

University of Massachusetts Dartmouth
Sigma Xi Scientific Research Honor Society
29th Annual Research Exhibition

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Posters on display Wed 1:00-3:00 and Thurs 10:00-12:00.
Student award winners announced Thursday at 12:30.

Organized by the UMass Dartmouth Chapter of Sigma Xi with financial assistance from the Office of the Chancellor and the Office of Research and Innovation.

1. Pungency as a trade-off in *Capsicum* species with respect to germination and cotyledon emergence

Joshua Comstock (U)
Tara Rajaniemi (F)

The pungency of the fruit of chili plants in the genus *Capsicum* serves as a valuable defense against both fungal pathogens and mammalian herbivores. However, despite the fitness value of defending seeds, the metabolism of capsaicin, a pungent chemical within chilis, represents a resource cost to the plant; these resources could be spent on other traits that increase fitness. This experiment is part of a study to determine what the pungency of chilis comes at the cost of; this specific experiment examines how pungency influences germination rate and efficiency of reaching early development milestones such as emergence of aboveground growth and cotyledons. Two cultivars of varying pungency from each of three species were observed as seedlings to this end, and only the most pungent cultivar examined had statistically significant delays in its early development milestones. It is unlikely that the cost of capsaicin synthesis is responsible for this delay because the inhibitory effect of capsaicin on early development is more likely responsible for this observation. A further experiment will be conducted to examine the effects of capsaicin synthesis on the traits of mature chili plants.

2. Investigating variation in circadian clock genes in *Callophrys* elfin butterflies

Nic LePage (U)
Genevieve Kozak (F)
Uma Knaven (G)
Brittany Velikaneye (G)

Circadian clock genes provide an avenue to understand seasonal behaviors in insects such as emergence timing and flight periods. Although the circadian clock has been thoroughly studied in model systems such as *Drosophila melanogaster* and *Bombyx mori*, these genes remain understudied in many other Lepidoptera. Differences in the flight pattern range of *Callophrys* elfins have been identified, with the eastern pine elfin (*C. niphon*) having an unusually long flight period compared to related species such as the brown elfin (*C. augustinus*) and frosted elfin (*C. irus*). Primers for *Callophrys* circadian clock genes were designed from a de novo assembly using primerBLAST and tested using standard PCR amplification. Two primers successfully amplified the sequence. Single Nucleotide Polymorphisms (SNPs) were identified in the genes Clock and Casein kinase 1 gamma. These sequences were used to compare both genetic variation between *Callophrys* species and variation between early and late emerging pine elfins. Most of the genetic variation occurred between different species, however some genetic variants were present within pine elfins. Clock is a main regulator of circadian (24 hours) timing and species differences may help us understand how this pathway changes as species adapt to different environments.

3. Exploring Viscosity of Vanadium-based Electrolyte Systems for Redox Flow Battery via Molecular Dynamics

Ahmed Yusif Abdulai (G)
Maricris Mayes (F)

Redox flow batteries (RFBs) represent a key technology for large-scale energy storage. However, increasing the concentration of active species to enhance energy density often results in high electrolyte viscosities, which hampers RFB performance. Here, we utilized molecular dynamics simulations to examine the viscosity and ionic conductivity of vanadium-based electrolytes using the LAMMPS package. Our study focused on how temperature influences the viscosity and ionic conductivity of the vanadium (IV) bis-hydroxyiminodiacetate [VBH]2- complex. To achieve this, we applied newly developed force field parameters for the [VBH]2- complex, integrated with OPLS-AA and OPLS-AA/CM1A for the solvent (acetonitrile) and the alkylammonium cations respectively. Our findings indicate that viscosity decreases as the temperature increases. Additionally, we observed larger cations lead to higher viscosities, which align with experimental observations. The ionic conductivity increased with increasing concentration, eventually reaching a stable plateau at higher concentrations. These findings offer key insights into the strategic design of electrolyte systems, enabling improved performance in RFBs.

4. Polyphenol-rich extracts of cranberry leaves inhibit bacterial biofilms through reduction of extracellular matrix and leakage of cellular materials

Martin Aborah (G)
Catherine Neto (F)
Frank Scarano (F)

Bacteria pathogens are responsible for causing infections related to indwelling medical devices. Therefore, novel antibiofilm strategies targeting bacterial cell-cell communication and the biofilm formation are urgently needed. Thus, the focus of our study is to evaluate the biofilm-inhibiting properties of polyphenolic fractions from cranberry leaves and elucidate the possible mechanisms of inhibition and the active compounds. Fractions (7) were obtained from cranberry leaves through column chromatography and characterized by HPLC and LCMS. Through the crystal-violet assay, the results revealed promising biofilm inhibition and eradication ability of hyperoside, procyanidin, and coumaroyl-quinic acid fractions, except E. faecalis and K. pneumonia where resistance behaviors were sometimes observed. Cellular leakage assay showed hyperoside fraction caused higher leakage of cellular materials (p< 0.05) compared to control and could account for its antibiofilm activity. Also, procyanidin and coumaroyl-quinic acid fractions appear to inhibit biofilm through reduction of extracellular matrix. These novel results indicate that cranberry leaves are potential biofilm inhibitors.

5. Inhibition of the Sulfate Reducing Bacteria, Desulfovibrio, Through Virtual Screening

Benjamin Mello (U)
Maricris Mayes (F)

Microbiologically influenced corrosion (MIC) occurs when microbial activities alter biofilm or metal interfaces, accelerating corrosion in industries such as marine. This process involves anaerobic and aerobic bacteria but is primarily due to sulfate-reducing bacteria (SRB). SRB contributes to corrosion by producing hydrogen sulfide which reacts with metal surfaces, forming sulfides and creating an acidic environment. Over 60 SRBs exist, but Desulfovibrio is found in carbon steel at higher abundances. A study estimates the global cost of corrosion at $2.5 trillion, with industrial corrosion alone at $1.45 trillion. Here, we show that virtual screening of a chemical database using docking software is a cost- and time-effective method to find inhibitors. We explored quaternary ammonium compounds (QAC) as potential Desulfovibrio inhibitors due to their low toxicity, cost, and effectiveness. Virtual screening runs using QACs resulted in favorable molecular interactions and good docking scores. We compiled over 12,000 QACs for further screening. Our findings suggest this approach can identify MIC inhibitors, reducing corrosion costs and supporting future validation and mitigation plans.

6. Characterization of Anti-inflammatory Triterpenoids, Phytosterols & Tocopherols in Cranberry Pomace, Seedless Pomace and Seeds

Md Sagir Mia (G)
Jillian Mauk (U)
Hang Ma
Catherine Neto (F)
Huifang Li, Christina Khoo

Vaccinium macrocarpon (American Cranberry) is commonly used to produce juice and other edible products. A byproduct called pomace is left behind containing the skins, seeds, peels, and stems. To determine the compositional differences between the seeds and the rest of the pomace, three different extracts were prepared: whole pomace, seedless pomace, and seeds-only. After isolation of the components by sieves, ultrasound-assisted extraction was employed to prepare the samples for characterization. Pentacyclic triterpenoids including ursolic acid, oleanolic acid, and others were analyzed and quantified using UPLC-MS. Quantification of neutral triterpenoids, phytosterols, and tocopherols was performed using GC-MS. The pomace extracts were fractionated using a silica gel column or vacuum liquid chromatography (VLC) to give better purification of the compounds found within each for further characterization and comparison. Anti-inflammatory potential of pomace extracts was assessed using LOX (lipoxygenase) inhibition assay. Results showed the abundance of anti-inflammatory natural products found within cranberry pomace and the compositional difference between the seeds and whole pomace.

7. Developing an Ultrasensitive Biosensor Using Metallic Nanoparticles for Early Detection of Neurological Diseases

Linh Dan Nguyen (U)
Wei-Shun Chang (F)

Neurological diseases are the leading cause of disability and death worldwide. Current diagnosis methods contain many limitations due to the lack of detection sensitivity, requirement of complex equipment, and high cost. The growing potential of nanomedicine provides a possible solution to these challenges. Nanoparticles are nanoscale materials that possess many characteristics such as low immunogenicity, high surface area-to-volume ratio, and high sensitivity. This project aims to utilize gold nanoparticles to develop a biosensor that can be used to probe and detect neurological diseases at a single particle level. Under a microscope, a nanosphere appears green. When one nanosphere comes into close contact with another, a red color shift occurs. By coating the nanospheres with the antigen and antibody pair associated with a neurological disorder, the color change of the nanospheres generated by the selective binding of antigen and antibody pairs is the mechanism of detecting neurological diseases. This detection mechanism is first verified using an Anti-FLAG-FLAG antibody-antigen pair. Results from this initial stage indicate that the detection mechanism is successful and can be further applied to detect the presence of neurodegenerative proteins.

8. ANTIOXIDANT ACTIVITY AND CYTOPROTECTIVE EFFECTS OF MASSACHUSETTS CRANBERRY (VACCINIUM MACROCARPON) CULTIVARS

Maureen Otieno (G)
Elena Depra (U)
Ryley Thatcher (U)
Catherine Neto (F)

The North American cranberry (*Vaccinium macrocarpon*) is recognized for its rich content of polyphenols associated with health benefits such as antioxidant and antibacterial properties, but these vary between cultivars and growing regions. The objective of this study was to compare three native and hybrid cranberry cultivars grown across Massachusetts for the best source of antioxidant content and quality. We harvested fruits at the UMass Cranberry Station from native variety Early Black (EB), new hybrid Mullica Queen (MQ), and a commonly grown hybrid Stevens (ST), and then prepared and analyzed extracts. The total phenolics content and content of proanthocyanidins (PACs) associated with urinary health benefits were determined using established methods. Antioxidant properties were assessed using the DPPH (free-radical scavenging) and FRAP (ferric reducing power) colorimetric assays, and antioxidant polyphenols were quantified using HPLC. Among the cultivars, hybrid MQ had the highest total phenolic content, followed by native EB. The best antioxidant activity was demonstrated by EB, for both free radical scavenging activity and ferric-reducing capacity, followed by MQ. HPLC shows both EB and MQ were richer sources of bioactive polyphenols and terpenoids than ST. Our data indicates that both EB and MQ cultivars are better options to enhance dietary intake of antioxidants and UTI-protective PACs than the popular ST cultivar. We hope this research will provide guidance for growers seeking to optimize crop quality and value.

9. Redox Mediated Flow Batteries: Next Generation Energy Storage

Daphne Poirier (U)
Tulsi Poudel (G)
Dr. Patrick Cappillino (F)

As the use of renewable energy increases, so does the need for grid-scale storage to ensure accessibility during downtimes. To this extent, a redox mediated flow battery (RMFB) is proposed. RMFBs combine two types of batteries: solid state and liquid redox flow. Combining the two results in high energy density and scalability, which is both cost effective and energy efficient. This research aims to optimize a solid "booster material" for the battery, which would be added to maximize the capacity of the system. Prussian blue analogues (PBAs; otherwise known as metal hexacyanoferrates) are known for their energy potential and tunability, making them ideal candidates. Four PBAs, vanadium, cobalt, nickel, and copper hexacyanoferrate, were synthesized through a dropwise addition. The compounds were then characterized for their electrochemical behavior with infrared spectroscopy (IR) and cyclic voltammetry (CV). The resulting data concludes that by switching the metal, the compound's properties are able to be adjusted. Preliminary results indicate that PBAs can serve as an effective booster material and can be tuned to match the battery conditions, which is ideal for future use in RMFBs.

10. Longitudinal Effects of Interleaved Versus Blocked Homework on Statistics Retention

John Augusta (G)
Brandon Guarini (G)
Mary Kayyal (F)
Trina Kershaw (F)

Research suggests that students struggle with statistical concepts and experience knowledge decay over time. This longitudinal study examined the effects of a homework intervention, interleaved versus blocked homework, on the long-term retention of statistical knowledge. Psychology students' statistical knowledge was measured through a final at the end of their Statistics course (Fall 2023/Spring 2024) and through an assessment at the beginning of their Research Methods (RM) course (Fall 2024/Spring 2025). Scores declined from the Statistics final exam to the RM assessment, indicating knowledge decay. A marginal three-way interaction suggested that the effect of homework intervention may have depended on the gap between Statistics and RM. Spring 2024 students retained more knowledge than Fall 2023 students, particularly in the interleaved group. Analysis revealed that students struggled with certain concepts across both courses. Difficulties with other concepts were found in Statistics but worsened in RM. Further, new difficulties emerged in RM. These findings suggest that semester timing may influence long-term retention more than homework structure alone.

11. The Aha! Experience: A Journey Through Epiphany and Heart Rate Rhythms

Zoe Ayn DiZenzo (U)
Heloisa Alves (F)
Trina C. Kershaw (F)

The Aha! experience is multidimensional, encompassing feelings such as pleasantness, surprise, suddenness, relief, and certainty. Physiological markers are also involved, including changes in skin conductance, pupil dilation, and heart rate (HR). Participants solved compound remote associates problems, rated Aha! experience dimensions, and had their HR continuously monitored. We found that correct solutions (true Aha!) had higher ratings of pleasantness, surprise, suddenness, and relief than problems that were solved incrementally or false insights. The three solution types differed on ratings of Aha! strength and certainty. An increase in HR in the last 5 seconds before solution, compared to baseline HR, was positively correlated with ratings of Aha! strength, pleasure, surprise, suddenness, and relief for true Aha! solutions. For incremental solutions, there was a positive correlation between HR change and surprise, but a negative correlation between HR change and suddenness. There were no significant relationships between HR change and the Aha! dimensions for false insights. Implications for theories of insight problem solving will be discussed.

12. Anger Expressions Linked to Early Home Environments and Externalizing Behavior

Claire Leamon (G)
Robin Arkerson (F)
Emily King (G)
H.H. Goldsmith

Children who show dysregulated anger that is unexpected for the context (e.g., “context-incongruent (CI)” anger during an entertaining game) show externalizing behaviors and emotion processing deficits. Little is known about the environments associated with CI anger. Children exposed to environmental confusion may filter out situational input, leading to emotional processing deficits. Further, the affective climate at home can impact development of emotion regulation. This study examined whether CI anger is the emotional bridge explaining the increased externalizing behaviors in chaotic and affectively dysregulated homes. Parents of 360 twins (ages 6-10) reported on home environment, externalizing behavior, and anger. As expected, children in more chaotic or affectively dysregulated homes were more likely to show CI anger and externalizing behavior. CI anger was associated with greater externalizing behavior. CI anger mediated the relationship between family environment and externalizing behavior. Chaotic and affectively dysregulated homes may disrupt acquisition of emotion processing skills, leading to dysregulated anger that puts children at risk for externalizing outcomes.

13. How Do Clinicians Develop Psychotherapeutic Treatment Plans? Examining How Often, and Why, an Assessment-Based Approach is Utilized.

Fiona Marques (U)
Judith Sims-Knight (F)

This study examines how clinicians develop psychotherapeutic treatment plans, specifically whether they rely on assessment-based approaches. We surveyed 74 clinicians with at least a master's degree in social work, clinical psychology, or counseling psychology. Participants, recruited through online advertisements and convenience sampling, completed a Qualtrics survey covering their use of assessments, how they apply them in treatment planning, and what factors could make assessments more useful. Results indicate that the type of therapy practiced, as well as clinicians' attitudes and knowledge about therapy effectiveness, may influence assessment usage and treatment planning decisions. Furthermore, the findings suggest some reasons why therapists may not use assessments to their fullest potential. Further research is essential to better understand how assessment-driven approaches are utilized in psychotherapy and how to support clinicians in integrating these techniques more effectively.

14. Using interleukin-12 to activate leukocytes and delay melanoma progression in zebrafish

Amber Hooda (U)
Tracie Ferreira (F)

Many common cancer treatments have known catastrophic effects on the immune system, causing a variety of dire medical consequences. A compromised immune system often has fatal consequences, with even the common cold holding potential for devastation due to a loss of innate defense. Immunotherapeutic treatments may provide alternate means to treat cancer by strengthening the immune system rather than disabling it. Interleukins, a category of cytokines released by certain cells, activate leukocytes, which may promote tumor destruction via activation of the innate and adaptive immune system. This independent study aims to test the benefits of recombinant interleukin-12 (IL-12) on zebrafish melanoma development via subcutaneous injections. This therapeutic production method relies on recombinant DNA technology, utilizing E. coli as a "cell factory" with the extracted zebrafish IL-12 gene supplied, and downstream purification processing as a work-in-progress. The modified NRAS zebrafish serve as the test model, in which melanoma development is induced by a co-injection of various genetic information at the fertilized, single-cell stage. With an experimental group and designated control, the efficacy of IL-12 subcutaneous melanoma injections will be explored.

15. Self-Learning AI for Predicting Marine Visibility in Real Time

William Girard (U)
Haiping Xu (F)
Donghui Yan (F)

Accurate weather forecasting remains a critical challenge, especially as climate change increases the frequency of extreme weather events. Visibility, defined as the maximum distance at which objects can be observed, is a key weather parameter, particularly in marine environments where poor visibility can lead to hazardous and costly accidents. To improve forecasting accuracy, we introduce Self-Learning AI (SLAI) models, which continuously adapt to real-time data, ensuring predictions are based on the most current and relevant information. Our approach employs a real-time marine visibility forecasting framework, utilizing a cluster of SLAI models trained on small, sequential data batches. These models automatically generate visibility predictions for both local and remote locations at four future time intervals: 15, 30, 45, and 60 minutes. This adaptive, AI-driven method enhances prediction accuracy, reduces safety risks, and provides a scalable solution for marine navigation. This poster highlights the advantages of an SLAI model cluster in dynamic, marine forecasting scenarios, including real-time prediction of a simulated storm in the open ocean.

16. Efficient Memory Management in Large Language Models: Side-Memory Architectures for Lifelong Learning

Manoj Sankuru (G)
Md Shohel Rana (F)

Existing methods for sequential editing of large language models (LLMs), such as ROME and MEMIT, suffer from severe catastrophic interference, poor edit locality, and high computational overhead—with interference rates surpassing 40% after just 50 edits. To address this, we introduce DGM-CAM: Dynamic Gradient Masking with Conflict-Aware Merging, a novel framework that dynamically allocates sparse parameter updates via task-specific gradient masks and merges edits using optimal transport for minimal interference. On benchmark models like GPT-3 and Llama-2, DGM-CAM achieves a 98% Edit Success Rate (vs. 85% for ROME) and reduces interference by 60% compared to MEMIT. It maintains over 95% accuracy on unrelated tasks even after 500 sequential edits, enabling real-time fact corrections, ethical adjustments, and bias mitigation with minimal computational cost.

17. TWIN: Advancing Digital Trust Through Explainable AI and Multimodal Misinformation Detection

Harsh Hetal Kumar Vora (G)
Mohammad Muid Uddin Chowdhury (G)
Md Shohel Rana (F)

AI-generated disinformation and deepfakes are rapidly proliferating at unprecedented rates, creating significant challenges of information integrity on digital platforms. Existing detection systems have primarily relied on single-modality methods, either textual or visual; however, such approaches frequently prove ineffective in combating advanced, multimodal attacks. Certainly, previous works have improved our power in addressing individual manipulation approaches, but those solutions often fail in the interconnection between textual cues and visual anomalies and thus only make space for challenging detection of misleading techniques. Motivated by these observations, we propose TWIN, a novel dual-modality framework that combines a fine-tuned T5 language model with a high-resolution Swin Transformer and an innovative cross-attention mechanism connecting the two. TWIN is built to take advantage of the strengths of both models: It analyzes the text semantically in detail, while also examining the images for subtle signs of manipulation, allowing the system to provide a more comprehensive picture of potential disinformation. To test our model, we will collect a large dataset of multimodal information covering 8,500 examples of news articles, social media posts and video clips with different levels of authenticity and manipulation. We will propose a methodology that includes the use of LIME for textual justification and saliency maps for visual attributions with gradient-based explainable AI techniques, to improve the transparency of the system's decisions and increase user trust. The empirical studies show that TWIN attains better than 90% detection accuracy, which is far better than existing single-modality methods, while reducing false positive rates and increasing user verification confidence. This work fills important gaps in the state-of-the-art while setting the foundation for resilient, explainable AI systems for safeguarding information in high-stakes domains.

18. A Bayes factor high frequency broadband active sonar for information fusion and decisions with uncertainty in depth.

Kenneth Bowers (G)
Jason Stevens (G)
Paul Gendron (F)

Detection of underwater objects with active sound sources is challenging in large part due to media refraction and boundary reflections. Presented here is a Bayes factor active sonar (BFAS) inference approach that incorporates environmental information regarding the refractive media, surface and volume reverberation and target depth uncertainty. BFAS operates as a set of time-varying quadratic forms in beam-delay space, optimally balancing target, reverberation, and noise subspaces. By using waveguide information, BFAS optimally attenuates reverberation subspaces while preserving the target subspace, effectively increasing signal-to-noise ratio despite target depth uncertainty. Depth-invariant modes are leveraged for a computationally fast BFAS characterization. Performance testing across various refractive environments is demonstrated and lends credence to the approach. [Funded by the Office of Naval Research]

19. A Performance Study of Artificial Intelligence Methods for Short-Term Energy Consumption Forecasting

Xianchao Guo (G)
Liudong Xing (F)

Irregular human behaviors and the limitations of univariate datasets pose significant challenges to data-driven energy consumption predictions for individual households. This work presents a comprehensive performance evaluation of 35 representative AI methods for short-term energy consumption prediction in terms of accuracy, efficiency, and security. The AI methods studied include common machine learning methods (decision tree, random forest, support vector regression, multilayer perceptron), the deep learning model of Long Short-Term Memory (LSTM) and its variants (e.g., Bidirectional LSTM, Nested LSTM, Stacked LSTM), as well as hybrid methods (e.g., Convolutional Neural Network (CNN)-LSTM, Empirical Mode Decomposition-LSTM, Stationary Wavelet Transform-LSTM, Empirical Wavelet Transform (EWT)-LSTM, Variational Mode Decomposition-LSTM, Singular Spectrum Analysis (SSA)-LSTM, and Federated-LSTM). Empirical studies of those AI methods using the UK-DALE household datasets are conducted, revealing useful insights in choosing appropriate AI methods for short-terms prediction projects. Specifically, hybrid AI models generally exhibit higher accuracy than single models. The superior performance of SSA on different households demonstrated its strong generalization ability. CNN-LSTM achieves the best efficiency performance among machine learning methods. Federated learning, while ensuring both forecasting accuracy and privacy preservation, can effectively predict energy consumption across various households using a consistent model. EWT-based models exhibit the strongest anti-interference capability among data decomposition methods.

20. Tunable structured illumination pattern generated by an interferometer improves the resolution limit in digital holographic microscopy

Sofia Obando-Vasquez (G)
Ana Doblas (F)
Raul Castaneda (F)
Rene Restrepo
Carlos Trujillo

A key feature of an optical microscope is its resolving power (i.e., resolution limit), which determines the smallest resolvable detail of the sample under study. In digital holographic microscopy (DHM), the spatial resolution is limited by the ratio between the light's wavelength (λ) and the numerical aperture (NA) of the objective lens via (λ/NA). The resolution can be improved by using a shorter wavelength and/or an objective lens with higher NA. Nevertheless, the use of objective lenses with high NA is not always suitable. The illumination of the sample with a periodic pattern (i.e., structured illumination, SI) is an alternative to increase the NA of the objective lens without its replacement. This study demonstrates the resolution improvement of a DHM system using SI, recovering finer details that usually are filtered out through the optical system. By building a dual Mach-Zehnder interferometer, we generate tunable sinusoidal fringes that effectively increasing the system's resolution. We enhanced the resolution up to 1.46 times in transmission-mode setup and up to 2 times in reflection-mode setup, making it the first system to achieve this, to our best knowledge.

21. Secure Federated Learning against Data Poison Attack

Rishit Prajapati (G)
Hong Liu (F)

Federated Learning (FL) is a decentralized machine learning paradigm that enables multiple clients to collaboratively train a global model while keeping their data private. By ensuring that raw data remains on local devices, FL mitigates privacy concerns associated with centralized data collection. However, while FL enhances privacy, it remains vulnerable to security threats, particularly data poisoning attacks. This trade-off between privacy and security presents a critical challenge in deploying FL systems.
In this work, we propose a novel secure aggregator that enhances the robustness of FL against data poisoning attacks. Our approach detects anomalies in the model parameters submitted by clients. Unlike traditional aggregation methods such as FedAvg, which blindly aggregate all client updates, our secure aggregator employs statistical and machine learning-based anomaly detection to isolate poisoned updates before they can impact the global model. Experimental results demonstrate that our method significantly reduces the effect of poisoning attacks while maintaining model accuracy. Our approach strengthens FL security, ensuring trustworthy collaborative learning.

22. Modeling Cascading Failure in IoT-Based Drone Mission System

Junxing Ren (G)
Liudong Xing (F)

Drone systems based on the Internet of Things (IoT) have been widely applied in modern applications such as disaster response and recovery, smart city management, and wireless communication relay. However, the growing scale and complexity of IoT-based drone networks increase their vulnerability to cascading failures. This poster presents how the failure of a critical node impacts system-wide performance by modeling failure propagation mechanisms. Based on the identified cascading sequences, a binary decision diagram-based analytical method is developed to assess the mission system reliability incorporating the effects of cascading failures. A detailed case study of a drone-based rescue mission system is performed to demonstrate the proposed cascading failure model and evaluation method. The case study also demonstrates how failure propagation extends beyond individual drone malfunctions, causing extensive damage to the entire system. This work emphasizes the need for developing effective strategies to enhance resilience against cascading failures in IoT-based drone systems.

23. WITHDRAWN

24. On idealized anticyclonic eddy simulations and applications to the eastern tropical Pacific

Parth Sastry (G)
Amit Tandon (F)
Mark Altabet (F)

How do large-scale structures in the ocean affect how dissolved oxygen gets transported? This question becomes even more pressing in regions of the ocean where oxygen concentrations are already at a minimum - called Oxygen Deficient Zones, or ODZs. We aim to answer this question in a particular region of the world's largest ODZ - the Eastern Tropical Pacific - using idealized numerical simulations. Here, strong seasonal winds force the ocean to form large vortices and carry coastal water rich in oxygen out into the ocean. We observe that oxygen gets advected, following the background flow, but also that winds in the region of interest cause waves and frictional effects that could cause bulk transport of oxygen northward, potentially ventilating other areas of the ODZ.

25. Interfacial Fracture of Hydrogen Bonded Double Network Hydrogels

Ryan Brise (U)
Davidson Joseph (G)
Dapeng Li (F)

This study examines the behavior of hydrogen-bonded double network (DN) hydrogels during fracture initiation, focusing on how different monomer concentrations affect fracture toughness. Fracture toughness is the ability of a material to resist crack growth under load. Hydrogel is a water-absorbing material that can hold large amounts of water while maintaining its shape, making it useful in applications like wound care, soft robotics, and contact lenses. The study uses a new testing setup and the J-integral approach to measure fracture toughness. Two types of DN hydrogels, made from amylopectin combined with polyacrylamide (Amy/PAAm) and poly(N-hydroxyethyl acrylamide) (Amy/PHEAAm), are tested under two loading conditions: static mode-I (opening) and mixed-mode (opening and shearing). The objective is to understand how varying concentrations (from 20 wt.% to 30 wt.%) impact toughness value. Results show lower concentrations improve fracture toughness; 20 wt.% Amy/PAAm hydrogel exhibited a 78% increase in fracture toughness compared to 30 wt.%. A similar trend is seen for Amy/PHEAAm gels. Results show these hydrogel configurations perform better under mixed-mode than mode-I loading.

26. Damage detection studies of Intra-ply Hybrid Carbon/Glass Composites under Shear Loading

Benjamin Farrar (U)
Vijaya Chalivendra (F)

In this study, an experimental investigation is conducted to evaluate the quasi-static shear behavior of glass-carbon intra-ply composites that are subjected to bi-axial stress field and arctic water conditions. Bi-axial stress and cold-water saturation simulate the conditions experienced by composites used in submerged pressure vessels. Composites are fabricated using a vacuum infusion process. A steel and aluminum bi-axial loading fixture is developed to apply bi-axial stress to sheets of composite. Samples are subjected to cold-water saturation for five days prior to loading. Other samples are subjected to five day bi-axial loading while submerged in a water tank maintained at 9 to 10 degrees Celsius. The effects of cold-water saturation are further analyzed by subjecting saturated samples to shear testing and obtaining piezo-electrical measurements using four circumferential probes. Piezo-electrical measurements help determine the extent of internal damage of the composite under stress. Experiments are in progress and the results will be presented at the symposium.

27. Dynamic Mixed-mode Fracture Criterion for Acrylonitrile Butadiene Styrene

Zhuoyuan Leng (G)
Vijaya Chalivendra (F)

This study investigates the dynamic fracture behavior of acrylonitrile butadiene styrene (ABS) — a widely used plastic in 3D printing — under rapid loading conditions. Specifically, the research focuses on mixed-mode fractures, which combine tension and shear stresses, using single-edge notched tension (SENT) specimens. Forces are applied at various angles to simulate real-world conditions and create comprehensive fracture criteria. Additionally, the influence of different printing orientations on ABS's dynamic fracture responses at varying pressure is examined. Detailed fracture surfaces are analyzed using scanning electron microscopy (SEM) to gain insights into crack initiation and propagation mechanisms. Complementary fracture tests at slower speed are also conducted for critical comparison. Experiments are ongoing, and complete results will be presented at the symposium.

28. Damage sensing Characteristics of Repaired Intra-ply Hybrid Composites

Eric Plummer (U)
Vijaya Chalivendra (F)

Composites are widely used throughout automotive, aerospace, and marine industries due to their high strength to weight ratio, temperature resistance, and modulus of elasticity. Parts such as wings, boat hulls and fan blades endure varying degrees of damage while under loading conditions. For this reason, it is useful to understand the damage characteristics of composite materials. An experimental study was conducted to investigate the tensile response and damage sensing characteristics of carbon fiber/ glass fiber intra-ply hybrid repaired composites. In this study, three different repair methods (tapered lap stepped lap, and scarf repair) were considered along with a control specimen with no repair. An adhesive of carbon nanotubes (CNTs) of 0.1 wt.% dispersed epoxy resin was used to glue the repaired interfaces. A four circumferential probe method was employed to determine the piezo-electric response associated with damage while applying tensile loading. The result indicated that the electric response of each repair method is quite unique compared to that of control specimen where the sudden jump of change in voltage is observed as the damage was progressed.

29. Arabian sea air-sea heat flux biases during the spring intermonsoon warming

Debarshi Sarkar (G)
Siddhant Kerhalkar (G)
Amit Tandon (F)

Air-sea fluxes in the Arabian Sea play a significant role in monsoon predictions. Weather forecasts models are initialized by data from reanalysis products, so it's important that these products are accurate. In this study, we quantify the air-sea flux biases of three reanalysis products, namely NASA’s MERRA2, the European ERA5, and the Japanese JRA3Q by comparing them with in-situ observations collected from three moorings in Arabian Sea spanning from 11oN to 19oN. This study focuses on the spring intermonsoon season (Feb-May) for two annual cycles in 2017 and 2018. The spring periods are marked by clear skies, low wind speeds and consistent ocean and atmosphere warming. Products overestimate the shortwave radiation reaching the sea surface during this season, representing inadequacy in fair-weather clouds. The products also predict higher wind speeds and a drier atmosphere, causing the model sea surface to lose more heat via evaporation, leading to a cool bias in the product’s sea surface temperature. These biases impact our ability to accurately capture the required meteorological and oceanic conditions for the monsoon, as well as its variability and progression.

30. Continuum Limits of Discrete Quantum Systems and their Algebras of Observables

Matthew Stearns (U)
David Kagan (F)

A new relationship, the stochastic/quantum correspondence, has recently been proposed between quantum systems and random (or “stochastic”) processes. The existing work focuses on systems that have only a finite number of possible states. However, many systems in the real world appear continuous. Our research explores how to extend the correspondence to the continuum. In this poster, I will focus on certain types of systems called spin chains and their continuum limits. I will describe the behavior of the observable features — the systems' von Neumann's algebras — when taking such limits. This work aims to aid us in developing a more conceptually clear picture of quantum mechanics, with the potential for new directions for both research and pedagogy.