures. However, these structures are susceptible to underwater shock loading due to their application in marine environments. This work focuses on experimentally investigating the response of curved polymeric composite sandwich structures to near-field underwater explosions (UNDEX). High-speed image acquisition and 3D digital image correlation (DIC) captured the panel deflection and the fluid-structure interaction. The oscillation and migration of the explosion gas bubble were studied for different standoff distances. Additionally, surface cavitation bubbles were examined under varying structural stiffness and loading intensities. Dynamic pressure sensors were positioned to record and characterize the loading generated using a bridge wire detonator. The results indicate a dependence of the dynamics of the surface cavitation bubble on the loading intensity and structural stiffness. Additionally, a greater migration of the explosion bubble towards the structure was observed for shorter standoff distances. Panels with a higher density of foam core exhibited greater strength and stiffness, resulting in lower panel deflections. Furthermore, a higher deformation mode in the sandwich structure was observed due to the curved geometry of the panels.

Research supported by: Office of Naval Research (ONR) Grant No. N00014-20-1-2877

34. Machine Learning-driven Optical Microfiltration Device for Improved Nanoplastic Sampling and Detection in Water Systems

Presenter: Liyuan Gong, PhD Graduate Student, Mechanical, Industrial and Systems Engineering

Advisor: Dr. Yang Lin

The rising presence of nanoplastics in water poses toxicity risks and long-term ecological and health impacts. Detecting nanoplastics remains challenging due to their small size, complex chemistry, and environmental interference. Traditional filtration combined with Raman spectroscopy is time-consuming, labor-intensive, and often lacks accuracy and sensitivity. This study presents an agarose-based microfiltration device integrated with machine learning–assisted Raman analysis for nanoplastic capture and identification. The 1% agarose microfluidic channel features circular micropost arrays enabling dual filtration: nanoplastics diffuse into the porous matrix, while larger particles (>1000 nm) are blocked by the microposts. Unlike conventional systems, this design achieves both physical separation and preconcentration, enhancing nanoplastic detectability. Upon dehydration, the agarose forms a transparent film, significantly improving Raman compatibility by minimizing background interference. This transformation enables direct Raman analysis of retained nanoparticles with enhanced signal clarity and sensitivity. Using 100-nm polystyrene nanoparticles (PSNPs) as a model, we evaluated device performance in distilled water and seawater across concentrations (6.25–50 µg/mL) and flow rates (2.5–100 µL/min). Maximum capture efficiencies of 80% (seawater) and 66% (distilled water) were achieved at 2.5 µL/min. A convolutional neural network (CNN) further enhanced spectral analysis, reducing mapping time by 50% and enabling PSNP detection in seawater at 6.25 µg/mL. This agarose-based system offers a scalable, cost-effective platform for nanoplastic sampling, demonstrating the potential of combining microfluidics with machine learning–assisted Raman spectroscopy to address critical environmental and public health challenges

Research supported by: This research was supported through the National Science Foundation (NSF, Grant 2347408) and the Water Resources Research Act Program funded by the U.S. Geological Survey (G21AP10622-02)

35. Reducing Stormwater Pollution through Enhanced Street Sweeping

Presenter: Andrew Sheerin, PhD Graduate Student, Civil and Environmental Engineering

Advisor: Dr. Vinka Oyanedel-Craver

This research employs a data-driven approach to enhance street sweeping in urban areas. Street sweeping is an effective nonstructural best management practice to reduce stormwater runoff pollution and prevent nearby waterbodies from impairment. In urban environments, pollutants such as nutrients, heavy metals, hydrocarbons, and microplastics accumulate rapidly, largely influenced by geographical and environmental parameters. Factors like land use, tree coverage, traffic volume, and season significantly correlate with the rate of pollutant accumulation. To address this, a Python and GIS-based tool, titled Stormwater Washoff and Pollution Tracker (SWPT), has been developed to analyze the geospatial distribution of pollutants and optimize street sweeping programs to mitigate stormwater runoff pollution. SWPT simulates the buildup, washoff, and removal of street solids under various street sweeping scenarios. A road prioritization model ranks road networks by incorporating user-defined weights for critical geospatial factors (e.g., land use, tree coverage). Optimization techniques are then applied to the road network to maximize the efficiency of street sweeper routes, ultimately reducing stormwater runoff pollution. The results generated by SWPT can assist states and municipalities in making informed decisions to improve their street sweeping programs. Additionally, the environmental impact of an enhanced street sweeping program are evaluated through a life cycle assessment.

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36. Estimation of Rayleigh Wave Phase Velocities and Attenuation Coefficients Using Three-Component Ambient Noise Beamforming.

Presenter: Mojgan Gharakhanlou, PhD Graduate Student, Ocean Engineering

Advisor: Aser Abbas

This study focuses on the in-situ estimation of shear wave velocity and attenuation coefficients using ambient vibration data collected through the Microtremor Array Method (MAM). The approach utilizes three-component array measurements to incorporate both vertical and horizontal motions of Rayleigh waves, allowing for improved directional resolution and more robust wavefield characterization. Two beamforming methods are employed: the Conventional Rayleigh Three-Component Beamforming (CRTBF) and the High-Resolution Rayleigh Three-Component Beamforming (RTBF), both of which are applied to extract the fundamental and higher Rayleigh wave modes across a range of frequencies.

The phase velocity dispersion curve has been successfully extracted and validated using the CRTBF and RTBF approaches, showing strong agreement with theoretical and reference velocity profiles. These results demonstrate the effectiveness of three- component array analysis in improving phase velocity estimates, particularly in complex subsurface conditions.

Future work will focus on extracting frequency-dependent attenuation coefficients from the same dataset. This will involve further development of the beamforming framework to enable the inversion of small-strain damping ratios. The combination of velocity and attenuation information will support more accurate seismic site characterization and is expected to benefit ground response modeling and geotechnical hazard assessments

37. Rapidly Deployable Coastal Observatory Enabled with Distributed Sensing.

Presenter: Katie Burrows, PhD Graduate Student, Ocean Engineering

Advisor: Brennan Phillips

Distributed sensing employs a fiber optic cable for continuous, real-time temperature, acoustics, and strain in situ measurement. While this technology is growing ever more popular above the sea, the complexity of deployment in the ocean is hindering its use in coastal observatories. Our research aims to prove that the deployment of these systems can be efficient and straightforward, which would encourage more scientists to gather valuable and novel information using fiber optic cables.

38. HELICSAuto: Automating the Development of Cyber-Physical Co-Simulation Framework for Smart Grids.

Presenter: Sayeb Tadvin, PhD Graduate Student, Electrical, Computer, and Biomedical Engineering

Advisor: Hui Lin

Co-simulation is a powerful technique integrating various simulation tools to create a unified simulation environment. It provides an in-depth understanding of the interplay between cyber and physical infrastructures in industrial control systems like smart grids. HELICS is a framework that facilitates co-simulation development by providing common interfaces to enhance simulators, synchronize their executions, and exchange information. In this work, we propose HELICSAuto, a code instrumentation procedure that automates the integration of domain-specific simulators with HELICS APIs. HELICSAuto requires developers to label their source code using a pre-defined syntax, after which an interpreter automatically instruments the code with minimal manual involvement. We demonstrate the effectiveness of HELICSAuto by successfully applying it to simulators based on PandaPower, PowerWorld, OPAL-RT, and PyDNP3 to create a transmission-distribution-communication co-simulation environment for complex smart grids.

39. Sanitizing Neurons: Pruning-based Backdoor Mitigation via Progressive Neuron Ranking using Adversarial Proxies.

Presenter: Abdullah Arafat Miah, PhD Graduate Student, Electrical, Computer, and Biomedical Engineering

Advisor: Yu Bi

Deep Neural Networks (DNNs) are widely used across various applications, but their growing adoption makes them increasingly vulnerable to adversarial threats such as backdoor attacks. In these attacks, adversaries embed triggers during training, causing the model to behave normally on clean inputs but misclassify when the trigger is present. Pruning backdoor-related neurons is a promising defense, yet existing methods struggle with accurate neuron identification, often degrading clean performance. In this work, we propose a novel approach to rank and prune backdoor neurons by directly leveraging their theoretical definition. Specifically, we prune individual neurons in batch normalization layers and measure performance deviations on clean and backdoor tasks to rank their importance. While backdoor task evaluation typically requires triggered samples, we show that targeted adversarial examples can be used instead when only clean data is available. We also introduce a method to detect the target label using a small number of clean samples. Our approach enables categorization of backdoor neurons based on their contribution, allowing for controlled pruning that balances clean task accuracy and backdoor mitigation.

40. Integrating Data Imputation and Augmentation with Interpretable Machine Learning for Efficient Strength Prediction of Environment-friendly Fly Ash-Based Alkali-Activated Concretes.

Presenter: Nausad Miyan, PhD Graduate Student, Civil and Environmental Engineering

Advisor: Sumanta Das

Fly ash-based alkali-activated concrete (AAC) is renowned for its superior mechanical performance and sustainability, presenting an attractive alternative to traditional Portland cement concrete. Despite these advantages, the broad compositional range of AACs presents challenges in precisely tailoring material properties. In this context, machine learning (ML) offers promising prospects to streamline and fast-track the development of advanced materials design strategies by predicting mechanical properties from compositional variations. Effective ML model development, however, hinges on the availability of a comprehensive, high-quality dataset. Previous studies often relied on literature-derived datasets, which typically include outliers, noise, and missing values, potentially leading to biased predictions. Moreover, limited dataset sizes could undermine the robustness of the models. Traditional ML methods applied to AACs also tend to lack interpretability. To address these issues, this research utilizes several data imputation methods and Generative Adversarial Networks (GANs) for data augmentation, effectively doubling the dataset size. Following this, ML algorithms such as Random Forest (RF), Extreme Gradient Boosting (XGBoost), and Neural Networks (NNs) are leveraged to predict compressive strength. The NN model, especially when enhanced by k-nearest neighbors (kNN) imputation (k = 5), demonstrated superior predictive accuracy compared to RF and XGBoost models. Further, SHAP (SHapley Additive exPlanations) analysis reveals key determinants of compressive strength, such as water content, SiO2, and curing conditions. Visualizations such as SHAP violin and river flow plots further elucidated feature contributions and property distributions. Overall, this study provides a robust framework for exploring composition-strength relationships in AACs, advancing the design of these environment-friendly materials.

41. STRATEGIC REINFORCEMENT OF WIND TURBINE BLADE TRAILING EDGES: IMPROVING BUCKLING RESISTANCE USING 3D PRINTED AUXETIC LATTICES.

Presenter: Raffaele Cuorvo, MSC Graduate Student, Mechanical, Industrial and Systems Engineering

Advisor: Sumanta Das

The structural integrity of wind turbine blades is critical to the efficiency and longevity of renewable energy systems. Among the most vulnerable components is the trailing edge, which is susceptible to local buckling due to aerodynamic loads, environmental stressors, and material fatigue. This thesis investigates a novel approach to enhancing the buckling resistance of wind turbine blade trailing edges through the strategic integration of re-entrant honeycomb auxetic lattice structures. These auxetic materials, characterized by a negative Poisson's ratio, offer superior energy absorption and lateral expansion under compressive stress, making them ideal for localized reinforcement.

The research employs Finite Element Analysis (FEA) using SolidWorks and Abaqus software to model a composite wind turbine blade composed of S818, S825, and S826 airfoils. The study simulates operational loading conditions and evaluates structural performance using failure criteria such as Tsai-Wu and Tsai-Hill. Critical stress zones along the trailing edge are identified and reinforced with optimized auxetic lattices. Comparative analyses are currently in progress. We expect the auxetic-reinforced designs to significantly improve buckling resistance while minimizing added weight and maintaining aerodynamic efficiency.

This strategic reinforcement method not only advances the mechanical durability of turbine blades but also contributes to sustainability by extending component lifespan, reducing maintenance frequency, and lowering material waste. Overall this research aims to offer a promising pathway for the development of more resilient and economically viable wind energy technologies.

42. Meso-structural Degradation and Mechanical Property Evolution in Cementitious Mortars Containing Microencapsulated Phase Change Materials under Extended Freeze-Thaw Cycles.

Presenter: Rakesh Paswan, PhD Graduate Student, Civil and Environmental Engineering

Advisor: Sumanta Das

This research explores the influence of incorporating microencapsulated Phase Change Materials (MPCM) on the evolution of both mechanical behavior and meso-structural damage in mortars in response to prolonged freeze-thaw conditions, employing Differential Scanning Calorimetry (DSC) for thermal analysis, comprehensive mechanical performance experiments, and high-resolution X-ray Tomography (XRT) to assess internal damage evolution. The DSC results highlight the thermoregulatory effect of MPCM, which influences the performance of the mortars under freeze-thaw conditions. Mechanical experiments show a trade-off between initial strength and long-term durability, with MPCM-enhanced mortars demonstrating significantly reduced strength loss when exposed to extended freeze-thaw cycles compared to control mortars. XRT images further corroborate these outcomes, illustrating less pronounced meso-structural degradation in MPCM-containing samples when exposed to extended freeze-thaw cycles. Overall, the findings in this research reveal that MPCM-infused mortars, particularly those with higher MPCM concentrations, exhibit significantly reduced internal damage and maintain better mechanical integrity compared to control samples. Collectively, these insights suggest that MPCM integration could be a pivotal strategy for designing more resilient and durable cementitious composites, paving the way for future advancements in construction practices tailored to withstand the challenges of freeze-thaw conditions.

43. Integrating Experiments, Finite Element Analysis, and Interpretable Machine Learning to Evaluate the Auxetic Response of 3D Printed Re-entrant Metamaterials.

Presenter: Bolaji Oladipo, PhD Graduate Student, Mechanical, Industrial and Systems Engineering

Advisor: Sumanta Das

Metamaterials have received extensive attention in fundamental and applied research over the past two decades due to their unique mechanical behavior. This research presents an interpretable machine learning (ML) approach for efficient response prediction of three-dimensional (3D)-printed metamaterials. However, developing such an ML-based model requires a large consistent, representative, balanced, and complete dataset. To this extent, an experimentally validated finite element analysis (FEA) approach is implemented to generate 8096 non-self-intersecting re-entrant honeycomb structures by varying the mesoscale geometrical features to obtain the corresponding Poisson's ratios. This dataset is leveraged to develop a feed-forward multilayer perceptron-based predictive model. The developed ML model shows excellent predictive efficacy on the unseen test dataset. Shapely additive explanation (SHAP) is then used for model interpretation. SHAP results show that the slant cell length is the dominant input feature dictating the model output whereas cell angle and vertical cell length show mixed trends signifying that other input features influence their effect on the model output. Moreover, cell thickness does not significantly influence the model output when compared to other input features. Overall, the integrated numerical simulation-experiment-interpretable ML-based predictive approach presented here can be leveraged to design and develop metamaterials for a wide range of engineering applications.

44. Evaluating the Adhesion Response of Acrylonitrile-butadiene-styrene (ABS)/Thermoplastic polyurethane (TPU) Fused Interface using Multiscale Simulation and Experiments.

Presenter: Jonathan Villada, PhD Graduate Student, Civil and Environmental Engineering

Advisor: Sumanta Das

This research implements reactive forcefield molecular dynamics (MD) simulation to evaluate the mechanical performance of the fusion bond line formed between acrylonitrile butadiene styrene (ABS), and thermoplastic polyurethane (TPU). The simulated interfacial adhesion responses, as obtained from MD simulation, are further implemented as the interfacial properties between ABS and TPU in an upscaled cohesive zone-based finite element analysis (FEA) model for macroscopic response evaluation. Such upscaling enables fair comparison of the simulated macroscopic stress-strain response with experimental results obtained for 3D printed ABS/TPU hybrid samples with a fusion-bonded interface. Overall, the stress-strain response predicted from a FEA-based model shows a good correlation with the experimental data signifying good predictive efficacy of the simulation approach. Thus, by interactively linking the molecular structures of the polymers and the processing parameters with the macroscale interfacial adhesion response of the fusion bond line, the experimentally validated comprehensive approach presented in this research paves the way for atomistic engineering of the molecular structures as well as efficient fine tuning of processing parameters to meet desired macro-scale performance needs besides enabling exploration of the mechanisms and atomistic origins of the interfacial damage at the fused bond line.