CSU
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2025 UNDERGRADUATE RESEARCH POSTER SESSION

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2025 Undergraduate Summer Research Award Poster Session

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*McNair Projects

Flows, Fame, and First Names: The Influence of Golden Age Hip-Hop on Black Onomastics

College of Arts and Sciences

Student Researcher: Dominique G. Holmes

Faculty Advisor: Thomas L. Bynum

Abstract

This study investigates hip-hop's influence on Black onomastic patterns at the dawn of the 21st century, with a focus on the genre's golden age and the given names of Black males born between 1990 and 2010. It aims to develop a non-linguistic, quantitative model for identifying distinctively Black given names, initiate a data repository of such names, and empirically assess hip-hop's influence on Black onomastics. Hip-hop artist names—specifically prominent male rappers from the golden age—serve as measurable variables within the analytical framework. This study employs a mixed-methods approach to data collection, incorporating artist selection, curated databases, and historical records. Existing scholarship on Black onomastics has predominantly sought to validate distinctively Black names and naming practices as organic cultural traditions rooted in the experiences of enslaved populations in the United States, with secondary attention to the Jim Crow and Civil Rights eras. Consequently, this historical emphasis has contributed to a relative lack of engagement with contemporary Black naming patterns. This study addresses that gap by foregrounding modern naming practices and offering a new lens through which to assess cultural influence. While hip-hop scholarship has occasionally touched on naming, it has primarily focused on artists' self-(re)naming practices or the aesthetic dimensions of stage names. In contrast, this research examines how the genre's broader cultural and commercial success has shaped onomastic traditions within the wider Black community.

**Supported by the McNair Scholars Program*

Black Power Movement and Black Nationalism Impact on the Black Community in Cleveland, Ohio

College of Arts and Sciences

Student Researcher: Daysean Scott

Faculty Advisor: Thomas L. Bynum

Abstract

While the Black Power and Black nationalist movements have been widely studied, this research focuses specifically on their impact in Cleveland, Ohio. Through oral history interviews with individuals involved in the Glenville and Hough uprisings, this study explores how the Black Power and Black nationalist movements influenced Cleveland's Black community during the 1960s. By examining key organizations such as Afro Set, Congress of Racial Equality (CORE), and New Libya, this research highlights their social, political, and cultural contributions to Cleveland's Black community. Centering Cleveland in the narrative, this study underscores the local dynamics of Black empowerment and self-determination, offering deeper insight into how grassroots activism shaped community identity and resistance. Ultimately, this research contributes to a more nuanced understanding of Black Power and Black nationalism's role in shaping Cleveland's Black community during this pivotal era.

**Supported by the McNair Scholars Program*

Ripple: The Bond Between Humans, Lake, and Ocean

College of Arts and Sciences

Student Researchers: Julia Whitaker and Kara Nottingham

Faculty Advisor: Qian Li

Abstract

Ripple – The Bond Between Humans, Lake, and River is an interdisciplinary animation project exploring the profound and healing relationship between people and water. At the center of this work will be a wave animation—created through a unique fusion of hand-painted art and computer-generated imagery. This wave will flow through the animation as a living, breathing character: carrying stories of rivers, embodying the rhythm of life, and revealing how nature heals humans just as humans must heal nature.

Global Assessment of Sampling Bias in Reservoirs in Water Quality Monitoring

College of Arts and Sciences

Student Researcher: Vrajkumar Piyushbhai Patel

Faculty Advisor: Ruchi Bhattacharya

Abstract

This study conducts a global assessment of sampling bias in water quality monitoring of reservoirs, focusing on key nutrient indicators: Total Phosphorus (TP), Total Reactive Phosphorus (TRP), Dissolved Organic Matter (DOM), and Chlorophyll-a (Chl-A). As reservoirs provide critical ecosystem functions for water supply, irrigation, and recreation, accurate monitoring of their water quality is essential. We analyze historical water quality data (1990-2025) from various reservoirs worldwide, assessing the adequacy and representativeness of sampling locations relative to the reservoirs' morphometry and key usage. Our methodology includes statistical evaluations to determine whether current sampling efforts sufficiently capture the spatial variability inherent in these water bodies. Preliminary findings indicate significant disparities in sampling intensity and distribution for water quality parameters, which may lead to underrepresentation of nutrient and pollution levels in specific areas of the reservoirs. This research highlights the need for optimized sampling strategies that account for the morphological characteristics of reservoirs to ensure comprehensive water quality assessments. Ultimately, our findings aim to inform best practices in water quality monitoring, contributing to better management of reservoir ecosystems and the formulation of policies that enhance water resource sustainability.

Assessment of Shifting Precipitation Regimes in Western Lake Erie Basin

College of Arts and Sciences

Student Researcher: Joshua Loomis

Faculty Advisor: Ruchi Bhattacharya

Abstract

Hydroclimate science is a field of research that is connected to many other fields of Environmental Science. Analyses of precipitation onto watersheds and streamflow into large bodies of water are necessary to maintain a robust understanding of Earth Science. Trends in rainfall were derived from precipitation gauges in the US Climate Reference Network (USCRN). The data were collected from 1971 to 2014 and analyzed using the R statistical analysis software. This research was conducted to reinforce understanding of watershed behavior as hydroclimate activity changes over time. In the Great Lakes of North America, we decided on the largest watershed flowing into the smallest lake for 2 major reasons. The smallest lake is acutely sensitive to input changes like nutrient loading and subsequent eutrophication. The other reason is that this watershed has 2 cities with a population of 250,000, and almost 75% of the land is used for agriculture. It contains important geospatial variables. This research was not intended to seek the satisfaction of a hypothesis but to add to the total understanding of basins at the watershed level. Geospatial differences across a larger area, like a basin, make this type of research worthwhile because of nonuniform variables. Nonpermeable surfaces, like in cities or the geochemistry in agricultural areas, make it beneficial to divide basins into their watersheds and conduct analyses in a more focused manner. The results here have shown an increase in precipitation over time. It's also shown that extreme weather events have become more common in recent years. This methodology details how multidecade precipitation trends affect the hydroclimate of this watershed's flow into Lake Erie.

**Supported by the McNair Scholars Program*

PlanetScope Satellite Detection of Ship-Induced Sediment Resuspension along the Lake Erie Coastline

College of Arts and Sciences

Student Researcher: Alyssa Wiemels

Faculty Advisor: Brice Grunert

Abstract

Commercial ship activity is essential to maintaining economic prosperity in the Lake Erie region, providing jobs and significant revenue annually to both small coastal towns and major metropolitan areas. However, ship traffic can resuspend lakebed sediment, potentially exposing sediment to environmental conditions that facilitate release of harmful excess nutrients and impair water quality. Environmental implications of ship-induced turbidity plumes- particularly in relation to internal sediment loading- remain largely unaccounted for in nutrient management plans. This research explores the potential for high spatial resolution satellite imagery as a tool to decipher sediment characteristics within ship-induced sediment plumes. Ideally, findings obtained from this project would serve to promote a more comprehensive assessment of phosphorous cycling and advance best practices for improving water quality in Lake Erie. Satellite imagery from commercial provider Planet Labs was obtained for three Lake Erie harbors: Cleveland, Toledo, and Fairport, then analyzed computationally using a total suspended matter (TSM) algorithm to derive sediment data relating to pictured plumes. Our findings suggest a TSM algorithm can be successfully applied to high spatial resolution satellite imagery in Lake Erie, estimating both sediment concentration and distribution within a ship-induced plume. However, several limitations typical of remote sensing were encountered, such as light interference between image pixels and adverse weather conditions influencing temporal availability of imagery. Future work may involve comparison between TSM algorithms to determine strengths and limitations in mapping Lake Erie sediment resuspension, or perhaps refining existing phosphorous estimation algorithms to retrieve more accurate phosphorous estimates for Lake Erie harbors.

Making TbTRF Mutant Targeting Constructs to Establish Conditional TbTRF Mutant Expressing T. brucei Strains

College of Arts and Sciences

Student Researchers: Leah Hoover and Lovlesh Thakur

Faculty Advisor: Bibo Li

Abstract

Trypanosoma brucei is the protozoan parasite responsible for African trypanosomiasis, also known as sleeping sickness. Antigenic variation is a mechanism used by pathogens like T. brucei to change their surface proteins, allowing them to evade the host's immune response and persist inside the host where they establish a long-term infection. Variant Surface Glycoproteins (VSGs) are the major surface antigens expressed on the T. brucei cell surface. T. brucei expresses only one type of VSG at a time and undergoes VSG switching. VSG genes are located at subtelomeric loci and are only expressed from subtelomeric specialized VSG expression sites. Only one expression site is active at a time, ensuring that the parasite expresses a single VSG coat on its cell surface. Our lab has shown that T. brucei telomere proteins not only are essential for genome stability but also are key regulators of antigenic variation. One protein, T. brucei TTAGGG Repeat-binding Factor (TbTRF), is a homolog of the mammalian telomere-binding proteins TRF1 and TRF2, but its precise functions in parasite telomere biology are not completely understood. This project aims to generate constructs to replace one endogenous WT TbTRF allele with various TbTRF mutants in an existing T. brucei strain where the other WT TbTRF allele is flanked by loxP repeats. Conditional deletion of the floxed TbTRF allele in these cells will allow us to examine TbTRF mutant phenotypes. Subsequent studies will help further understand the molecular mechanisms of TbTRF functions in telomere biology and in antigenic variation. Ultimately, understanding TbTRF's role in telomere function and genome stability will shed light on how T. brucei avoids immune detection through VSG switching. Such insights can open the door to new strategies for therapeutic intervention against African trypanosomiasis.

Making constructs to test the FLP-FRT system and a triple-inducible expression system in Trypanosoma brucei

College of Arts and Sciences

Student Researchers: Carson Smith, Joel Chavez, Chibugo Jessica Okoronkwo, and Prem Kushwaha

Faculty Advisor: Bibo Li

Abstract

Trypanosoma brucei (T. brucei), a unicellular eukaryotic protozoan parasite, causes Human African Trypanosomiasis (HAT, also known as African sleeping sickness). This disease is transmitted by the bite of a tsetse fly that has been infected by the parasite. T. brucei proliferates in the extracellular spaces of the infected mammalian host such as the blood, lymph, and interstitial fluids. T. brucei is challenging to eliminate due to an advanced mechanism that it employs to avoid the host's immune response called antigenic variation. The parasite is coated with immunogenic proteins called variant surface glycoprotein (VSG), which is the major surface antigen of this parasite. The parasite regularly switches its VSG coat to evade the host's immune response. This antigenic variation is an essential pathogenesis mechanism, and we are currently investigating its underlying mechanisms using molecular and genetic approaches. However, current molecular and genetic manipulation tools available in T. brucei are limited. The goal of our research project is to make several constructs necessary for the establishment of a triple-inducible system that allows independent, temporal, and dose-dependent expression of three independent components in a single T. brucei genetic background. To achieve this goal, we would like to introduce FLP-FRT targeted recombination system, cumate inducible system, and vanillate inducible system into T. brucei in addition to the already existing Tet-inducible gene expression control system. These various constructs, once made, will be transfected into T. brucei cells to establish the triple-inducible strain.

Measuring Urban Green Space: A Systematic Review of Existing Methods

College of Arts and Sciences

Student Researcher: Molly DuPerow

Faculty Advisor: Zihan Lin

Abstract

Urban green spaces (UGS) is a key component of city environment and offer ecological, health, and social benefits to urban population. Yet, the methods used to measure UGS vary widely, complicating comparisons across studies and limiting their application to urban planning and climate adaptation assessment. This study shows a systematic review of peer-reviewed literature from 1975 to 2026 that examined approaches for quantifying, mapping, and evaluating UGS. Following PRISMA 2020 guidelines, 145 research and review articles were selected from Web of Science and ScienceDirect after eligibility screening. Results show that most studies relied on quantitative approaches, particularly remote sensing using vegetation indices, GIS analysis of accessibility and neighborhood-level greenness ratio. Recent research increasingly adopts UAV, LiDAR, and street view images to capture high-resolution variations. A smaller but growing body of research applies qualitative approaches using surveys, participatory mapping and crowdsourced data. Publication trends reveal rapid growth after 2000, with the United States and China leading output. The review also highlights key gaps, especially the heavy focus on UGS quantity at the expense of quality and social meaning. We argue for an integrated framework that combines quantitative and qualitative measurements by leveraging emerging technologies such as machine learning. Enhancing measuring of UGS is essential for advancing sustainable and resilient urban development.

Evaluating Meadow Restoration Success at Circe Emerald

College of Arts and Sciences

Student Researchers: Markus White and Joshua Smith

Faculty Advisor: Emily Rauschert

Abstract

Ecological restoration involves modifying a previously disturbed area and increasing the ecological value and ecosystem services. In Northeast Ohio, park districts are often tasked with restoring areas that were previously agricultural. Restoration often involves changing management, such as mowing, removing non-natives, and seeding native plants. An example of this is Circle Emerald, in the Cleveland Metroparks, which was previously agricultural. A previous plant survey focused on areas that were seeding and unseeded. We resurveyed parts of Circle Emerald to determine non-native and native plant species presence and abundance. We focused on the unrestored areas which previously had more non-native species. We used the North Carolina vegetation protocol to survey the same areas with the same methods. We expected there would be an increase in the native cover due to higher abundance of natives in the area. We identified many new plants that were not observed in previous surveys. We continue to observe higher non-native cover 65% vs 35% native cover. However, we did observe more native plants (36) than non-native plants (30). Future research will compare seeded and unseeded plots to see if gains are similar.

Purification of Methanococcus jannaschii Dihydroorotase and Co-crystallization with Ligands

College of Arts and Sciences

Student Researchers: Buraq Mohammed and Mohammed Asi

Faculty Advisor: Jacqueline Vitali

Abstract

Dihydroorotase catalyzes a reversible reaction that converts N-carbamoyl-L-aspartate to L-dihydroorotate and vice versa in the third step of de novo pyrimidine biosynthesis. The products of this pathway are the pyrimidine nucleotides that are the building blocks of DNA and RNA, and for this reason the enzyme is a target to determine drugs against cancer and parasitic infections. In this experiment we used the enzyme from an archaeon, *Methanococcus jannaschii*. We used the archaeal enzyme because it shares many cellular characteristics with eukaryotes. We purified the enzyme and crystallized it with substrate analogs. We started with ready frozen cells. The purification included an ammonium sulfate precipitation step, a heat step, cation exchange and hydrophobic interaction chromatographies. The crystallization was done using the hanging drop method. We used 24 well plates and we greased their tops. In each well we put 500 ul of a reservoir solution in a gradient of pH and precipitant concentration. On plastic coverslips we place 1 ul of the reservoir solution, 0.5 ul of the ligand solution, and either 1 or 2 ul of the protein solution depending on its concentration and we inverted them on top of the reservoirs. We checked the crystals with an optical microscope to evaluate if they grew and to get a sense of their quality. The crystals will be used to determine the structures of the complexes and give insight into how the substrate and/or substrate analog bind to the protein and the mechanism of catalysis.

Design and synthesis of fluorescent probe for cardiolipin analysis

College of Arts and Sciences

Student Researchers: Danielle M. Mafuta, Ola Tsikhun, and Dina S. Hussein

Faculty Advisors: Warren C. Boyd and Yana I. Sandlers

Abstract

Cardiolipin is a unique phospholipid found in the inner membrane of the mitochondria. It plays an important role in maintaining the anatomy and physiology of the mitochondria by regulating the activity of proteins involved in energy production, making it essential for cellular health. Oxidized cardiolipin is important due to the fact that it is a signal for mitochondrial damage. In pathology, detecting early signals of damage to mitochondria is important for developing preventive strategies and treatments. In my research project I performed key steps towards synthesis of MitoCLOX, which is a fluorescent probe specifically designed to detect oxidized cardiolipin. This molecule will help in visualizing mitochondrial oxidative stress. The synthetic approach involves attaching a fluorescent probe to a mitochondrial-targeting triphenyl phosphonium (TPP) through a linker. The probe is designed to be sensitive to lipid peroxidation that reacts with an oxidized cardiolipin to produce a fluorescent signal. This will allow MitoCLOX to selectively target mitochondria and help visualize oxidative stress. Our final goal is to create a reliable tool to understand the role of oxidized cardiolipin in mitochondrial dysfunction and disease treatment.

During my work in laboratory, I have learned to perform following techniques: Preparation of standard solutions, dilutions, pipetting techniques, samples derivatization for GCMS analysis, GCMS operation and library search, evaporation, crystallization, liquid chromatography separation, organic synthesis techniques (liquid-liquid extraction, work in oxygen and water free environment), 31P-NMR, 13C-NMR and 1H-NMR. I have also observed cell culture techniques and LC-MS analysis.

Synthesis and Characterization of Azo-Podophyllotoxin Derivatives as Potential Treatment for Triple Negative Breast Cancer

College of Arts and Sciences

Student Researchers: Maheen Sajid and Ruchitha Korem

Faculty Advisor: Bin Su

Abstract

Triple Negative Breast Cancer (TNBC) represents one of the most aggressive forms of breast cancer, accounting for 15-20% of all breast cancer cases. Unlike other breast cancer subtypes, TNBC lacks three key receptors (estrogen, progesterone, and HER2), making it unresponsive to targeted hormone therapies and resulting in limited treatment options and higher mortality rates.

This research focuses on synthesizing SU056 analogs, azo-podophyllotoxin derivatives designed to target both tubulin and Y-box binding protein-1 (YB-1). YB-1 is a proto-oncogenic protein that contributes to drug resistance, DNA repair enhancement, and cancer cell survival in TNBC progression.

A three-step synthetic approach was employed: SN2 reaction using p-toluidine and 2-chloroethyl chloroformate, nucleophilic substitution with KOH in ethanol at 90°C, and the third step combined various aldehydes, tetronic acid, and L-proline as catalyst. Twenty compounds were successfully synthesized and purified through recrystallization using ethyl acetate and ethanol, with some compounds requiring column chromatography.

Complete structural characterization was achieved using ^{1}H NMR, ^{13}C NMR, HPLC analysis, and mass spectrometry, confirming target structures. This synthetic work establishes a foundation for future biological evaluation against TNBC cell lines to assess the compounds' potential therapeutic effectiveness.

Evaluation of Nimesulide Derivatives as Potential Anti-Trypanosomal Agents

College of Arts and Sciences

Student Researchers: Alia M. Al-Rousan and Fatma M. Salem

Faculty Advisor: Bin Su

Abstract

Human African Trypanosomiasis (HAT), or sleeping sickness, remains a neglected disease with few safe and effective treatment options. We evaluated 20 nimesulide derivatives against *T. brucei* bloodstream forms using MTS and MTT assays and assessed cytotoxicity in HEK-293 and RAW 264.7 cells. Several compounds demonstrated low micromolar activity with high selectivity, particularly compounds **20,19, and 4**. These findings highlight nimesulide derivatives as promising leads for anti-HAT therapy and support further optimization and in vivo evaluation.

A COX-2 Inhibitor Analog Induces Androgen Receptor Degradation in Glioblastoma Cells: Initial Findings on AR Modulation in Glioblastoma

College of Arts and Sciences

Student Researchers: Blake E. Wilt, Alia M. Al-Rousan, and Xiaotong Zhao

Faculty Advisor: Bin Su

Abstract

Glioblastoma (GBM) is an aggressive brain tumor with limited therapies and higher incidence in males, implicating androgen receptor (AR) signaling. AR antagonists have shown limited success due to frequent mutations, but AR degraders eliminate AR regardless of mutation status. Here, we examined Compound A, a novel analog of the COX-2 inhibitor Nimesulide, in T98G GBM cells. Western blot analysis showed dose-dependent AR degradation, with significant reduction at low micromolar concentrations (1μM). These results identify Compound A as a potent AR degrader and promising therapeutic candidate for GBM.

Profiling Desialylation and Sialidase Expression of THP-1 Monocytes and Macrophages Upon LPS Stimulation

College of Arts and Sciences

Student Researcher: Morgan Pychowycz

Faculty Advisor: Xue-Long Sun

Abstract

The attachment of terminal sialic acids (Sias) to glycans that coat the cell's surface is a process known as Sialylation and is involved in a variety of biological processes. On the contrary, the process of removing Sias from terminal glycans catalyzed by a sialidase is known as Desialylation, and is involved in many pathological pathways. The four isozymes of mammalian sialidase- Neu1, Neu2, Neu3, and Neu4- exhibit different subcellular localization as well as different specificities toward glycan substrates. Lipopolysaccharide (LPS), a component found in the outer cell membrane of gram-negative bacteria, induces endogenous sialidase expression in monocytes and macrophages. This could result in the desialylation of TLR4, therefore activating and sustaining the LPS/TLR4 signaling pathway. In this study, we investigated the desialylation profile of monocytes and macrophages upon LPS stimulation. Higher expression of sialidases on the cell's surface was confirmed in LPS-stimulated THP-1 macrophages. Additionally, sialidase levels in cell culture media were significantly increased, indicating sialidase secretion upon LPS stimulation. Lectin blot analysis as well as flow cytometry showed cell surface and total protein desialylation of LPS-treated THP-1 immune cells. Treatment with the sialidase inhibitor 2,3-dehydro-2-deoxy-N-acetylneuraminic acid (DANA), attenuated proinflammatory cytokine production by modulating IKBα phosphorylation and downstream inflammatory signaling pathways. This is the first systematic profiling of desialylation of macrophages upon LPS stimulation, stipulating that the expression and secretion of endogenous sialidase is implicated in the LPS/TLR4 signaling pathway, where sialidase inhibitors could act as anti-inflammatory agents.

Synthesis and Characterization of Chondroitin Sulfate Isoforms

College of Arts and Sciences

Student Researcher: Corbin W. Wiley

Faculty Advisor: Xue-Long Sun

Abstract

Thrombomodulin (TM) is a proteoglycan that exists on the membrane surface of endothelial cells and takes part in the protein C (PC) anticoagulation pathway, in which it serves to modulate the activity of thrombin, a serine protease, from procoagulant to anticoagulant. TM's anticoagulant activity arises from only one of its five domains: EGF-like domain (TMD1). Further, TMD1 consists of six subdomains, EGF-like domains 1-6, of which only three are responsible for TM's thrombin-modulating activity: EGF-like domains 4-6 (TM_{456}). However, it is speculated that chondroitin sulfate (CS) at TM's serine/threonine-rich domain also participates in TM-thrombin interactions, thus enhancing TM-mediated protein C activation. It is believed that CS, a glycosaminoglycan (GAG), plays a role in the initial binding between TM and thrombin. CS exists as several isoforms (e.g., CS-A, -B, and -C) that vary in their sulfation patterns. In our study, we enzymatically degraded CS-A, -B, and -C into hexa- and tetrasaccharides. Herein, we discuss the synthesis and characterization of various low molecular weight CS isoforms.

The Role of RNAse L in TLR4-Mediated IL-10 Regulation During Acute Lung Injury

College of Arts and Sciences

Student Researchers: Garrett Worden, Xiaotong Zhao, and Mridini Kandala

Faculty Advisor: Aimin Zhou

Abstract

Acute lung injury (ALI) is characterized by an uncontrolled inflammatory response in the lungs, leading to severe impairment of pulmonary function and high mortality. Interleukin-10 (IL-10) is a key anti-inflammatory cytokine that protects against endotoxin-induced tissue damage. RNase L, a pivotal enzyme in the interferon-inducible 2-5A system, has been linked to immune regulation, but its role in IL-10 induction during endotoxin stimulation remains unclear. This study aimed to determine whether RNase L is required for IL-10 induction in macrophages and lung tissues following lipopolysaccharide (LPS) stimulation. IL-10 expression was examined in RNase L wild-type (RL+/+) and knockdown (RL−/−) RAW 264.7 macrophages by Western blot after LPS treatment. Additionally, IL-10 production was quantified by ELISA in plasma, lung tissue homogenates, and bone marrow–derived macrophages (BMMs) from RL+/+ and RL−/− mice exposed to LPS. Western blot analysis showed that LPS stimulation increased IL-10 expression in both RL+/+ and RL−/− macrophages. However, the magnitude of induction was substantially greater in RL+/+ cells compared to RL−/− cells. Similarly, ELISA results demonstrated that IL-10 levels in plasma, lung tissue, and BMMs were significantly higher in RL+/+ mice than in RL−/− mice after LPS treatment, indicating that RNase L is essential for effective IL-10 induction in response to endotoxin stimulation. The impaired IL-10 expression observed in RNase L deficient cells and tissues suggests that RNase L plays a protective role in limiting inflammation during ALI and may serve as a potential target for therapeutic intervention in inflammatory lung disorders.

Keywords: Acute lung injury (ALI); RNase L; Interleukin-10 (IL-10); Lipopolysaccharide (LPS); Macrophages

Neuromechanical wave resonance as a design principle in fluid-structure interaction systems

College of Arts and Sciences

Student Researcher: Timothy J. Sedor

Faculty Advisor: Alexander P. Hoover

Abstract

Active materials, such as materials with embedded musculature and nervous systems, have both passive and active properties that drive their motion. Recently, Hoover et. al [1] observed the effect of driving an elastic bell at its material wave speed yielded significant performance enhancement when turning, in a phenomena that is described as neuromechanical wave resonance. In this study we investigate further the effects of neuromechanical wave resonance by designing a set of computational models that further elucidate the role of wave resonance by tying the activation wave speed of mechanical model to the material wave speed of the system. We first examine this a reduced 1D model, before incorporating this design into a set of 2D and 3D fluid-structure interaction models.

The effects of spanwise variation on the swimming performance of flexible undulating panels

College of Arts and Sciences

Student Researcher: Isaac James

Faculty Advisor: Alexander P. Hoover

Abstract

We aim to decouple the role of passive and active properties in the swimming performance of flexible organisms as modeled by a two-dimensional flexible panel. We utilize the immersed boundary method to model the fluid structure interactions of the panel as it is immersed in a viscous, incompressible fluid. The passive properties are described by the elasticity of the panel while the active properties are described by the active stress that drives its motion. The one-dimensional Euler-Bernoulli beam equation is then used to analyze the deflection of the panel as it is propulsed by an active stress wave traveling along its top and bottom half in an alternating pattern. Overall, we vary the stiffness of the flexible panel along with the frequency at which it is actuated, the wavelength of the active stress, and the strength of the tension applied by our actuation to breakdown these passive and active properties.

Decoupling the Passive and Active Dynamics of Internally Actuated Flexible Panels

College of Arts and Sciences

Student Researcher: Kylie DeRosha

Faculty Advisor: Alexander P. Hoover

Abstract

We aim to decouple the role of passive and active properties in the swimming performance of flexible organisms as modeled by a two-dimensional flexible panel. We utilize the immersed boundary method to model the fluid structure interactions of the panel as it is immersed in a viscous, incompressible fluid. The passive properties are described by the elasticity of the panel while the active properties are described by the active stress that drives its motion. The one-dimensional Euler-Bernoulli beam equation is then used to analyze the deflection of the panel as it is actuated by an active stress wave traveling along its top and bottom half in an alternating pattern. Overall, we vary the stiffness of the flexible panel along with the frequency at which it is actuated, the wavelength of the active stress, and the strength of the tension applied by our actuation to breakdown these passive and active properties.

Developing discrete-to-continuum nerve net models for jellyfish locomotion

College of Arts and Sciences

Student Researcher: Daniel Miller

Faculty Advisor: Alexander P. Hoover

Abstract

Jellyfish, members of the taxonomic class Scyphozoa, lack a central nervous system. Instead, they utilize a system nerve nets, whose communication is mediated by a symmetrical arrangement of multiple pacemaker like structures called rhopalia, that are responsible for propagating action potential. One of the nerve nets, dubbed the Motor Nerve Net, interacts with the subumbrellar musculature and produces complex macroscopic behaviors such as turning and swimming. This study explores how small scale action potential and transmission dynamics can lead to large-scale behavior. We employ a set of Hodgkin-Huxley type equations to model the ion channels of a nerve's axon as conductance that change according to probabilities based on transmembrane voltage. Transmission dynamics were further explored by choosing different probability distributions for neuron orientation. Propagation speeds and synapse count were compared between different distributions. The ultimate goal is to interpolate the data from these action potential propagation simulations so transition from a discrete to continuous model, with a function approximation method, such as a 2D fast Fourier transform.

Discrete Heine-Shephard Problem for Four Planar Bodies

College of Arts and Sciences

Student Researcher: Darren Gerrity

Faculty Advisor: Ivan Soprunov

Abstract

The mixed volume is a geometric invariant that generalizes many familiar invari-ants such as height, volume, and surface area. The Heine-Shephard problem is to fully describe the space of all realizable mixed volumes of n convex bodies in Rd. In [1], a partial description was given in the case of four planar bodies via the Plücker type inequalities. This project was an attempt to see if the same description suffices for a smaller class of geometric objects: the lattice polygons. These are a natural class of shapes to consider, as the mixed area of these shapes has applications in algebraic and tropical geometry.

Characterizing Mechanical Properties of Primary Cilia Using Optical Trapping

College of Arts and Sciences

Student Researchers: Emily Schaffer and Joel McRaven

Faculty Advisor: Andrew Resnick

Abstract

Although solitary or sensory cilia are present in most cells of the body and their existence has been known since the sixties, very little is known about their functions. One suspected function is fluid flow sensing- physical bending of cilia produces an influx of Ca^{++}, which can then result in a variety of activated signaling pathways. Defective cilia and ciliary-associated proteins have been shown to result in cystic diseases. Autosomal Dominant Polycystic Kidney Disease (ADPKD) is a progressive disease, typically appearing in the 5^{th} decade of life and is one of the most common monogenetic inherited human diseases, affecting approximately 600,000 people in the United States. Because the mechanical properties of cilia impact their response to applied flow, We asked how the stiffness of cilia can be controlled genetically. We performed an experiment comparing the mechanical properties of untreated LLC-PK cells to LLC-PK cells subjected to knockdown of a ciliary associated protein CFAP20. Cilia were optically trapped and the bending modulus measured. We found that cilia lacking CFAP20 are significantly weakened. We also found that cilia lacking CFAP20 are longer than untreated cilia.

Characterizing Primary Cilium Mechanics Using Optical Tweezers

College of Arts and Sciences

Student Researcher: Joel McRaven

Faculty Advisor: Andrew Resnick

Abstract

Primary cilia are small, nonmotile, microtubule-based, sensory organelles that extend from nearly all mammalian cells. Their mechanical properties are thought to be essential for their ability to transduce signals, and disruptions in their structure are linked to a variety of human diseases known as ciliopathies, including polycystic kidney disease (PKD). Recently, this correlation of primary cilia functionality to diseases has led to a closer examination of what the mechanical properties of cilia are.

This project focused on quantifying how mechanical stiffness of the ciliary tip is affected by knockdown of the Cilia and Flagella Associated Protein 20 (CFAP20), which helps stabilize the inner junction between microtubule doublets in the axoneme. CFAP20 decrease is expected to compromise axonemal integrity, potentially lowering the cilium's stiffness. Using optical tweezers, we held the distal tips of wild-type and CFAP20-knockdown primary cilia in a fixed position, measured their lengths by lowering the stage, and analyzed their Brownian motion to determine tip stiffness. By comparing the mean squared displacement (MSD) of the ciliary tips over time, we extracted stiffness values and observed how they varied between conditions. Data were corrected for drift using a linear regression method applied to the long-time MSD data and fitted to a model from which stiffness was extracted. Microspheres served as calibration controls, and cilium MSD values from different days were normalized.

Our preliminary findings suggest that knockdown of CFAP20 leads to a measurable decrease in ciliary stiffness, supporting its proposed structural role. These results offer new insights into how molecular changes at the axonemal level can affect whole-organelle mechanics, potentially impacting ciliary function in health and disease.

Building a Software Package for Multiangle and Depolarized Dynamic Light Scattering Analysis

College of Arts and Sciences

Student Researcher: Jacob Forester

Faculty Advisor: Kiril A. Streletzky

Abstract

Dynamic Light Scattering (DLS) and Depolarized Dynamic Light Scattering (DDLS) are techniques used to study the structure and dynamics of particles in a solution by observing their Brownian motion over time through the intensity fluctuations of scattered photons. DLS/DDLS is used in many fields from Biopharmaceuticals to Nanomaterials. This project focuses on streamlining the analysis process in a lab that utilizes DLS/DDLS to study various systems. This is done through writing software that incorporates over a decade of fragmented homemade code. The key steps involved in the process are data preprocessing, normalization, fitting, and postprocessing. All of these steps were incorporated into a GUI where the user interface was iteratively gauged through other members of the lab. The resulting software performs each of these steps internally or through running the previously utilized programs through the software.

The Dynamics of Microgels with Varying Crosslinker Concentration

College of Arts and Sciences

Student Researcher: Patrick Barrett

Faculty Advisor: Kiril A. Streletzky

Abstract

Polysaccharide microgels are a widely studied class of materials which combine colloidal properties with the environmentally responsive nature of polymer gels. This combination allows for potential applications in targeted drug delivery, biosensing, and other medical applications. One type of microgel which seems promising for such applications is hydroxypropyl cellulose (HPC) polymers crosslinked by divinyl sulfide (DVS). HPC microgels display a reversable volume phase transition at the critical temperature T_V. Previous studies into other types of microgels (mostly PNIPAM) have shown that by varying the amount of crosslinker used in the synthesis process, the structure and behavior of the microgels is altered. Our goal is to study how HPC microgels respond to the same variation in crosslinker concentration by using Dynamic Light Scattering (DLS) and Static Light Scattering (SLS) measurements from HPC microgels across a wide range of crosslinker concentrations, tested above and below T_V. It was found that at low crosslinker concentrations, HPC microgels followed standard behavior for homogenous crosslinking, becoming smaller and denser above T_V and following Flory-Rehner theory. At high crosslinker concentrations, however, the microgels displayed an increase in size and a decrease in density above T_V. The differences between low and high crosslinker samples are likely caused by inhomogeneous crosslinking, which becomes more pronounced at higher crosslink concentration. This conclusion was reached after light scattering results were compared to existing models for microgels found in previous studies.

An Iterative Quadratic Solution to the True Anomaly for Keplerian Orbits

College of Arts and Sciences

Student Researcher: Michael Angelo De La Cruz Ortiz

Faculty Advisor: Ulrich Zürcher

Abstract

The true anomaly ϕ is defined as the angular displacement of a particle measured from the major axis of its conical orbit. The origin of such angle located at a focal point of the conic section where an inverse square law force originates. The problem being that Kepler's Equation which allows one to solve for the true, mean and eccentric anomalies is transcendental and therefore we commonly depend on numerical methods for determining the true anomaly after some elapsed time. This publication presents a geometric treatment for analytically re-phrasing such a problem to an areal optimization problem. Such treatment enables a quadratic solution to be iterated upon for the true anomaly of a particle in a Keplerian orbit after a period of time.

**Supported by the McNair Scholars Program*

Racial Discrimination Policies in Northeast Ohio Schools

College of Arts and Sciences

Student Researcher: Jashona Broome

Faculty Advisor: Blair Baker

Abstract

Racial discrimination remains an ongoing issue within school systems. Students from diverse racial and ethnic backgrounds are always being excluded, teased, or mistreated by classmates. While many schools have policies in place to prevent discrimination and bullying, it is not clear whether these policies are properly enforced or effective. The purpose of this research was to examine how some schools in Northeast Ohio are addressing these issues. We started by creating a District policy codebook that helped us collect information from public school websites. We checked to see if schools had a diversity statement, anti-discrimination policy, and clear consequences for bullying or racism. We also checked if their policy directly mentions race, color, or related terms. Out of the schools we reviewed, only 19 had policies that mentioned race or color. About 12 schools had policies that were very general and did not include any direct reference to race or discrimination. In addition, only 10 schools had a clear student support system, such as counselors or programs to help students after discrimination occurs. This study has provided a look inside which policies have good polices and which ones need work. But we still don't know how well those polices work in the school system. The next step is to create a short survey for school administrators, like principals or assistant principals. The survey will ask how they respond when students report discrimination. Our goal is to learn how school leaders handle these situations and to find out what support they might need. In the future, we hope this research will lead to better school rules, better training for staff, and safer learning environments for all students, especially students of color.

**Supported by the USRA Program and the McNair Scholars Program*

Shortening a Multi-Dimensional Survey using AI

College of Arts and Sciences

Student Researcher: Nyana Campbell

Faculty Advisor: Michael Horvath

Abstract

Many organizations used scientifically-developed surveys to assess workplace attitudes. However, lengthy surveys are sometimes impractical for fast-paced jobs and busy employees. Traditional methods of shortening surveys are effective but can require time and several groups of employees for development. Recently, advances in Artificial Intelligence (AI) allow for alternative approaches, but it remains to be seen what types of prompts are most effective in generating shortened surveys. Our study continues previous research by exploring multiple ways of prompting AI to shorten a survey. Specifically, we examine the result of asking AI to shorten a preliminary version of a survey vs. a version that had already been slightly shortened using traditional means. We also explore the result of asking the AI for a single item per survey dimension vs. allowing it to choose. Our results showed that the type of prompt produced shortened versions that differed in the number of items as well as the number of dimensions.

Interviewing AI: Understanding Large Language Model Decision-Making

College of Arts and Sciences

Student Researcher: Nyana Campbell

Faculty Advisor: Michael Horvath

Abstract

AI is transforming the modern workforce at a rapid pace, creating opportunities and challenges in terms of its use throughout a variety of fields within the workforce. For researchers, AI can be utilized as a method of gaining an alternative perspective, assistance with organizing information, and simplifying conclusions. These tasks can range from simple and repetitive to a slightly more complex role involving tasks such as decision-making. AI can help with organizing data, identifying patterns, and presenting conclusions. AI has the potential of assisting in various fields and aspects of life in the near future. This research project involves interviewing AI in hopes of having a better understanding of the decision-making process a LLM goes through in order to simplify a 125-item survey on job-seeking strategies with 21 dimensions. Using one version of ChatGPT that is signed out and one that is signed in with an email that was created for the study to see if there is a difference in the quality of the explanation. When the LLM explains how it shortened the survey and how many items are now, the researcher will begin the interview, focusing on the responses to gather information on the framework and themes within both models of the LLM. Knowing the reasoning behind the decision-making process of a large language model is crucial for research in fields that wish to utilize the LLM software as a tool. This study has the intention of giving a broader explanation behind the responses that are generated by ChatGPT in terms of reducing the number of items within a survey.

**Supported by the McNair Scholars Program*

Religious Practices and Faith Alongside Queer Identities: Understanding Queer Muslims

College of Arts and Sciences

Student Researcher: Elisha Sledge

Faculty Advisor: Shereen Naser

Abstract

This study explores the experiences of queer Muslims and the interaction between religion—particularly Islam—and LGBTQ+ identities. Through an analysis of over 80 articles and planned surveys of religiously observant college students (pending IRB approval), it examines how religious fundamentalism and in-group dynamics influence acceptance or rejection of LGBTQ+ identities. Key themes include identity conflict, internalized stigma, and religious rejection. The research aims to amplify queer Muslim voices and promote inclusivity within faith communities.

**Supported by the McNair Scholars Program*

Parenting and the Self: Examining the Impact on Self-Esteem, Guilt, and Shame

College of Arts and Sciences

Student Researcher: Evelyn Buchanan

Faculty Advisor: Maria Rowlett

Abstract

Most research today focuses on mothers, but limited studies also include fathers. Growing evidence has proven that regardless of gender, all parents face challenges related to self-esteem, guilt, and shame. This study investigated how parenting affects self-esteem, guilt, and shame, considering both gender differences and the amount of time parents spend with their children. A total of 64 people participated, including 56 parents and eight non-parents, who were recruited through social media and referrals. Participants completed three validated self-report measures: the Rosenberg Self-Esteem Scale (RSES), the Guilt About Parenting Scale (GAPS), and the Guilt and Shame Experience Scale (GSES). Data was analyzed using IBM SPSS Statistics. Results showed significant negative correlations between self-esteem and both parental guilt and shame. This means the higher the level of guilt and shame, the lower the self-esteem. Additionally, a significant positive correlation was found between guilt and shame, indicating that as one increases, so does the other. When looking at differences based on time spent with children, those who spent 4–6 hours a day with their kids reported feeling more guilty than those who spent less than 1 hour or more than 7 hours. Additionally, women tended to report higher levels of parental guilt than men. The findings suggest that mothers have a greater impact on their emotional well-being, shining light on the need for further investigation into the emotional challenges faced by both mothers and fathers. Addressing feelings of guilt and shame is important in providing psychological and social support.

Keywords*:* parenting, gender differences, guilt, shame, self-esteem

**Supported by the McNair Scholars Program*

Does Religion Matter in Stress and Coping?

College of Arts and Sciences

Student Researchers: Ashley Cohn and Laura Torio Marron

Faculty Advisors: Ilya Yaroslavsky and JohnBosco Chika Chukwuorji[1]

Abstract

Over 70% of Americans are religious and observe a variety of religious traditions, including Western and Eastern faiths, such as Christianity and Islam. Although the vast majority of religious Americans are Christian, the American population of Islamic faiths is projected to increase considerably by 2050. This prevalence reflects the need to understand how religion, a central part of many people's lives, differentially shapes stress management. Stress management involves emotion regulation (ER), or cognitive, interpersonal, and behavioral efforts to modulate emotion; some approaches are generally effective (adaptive) while others exacerbate distress and undermine healthful behavior (maladaptive). Religion-linked ER, one of myriad strategies, is generally adaptive.

Still, it's important to consider how the role of religious coping in stress management differs depending on one's faith, so practitioners remain sensitive to religious clients' needs. For instance, Judeo-Christian adherents often follow more individualized and variable practices. In contrast, US Muslims more consistently observe the structured daily prayers their faith prescribes, making opportunities for religious coping more frequent and routinized. Therefore, one might expect Muslim clients to benefit more from religious coping than other religious groups, yet few studies have compared the efficacy of religious coping among Muslim and Christian samples. As a result, this study compared the effects of religious and secular coping strategies on stress in these religious groups. We hypothesized that religious coping would predict stress more than the secular coping strategies in both groups, and that the Arab Muslim group would show a significantly higher association between religious coping and stress.

[1]*Senior Lecturer and Clinical Psychologist, Department of Psychology, University of Nigeria*

The Impact of Film Quality on Viewers

College of Arts and Sciences

Student Researchers: Sam Grossman and Cheyenne Burrell

Faculty Advisor: James B. Joyce

Abstract

This research looks at the impact of viewing medium when watching a movie, and how it impacts viewer appreciation. Utilizing an experiment of viewing horror films that utilize low-fidelity content to push the story and fright of the movie, the poster examines how the viewers responded to the scenes shown from 4 different movies using that technique. The results show that there seems to be some correlation between the use of low-fidelity and viewer response/appreciation. This suggests that viewing medium (such as VHS, DVD, Blu-Ray, streaming, etc.) has an impact on how a viewer appreciates a film.

Editing Women's Voices in Migration and Motion

College of Arts and Sciences

Student Researchers: Rojda Aladag and Rachel Wuske

Faculty Advisor: Cigdem Slankard

Abstract

This dual research project is comprised of a feature-length documentary and a short documentary.

- The feature-length documentary tentatively titled *Migrant Women* examines how technology can help bring people together and create support systems through online communities.
- The short documentary, tentatively titled, *Pole* relays the inspiring story of a performing artist while she explores pole to strengthen body and mind.

Archaeological Investigations at the Fort Hill Earthwork Complex 2025

College of Arts and Sciences

Student Researchers: Reese Dudley and Brett Schlosser

Faculty Advisor: Phil Wanyerka

Abstract

Archaeological investigations were conducted this past summer by archaeologists from Cleveland State University at the Fort Hill Earthwork Complex, located in the Rocky River Reservation of the Cleveland Metroparks. Our previous investigations between 2017 and 2019 have revealed that the earthwork was created by the Adena culture between 360 and 156 BCE and that this earthwork complex likely represented an ancient cosmogram of the Adena world. This year's research was aimed at following up on previous non-invasive geophysical surveys, which included LIDAR and the use of a magnetometer and ground penetrating radar, that identified numerous magnetic anomalies in the wooded area immediately west of the earthwork complex. Thus, the archaeological investigations carried out in 2025 were the third season of a multi-year plan aimed at conducting a systematic Phase I shovel test inventory survey of the entire Fort Hill plateau in order to look for other areas of prehistoric occupation in order to determine their age and cultural affiliation.

Camp NeuroSparks – Year Two: Continuing the Journey of Growth, Support, and Hope for Chronic Brain Injury Survivors and Their Caregivers

College of Health

Student Researchers: Alesha Hanna-Kotula and Elle Speed

Faculty Advisor: Melissa Volk

Abstract

This literature and application review is looking further into the use of home programs, community programs, smart devices, applications, and resources available to individuals with chronic traumatic brain injury (defined as at least 2+ years for this literature review). Research from Wang et al (2016) completed a survey study of twenty-nine veterans who had sustained a traumatic brain injury and their use of assistive technology. The survey found that smartphones and app use were widely used to compensate for cognitive limitations. However, more than 75% of the participants did not have any training in the use of these devices and applications. The study concluded that there should be future development of assistive technology for those with traumatic brain injuries and supports the need for training and help with acquiring portable electronic assistive technology devices. Research by Beaulieu-Bonneau et al (2020) also have preliminary results from a descriptive study where they explored the use of portable electronic devices for those with moderate and severe traumatic brain injuries. They interviewed twenty-one participants that on average were 2.6 years post injury. They found that 91% of the participants had a smartphone and 52% had a tablet and all had used the devices prior to their injury. Of note 30% found the device more difficult to use after their injury. Of those that found the device more difficult to use, 50% had help from a family member or healthcare provider. 16% felt that they did not have enough support and 50% were moderate to highly interested in additional training. The overall aim for this literature review is to then take the information and continue to explore potential designs for programs targeting chronic brain injury survivors and compile a list of resources and applications for use with brain injury survivors.

Key Words: chronic TBI, traumatic brain injury, home programs and traumatic brain injury, community programs and traumatic brain injury, smart devices and traumatic brain injury, application use with traumatic brain injury

Biomarker Collection for Percent Change Analysis of Cortisone

College of Health

Student Researchers: Meagan Maharaj, Layla Seder, Alexandra Milosavljevic, and Sheana Gardner

Faculty Advisors: Michael Hammonds and Tony Sahley

Abstract

Purpose: To enhance undergraduate student experience, skill and confidence in quantitative biomedically related science.

Meagan, Alexandra, Layla, and Sheana were the undergraduate investigators.

Prediction: Our prediction was that cortisone concentration in mouse serum would be elevated in brainstem stimulated (STIMS) mice compared to control non-stimulated mice (CONTROLS) that received the sham surgery but no simulation. The third group (BASELINE) established a baseline of cortisone concentration from non-surgical, non-stressed mice that were also non-stimulated. The baseline cortisone concentration phase established a single value that was used to normalize the raw concentration data collected from stimulated and non-stimulated groups, and to produce a *percent change from baseline* value for each raw data point. That treatment uncovered a biological relevance of the difference between the STIMS and CONTROLS and reduced individual raw data variation. The equation used for normalizing raw data was [(raw data – baseline value)/baseline value]*100

The brainstem nucleus of interest in the STIMS and CONTROLS groups was the locus coeruleus, a nucleus strategically involved in the complex systemic stress response.

Results: Raw data analysis of the comparison between STIMS and CONTROLS was not convincing, ρ greater than 0.05. The normalized data comparison indicated brainstem-stimulated cortisone was significantly higher than non-stimulated controls and biologically relevant, $\rho \leq 0.0369$ (table and graph).

Percent-Change Normalization of IL-6 Following Brainstem Stimulation in Mice

College of Health

Student Researcher: Layla Seder

Faculty Advisor: Michael Hammonds

Abstract

Interleukin-6 (IL-6) is a key pro-inflammatory cytokine involved in regulating immune responses and has been implicated in several neurodegenerative and inflammatory disorders. In neuroscience research, variability in IL-6 levels across animal models limits accurate interpretation. This study explores a percent-change normalization technique to improve the reliability of IL-6 quantification following brainstem stimulation in mice. By using a pooled baseline from non-stimulated, naïve mice, this approach compensates for biological variability introduced by stress, circadian rhythms, and other external factors. Mice underwent dorsal vagal complex stimulation, and IL-6 levels were measured using enzyme-linked immunosorbent assay (ELISA). The percent-change from baseline was calculated and statistically evaluated using t-tests and ANOVA. Findings suggest that this normalization method effectively reduces inter-animal variability and enhances comparability across groups. These results support percent-change normalization as a valuable tool for future studies of cytokine expression, particularly in settings where repeated sampling is not feasible and immune markers are highly variable.

**Supported by the McNair Scholars Program*

Effects of Tail Mass Distribution on Kinematics and Stability during Arboreal Locomotion

College of Health

Student Researcher: Katie Russell

Faculty Advisor: Andrew Lammers

Abstract

Stability is an important component of locomotion so that the likelihood of stumbling or falling is reduced. This is especially important on treacherous substrates like tree branches. Many animals that habitually travel on such arboreal supports use their tails as counterweights, or to dynamically change the location and movements of the center of mass, so that stability can be maintained or improved. To test the effects of tail mass on locomotion and stability, we trained six laboratory rats to travel on a cylindrical trackway 2.9cm in diameter. The trackway was covered with a thin layer of cork to serve as a natural-like tree bark. We artificially changed the mass of the tail to determine if this would change aspects of locomotion and/or how the animal used their tails. We carried out trials where weights or sham weights were added to either proximal or distal sections of the tail. We used two cameras to capture videos of the animals traveling on the trackway. We found that speed was lower in control trials, but that limb phase (a measure of footfall pattern) was unaffected by the weights or shams. We conclude that added mass only minimally affects locomotion or stability in rats. However it is possible that animals that use their tail dynamically, such as squirrels, might be more strongly affected by altering tail mass.

Poster learning objective: changing tail mass only minimally affects the locomotion of a generalized mammal, but tail mass might strongly affect an arboreal specialist like a squirrel.

Key words: arboreal, biomechanics, locomotion, quadruped, kinematics, rat

Segregated in Life, Divided in Death: Mortality and Racial Trauma in Cleveland Cemeteries

College of Health

Student Researcher: Aaliyah Byrd

Faculty Advisor: Anne Su

Abstract

Cleveland in the early 20th century was a rapidly industrializing city. City-operated burial grounds offer a powerful lens into public health inequalities. This project investigated if and how patterns of trauma-related death were shaped by structural inequalities in 1925 Cleveland. By analyzing burial records across race, gender, and location, it aimed to uncover how social conditions may have determined exposure to violence even in death.

Trauma data were drawn from Cleveland's 1925 Register of Interments for all city cemeteries. Causes of death were grouped using language from the Board of Health's 1925 "Death by Force" classification system, then categorized by race, location, and listed cause of death. Harvard Grove and Highland Park cemeteries were the most populous and therefore were chosen for further analysis. Historical texts and public health records were used to contextualize the social and geographic landscape of Cleveland in 1925.

Results show that among traumatic deaths, suicide was almost exclusively listed as cause of death for White decedents, while Black decedents were overwhelmingly represented in categories such as gun-related homicide and blunt trauma. For example, Harvard Grove recorded 35 White suicides and only one among Black decedents; Highland Park recorded 25 White suicides and only 2 among Black descendants. This disparity suggests structural inequalities influenced both exposure to violent death and a lack of institutional recognition for Black psychological trauma.

These findings reveal that structural violence in 1925 Cleveland extended beyond life into death, influencing how trauma was experienced, classified, and remembered.

**Supported by the McNair Scholars Program*

Homeless in Cuyahoga County: A Case Study of One Mother Accomplishing Family Preservation

College of Health

Student Researcher: Nikylah Smith

Faculty Advisor: Wendy Bilgen

Abstract

This research presents a case study of a mother's experience with homelessness. The research question that prompted this study is what factors have helped a family with children experiencing poverty and homelessness stay together and out of the child welfare system. A case study is a qualitative approach that helps the researcher to understand specific experiences of a phenomenon. This study explored a homeless mother's experience with a domestic violence crisis that led to her and her children's homelessness. When a family is faced with homelessness, it is due to a few factors. Some factors include poverty and domestic violence. Literature is explored that touches on poverty, homelessness, domestic violence and how these factors negatively impact American families and contribute to family separation. Domestic violence is a leading cause of homelessness for women and children, and inadequate housing often leads to family separation in Ohio. Through this case study, three themes stood out in the participant's story: the role of her childhood experiences; the impact of domestic violence; and the necessity of access to formal support. This study highlighted what was helpful for one family, what services they needed, and what they wish they could have received to accomplish family preservation.

**Supported by the McNair Scholars Program*

Examining "The Link" in community practice: Interprofessional collaboration and the emotional labor of animal care workers

College of Health

Student Researcher: Lauren Caswell

Faculty Advisors: Aviva Vincent, Linda Quinn, and Virginia Bhemer[2]

Abstract

This research focuses on the experiences of Animal Care Workers through “The Link” framework, which refers to The Link between interpersonal violence and animal abuse, in an effort to improve understanding about the implications of humane welfare on interpersonal relations. The intended aims were to explore new opportunities to eliminate the disconnect between affected persons: pet owners and humane workers. Researchers administered an open community survey to professionals across human and animal service fields, offering participants the option to join semi-structured focus groups. These conversations invited participants to share their experiences related to abuse recognition, response practices, knowledge of The Link, and the extent of cross-reporting behaviors. Participants voiced their struggle with their perceived lack of professional support, such as confidence in whom they could go to overcome these emotional-taxing obstacles. However, the participants demonstrated their emotional resiliency by turning the semi-structured conversation to opportunities, such as creativity with resources, forming a community of support, identifying a mentor, contacting a special animal law prosecutor for guidance, or going to the Dog Warden Association for help. Applying the participant’s identified opportunities to the policy recommendations of HB33, and current community practices provides a framework for future training, collaborative practice, and legislative mandate(s). ACWs require professional support to improve their mental health and wellbeing. There are a plethora of opportunities to reduce interprofessional tension, with the most pragmatic being a state-wide required training for all mandatory reporters on the concept and importance of recognizing and reporting The Link.

[2] *DVM, MPH, The Ohio State University*

In Their Words: Family Structure, Roles, and Interaction in Resettled Congolese Families

Levin College of Public Affairs and Education

Student Researcher: Taylor M. Lucas

Faculty Advisor: Grace H.C. Huang

Abstract

In 2024, an estimated 1.2 million people from the Democratic Republic of the Congo were among 9.8 million displaced or stateless individuals worldwide. The United States admitted over 100,000 refugees, with Ohio ranking among the top three states for Congolese resettlement, following Texas and Kentucky. Congolese families accounted for approximately 40% of Ohio's refugee admissions. Many have experienced war and loss, disruptions that reshape family systems during and after resettlement.

This qualitative study explores family functioning by examining structure, roles, and interactions among resettled Congolese families. Based on semi-structured interviews with 29 refugee mothers and fathers, three core themes emerged: *a) family interaction: navigating traditional and emerging family dynamics, b) family roles and shared responsibilities, and c) family structure: reconfiguration and construction*. Findings illustrate how resettlement reshapes traditional family systems. Children often serve as cultural brokers, shifting authority and contributing emotional strain. While education is highly valued as a moral obligation, financial pressures may lead youth to prioritize employment, influencing long-term educational and career outcomes. Large family size, often viewed as a sign of prosperity, is sustained through shared responsibilities and resilient parenting practices. These dynamics underscore the need to view Congolese families as interconnected systems navigating cultural transition, economic hardship, and structural barriers.

SynthoPlate, a Synthetic Platelet Surrogate, Reduces Blood Loss in Preclinical Models of Severe Thrombocytopenia

Washkewicz College of Engineering

Student Researcher: Mishal Ahmad

Faculty Advisors: Emily Gahagan[3], Baylee Traylor[3], Emma Quill[3], Kristin Aldridge[3], Ujjal Didar Singh Sekhon[3], Christa Pawlowski[3], and Michael Bruckman[3]

Abstract

Uncontrolled hemorrhage is a leading cause of preventable mortality, yet the clinical utility of platelet transfusions is critically limited by their short shelf-life, stringent storage logistics, and alloimmunization risks. This necessitates the development of a stable, off-the-shelf hemostatic agent that can be deployed instantly at the point of care. Here we report the design, synthesis, and characterization of SynthoPlate (SP), a fully synthetic, lyophilized liposomal nanoparticle engineered as a platelet mimetic hemostatic agent. SP is surface-decorated with a synergistic combination of peptides that emulate key thrombotic functions without requiring blood-type matching. Upon intravenous administration, SP emulates primary hemostasis by adhering to the vascular injury site through von Willebrand factor-binding peptide (VBP) and collagen-binding peptide (CBP) and amplifying aggregation of activated platelets through fibrinogen-mimetic peptide (FMP), essentially forming the 'platelet plug.' SP is manufactured via thin-film hydration, extrusion, and lyophilization of the liposomal drug, which then is characterized by physicochemical parameters such as size, zeta potential, pH, osmolality, and high-performance liquid chromatography (HPLC). In severe thrombocytopenic animal models, SP demonstrated potent efficacy, reducing total blood loss by 73% in murine tail transections and by about 30% in rabbit ear lacerations, with hemostatic rates comparable to donor platelets. Exhibiting a robust safety profile with a >250-fold therapeutic window, SP is a promising, readily deployable therapeutic poised to address the critical unmet need for immediate hemorrhage control in trauma, surgery, and the management of thrombocytopenia.

[3]*Haima Therapeutics, LLC*

Plastic Waste to Energy via Chemical Reactions in Multiphase Environments

Washkewicz College of Engineering

Student Researcher: Isaiah M. Gerdeman

Faculty Advisor: Jorge E. Gatica

Abstract

More than 250 million metric tons of municipal waste are produced by Americans each year. Most of this waste is either unrecyclable, incinerated, or placed in landfills. With the adverse effects caused by incinerators, and landfills reaching maximum capacity, finding a solution to this ever-growing problem has become more apparent than ever. The concern from scientists and engineers has grown, and solutions and better alternatives to current waste management practices have become increasingly needed. One such solution is waste gasification, a process that breaks down carbon-based materials into synthetic gas (syngas). This process has advantages over traditional procedures such as incineration, as it requires a much lower temperature and produces fewer by-products, thus leading to a lower energy footprint.

At Cleveland State University, a catalytic gasification process is being investigated in a low-to-medium temperature and high-pressure reactor. The goal for this research project is to resolve the fluid dynamics of a multi-phase reacting environment where waste substrates are converted to syngas with the aid of solid catalysts. To do this we used simulation software to gather data from a model of our system. To find the overall reaction energy I focused on one particle that was randomly selected and did my analysis on that. Then I started by modeling the stokes flow system with a single particle in COMSOL. Then once I had the raw data, I used MATLAB to analyze it. To isolate the reaction energy, I attempted to solve the heat and mass transfer energy, but in doing this I had to find the boundary layer which took me the rest of the summer.

Transformation, Expression, and Purification of an Elastin-Like Polypeptide

Washkewicz College of Engineering

Student Researchers: Mikala McCay and Ella Kleybort

Faculty Advisors: Edward Turk[4] and Nolan Holland

Abstract

Elastin-like polypeptides (ELPs) are temperature-responsive biopolymers with potential uses in tissue engineering and bioprinting. In this study, we worked with an ELP fused to superfolder Green Fluorescent Protein (sfGFP), which provides a visible marker to simplify tracking during production and purification. The plasmid encoding sfGFP–ELP was provided to us and initially tested for expression in Escherichia coli Vmax, but these attempts were unsuccessful. We then transformed the plasmid into E. coli BL21, where protein expression was achieved. Purification was carried out using inverse transition cycling (ITC), taking advantage of the ELP's ability to aggregate and re-dissolve with changes in temperature. The purified protein was analyzed for yield and purity, confirming that this approach is effective for producing sfGFP–ELP. While this construct is not intended for direct use as a bioink, it serves as a valuable tool for developing and refining methods that will support future ELP-based bioink production.

[4] *Gilmour Academy*

pH-Dependent Thermal Inactivation Models for Pathogen Control During Poultry Scalding

Washkewicz College of Engineering

Student Researchers: Sarah N. Fergus and Vyshnavi Ciluveru

Faculty Advisors: Chandra Kothapalli, Shawn D. Ryan, and Daniel S. Munther

Abstract

Poultry scalding is a critical step in commercial processing designed to remove feathers and reduce microbial contamination, yet it can also serve as a potential route for cross-contamination of foodborne pathogens such as Salmonella. Current industry standards do not consider the impact of water pH on pathogen inactivation during thermal processing. This study aims to develop and validate pH-dependent thermal inactivation models to enhance microbial safety in poultry scalding operations. Laboratory-scale experiments utilized a cocktail of five different strains of Salmonella as model organisms to examine microbial reduction at various pH levels (4, 6, 7, 8, 10) and scalding temperatures (48°C, 52°C, 56°C, 60°C), both in the presence and absence of organic load. Results indicate that both temperature and pH significantly influence pathogen survival; elevated temperatures and more acidic pH values (4, 6) achieved greater log reductions in bacterial counts, while the presence of organic load impairs thermal inactivation, highlighting its protective effect on pathogens. The findings highlight the synergistic effect of optimizing both pH and temperature for enhanced pathogen control. Mathematical models generated from experimental data can predict microbial inactivation under varying conditions, providing a framework for scalding process optimization. Adoption of these pH-dependent models may allow processors to reduce thermal energy input without sacrificing food safety, thereby improving sustainability. This research addresses notable gaps in industry knowledge regarding the role of water chemistry in microbial inactivation and offers practical guidelines for reducing the risk of foodborne illness during poultry processing. Implementation in commercial settings and future studies on additional pathogens are recommended to further validate and expand the applicability of these models.

Investigating How Sweat Biomarkers Change Throughout the Menstrual Cycle

Washkewicz College of Engineering

Student Researchers: Elly Obondo, Victoria Stege, and Madison Luthy

Faculty Advisor: Chelsea Monty-Bromer

Abstract

The menstrual cycle is associated with hormonal and metabolic shifts that may influence hydration, performance, and recovery. While blood-based biomarkers such as cortisol, glucose, and leptin have been studied across cycle phases, little is known about electrolyte changes, particularly in sweat. This pilot study tested the potential of using sweat as a non-invasive medium to track sodium, potassium, and lactate in female athletes. Sweat samples were collected during 3-4 exercise sessions across one menstrual cycle in a cohort of cross-country runners. Analysis revealed challenges with low sweat volume and incomplete datasets, but preliminary results suggested potential phase- related variation in sodium and potassium, with inconsistent but notable changes in lactate. The study was limited by low sampling frequency, small volumes, exercise- dependent collection, and single-cycle duration. Despite these challenges, findings demonstrate both the promise and the practical limitations of sweat-based biomarker tracking. Future work should employ larger, more diverse cohorts with longitudinal, high- frequency sampling to fully evaluate the utility of sweat for menstrual-cycle biomarker monitoring.

Poly(Styrene -Isobutylene-Styrene) (SIBS) triblock Copolymer-based Ion-exchange Membrane for Vanadium Redox Flow Battery (VRFB)

Washkewicz College of Engineering

Student Researchers: Abdul Fattah Geith and Najem Alarwan

Faculty Advisor: Metin Uz

Abstract

The VRFB, a large-scale, rechargeable battery which stores energy in the form of vanadium electrolyte oxidation states, is one of the most fine-tunable batteries known to the energy storage community. In discussions about cleaner energy, the VRFB is an overlooked technology due to its costliness. Recently banned in Europe due to public health concerns, Nafion-117, the benchmark modern ion-exchange membrane, is a large contributing factor to the cost-of- integration bottleneck. Although the properties of Nafion-117, such as high tensile strength, low vanadium ion permeability, and high proton conductivity, warrant its use in VRFB, there is still a critical need for cost-effective alternatives. To address this critical need, in this study, sulfonated poly(styrene -isobutylene-Styrene) (S-SIBS), known for its stability in acidic environments due to its isobutylene block, was explored using different degrees of sulfonation (DS). S-SIBS membranes were prepared by performing a sulfonation reaction of SIBS with sulfonation agent followed by the dissolution and casting of the product. The standardization of DS characterization for S-SIBS is essential, as the proton conductivity and vanadium ion permeability are directly correlated with the DS. For this purpose, an ion-exchange capacity (IEC) test was performed; initially converting all available proton exchange sites of the membrane to -SO_3H form, followed by a conversion to -SO_3Na form, allowing for direct calculation of DS. Higher DS were found to be correlated with higher proton conductivity in S-SIBS yet also correlated with higher vanadium ion permeability and hydrophilicity. S-SIBS-4, with a 34.3% DS, was found to have a ~16.2% higher selectivity than Nafion-117 at an estimated 15% of the cost, deeming this material a promising new ion-exchange membrane candidate for VRFBs. For the ongoing future experiments, additional structural analysis (SEM and TGA) along with the chemical stability and battery efficiency (i.e., as coulombic efficiency (CE), voltage efficiency (VE) and energy efficiency (EE)) will also be evaluated. In addition, the effect of filler content in the membrane structure on the membrane performance will also be evaluated in future studies to further optimize the membrane properties.

Assessing Mechanical Properties of Glass Fiber-Reinforced Concrete in Local Roadways

Washkewicz College of Engineering

Student Researchers: Matthew A. Kleps and Meghana Yeluri

Faculty Advisor: Srinivas Allena

Abstract

Glass fiber-reinforced concrete (GFRC) improves mechanical and physical properties of concrete, yet its use in pavements remains limited due to insufficient research. This study investigates the potential of recycled glass fibers (RGF) from post-industrial sources as a sustainable alternative to virgin glass fibers (VGF) for use in local roadways. The objective of this research was to improve mechanical performance of pavement concretes subjected to structural and environmental loads. Glass fibers and polyolefin (PO) fibers were added by replacing fine aggregate by volume. Mechanical performance was assessed through compressive, splitting tensile, and flexural strength testing while physical behavior was evaluated with drying shrinkage. At 28 days, VGF produced the greatest increase in compressive strength relative to control while PO and RGF resulted in reduction of strength. Splitting tensile strength was improved with VGF and PO compared to 28-day control while RGF slightly decreased strength. Modulus of rupture strength increased the greatest with VGF, PO, and RGF in respective order, relative to control at 28 days. VGF had reduced the most drying shrinkage while PO exhibited the greatest shrinkage over 91 days. The findings suggest that RGF offers a cost-effective, environmentally friendly alternative to VGF, with promising implications for sustainable pavement-grade concrete applications.

Comparison of Brake Reaction Time for a Repeated Event

Washkewicz College of Engineering

Student Researcher: Perry N. Beerer

Faculty Advisor: Jacqueline M. Jenkins

Abstract

Studying brake-reaction time to unexpected events benefits from knowing how much time needs to pass between the first and second occurrences of an event for the second occurrence to be perceived as a surprise. Without this knowledge, studies are limited to measuring the brake reaction time to a single unexpected event. Being able to include a second event would greatly improve the efficiency of such experiments. The purpose of this study was to determine if the time between braking events could be increased such that the response time for an initial event and a subsequent event would be similar. Assuming that the first event is unexpected, similar brake reaction times would suggest that the second event is also being perceived as a surprise.

A driving simulation study was designed as a repeated measures, single factor experiment, where the time between events was varied across three driving simulation scenarios. Each scenario modeled a two-lane rural roadway with a posted speed limit of 55 mph and a moderate amount of ambient traffic. The unexpected event was the appearance of a deer in the travel lane. Eleven participants, aged 25 to 60 years, were recruited. Each drove a practice scenario to adapt to the simulated environment. Ten participants continued and were assigned to one of three experimental scenarios. Preliminary results showed some unexpected behaviors. Three of the participants were exceeding the speed limit when the first deer appeared. Instead of braking, eight participants steered around the deer, sometimes into the opposing lane of traffic, and nine drove straight through the deer.

AI-Powered System for Detecting Real-Time Traffic Conditions from Camera Imagery Data

Washkewicz College of Engineering

Student Researchers: Ke Ren, Abdul Shaban Ngereza, and Ntemi Methusela Masanja

Faculty Advisor: Emmanuel Kidando

Abstract

State Departments of Transportation (DOTs) and local agencies allocate substantial portions of their budgets to install, operate, and maintain vision-based traffic camera systems for real-time traffic monitoring and surveillance. However, most existing systems depend heavily on human operators to continuously review video footage for incident detection and traffic condition assessment. This approach is labor-intensive, susceptible to operator fatigue, and often leads to inaccuracies in detection as well as reduced overall efficiency. To address these challenges, this research focused on developing an automated traffic monitoring system leveraging computer vision and deep learning techniques. Specifically, we implemented the YOLOv8 (You Only Look Once) object detection model to analyze highway traffic patterns across various locations in Ohio. In the data collection phase, an automated algorithm was implemented to acquire real-time imagery through the Ohio Department of Transportation's open Application Programming Interface (API). The collected images were then annotated to construct a training dataset. Several YOLOv8 sub models were independently trained and systematically compared to assess their relative performance and accuracy. The proposed system achieved an accuracy of 90% in detecting passenger cars and trucks. These findings highlight the potential of vision-based deep learning models to support more accurate, efficient, and data-driven decision-making in traffic management.

Computationally Guided Framework to Demolition and Deconstruction of Civil Infrastructure

Washkewicz College of Engineering

Student Researchers: Muhammad Haseeb, Enock Tongyem, and Stephen Asare

Faculty Advisors: Josiah Owusu Danquah and Salwa Beheiry

Abstract

Conventional approaches to demolition and deconstruction tend to adhere to fixed plans and last-minute responses, potentially resulting in safety risks, inefficiencies, cost overruns, and limited reuse of materials. This Undergraduate Summer Research Award (USRA) project centered on: (1) assessing the current workforce trends in the demolition sector, specifically within the Cleveland area, and (2) proposing a framework that integrates Structural Health Monitoring (SHM), AI-based decision-making, and IoT sensors to support proactive deconstruction/demolition management with emphasis on safety, efficiency, cost-effectiveness, and sustainability. Based on our initial literature review and stakeholder consultation, a computationally guided framework was proposed with the potential to reduce demolition accidents by 25–40%, enable 15–30% faster demolition execution, boost material recovery rates to 60–80% and reduce landfill waste by 20–40%.

Enhancing Intellectual Property Recommendation Systems Through Preprocessing Replication and Updating Data

Washkewicz College of Engineering

Student Researcher: Lewis Davis

Faculty Advisor: Sunnie Chung

Abstract

Jobs, income, education, and crime rates in an area significantly influence home-buyer preferences for residential living spaces. The number of beds, the sewer and water system, gas, electricity, and lot size are just a few important contextual features that can change a consumer's decision on a home. A recommendation system using all of this data would thereby become supremely useful. In previous work, a recommendation system using geospatial information and machine learning from the information gathered from utilizing open data resources like the government census was employed to assess the desirability of a given property. However, the reproducibility of the system's pipeline is uncertain. To evaluate this, we validate the previous intelligent property recommendation system by reconstructing its pipeline with current open datasets and re-computing the geospatial features, property price from Cuyahoga County open data, crime rate collected from the FBI, school information from the Ohio Department of Education, and the area income level and diversity from the US Census Bureau. We are following the methodology of previous work in creating the intelligent recommendation system, first with the already preprocessed data, then validated with the use of newer data. Our results confirm the pipeline's reproducibility regarding data integration into a common database, MySQL.

**Supported by the McNair Scholars Program*

Investigating the Impact of Robot Speeds on a Human Collaborator's Cognitive Workload

Washkewicz College of Engineering

Student Researcher: David Coy

Faculty Advisor: Apostolos Kalatzis

Abstract

Collaborative robots belong to a growing market, and they're used in various applications to enhance human productivity. Introducing a robot collaborator to a human; however, can also introduce new problems that need to be solved. One such problem is how a robot impacts the required amount of mental effort a user must exert to complete a task, known as cognitive workload. Excessive demands made on a user's cognitive workload can be mitigated by enabling the robot to interpret and react to the human collaborator's behavior, so the robot can autonomously adjust its behavior to meet the human's needs. This experiment investigates how robot speed impacts the cognitive workload of a human collaborator. As an analogue for a manufacturing process, participants will perform a Lego assembly task in collaboration with a robot at three different speeds. To measure the participants' cognitive workload, an eye tracker will be worn to track pupil dilation, blink rate, and blink duration. Additionally, participants will fill out questionnaires after each trial. This preliminary investigation can be built upon by developing an algorithm to allow the robot to react to input data from the eye tracker and autonomously adjust its speed such that the user experiences an optimal cognitive workload.

Exploring CUDA Acceleration to Speed Up RSA Cryptography

Washkewicz College of Engineering

Student Researcher: David Awkar

Faculty Advisor: Haodong Wang

Abstract

The purpose of this study was to investigate if GPU parallelism can be used to speed up RSA cryptographic operations. RSA is a common encryption algorithm used to secure network communications worldwide. We used several optimizations including Montgomery Modular Multiplication and the Chinese Remainder Theorem to maximize speeds.

From Signals to Significance: Interpreting Wearable Ring Sensor Data

Washkewicz College of Engineering

Student Researcher: Mohammed Arshad

Faculty Advisor: Ye Zhu

Abstract

Tracking mental health is difficult because it often depends on people reporting how they feel, which can be inconsistent. Wearable devices provide another option: they collect data all day from the body, such as heart rate, sleep, and activity, which may also reflect mood. This project looks at whether signals from a wearable ring can be used to predict daily mood with machine learning.

Data was collected for about 27 days from one person using the ring, which recorded heart rate, heart rate variability, steps, skin temperature, and sleep stages. Each day also included a self-reported mood score. To make the data more reliable, all times were set to Cleveland local time and the mood scale was simplified from five levels to three (low, mid, high). Missing or unclear data points were removed.

We trained a Long Short-Term Memory (LSTM) model in Python to learn from short time windows of this data. When tested on separate July files, the model reached about 42–45% accuracy. The results showed it was better at recognizing “low mood,” while “mid” and “high” moods were harder to tell apart.

Even though accuracy was limited, the study shows that machine learning can find patterns in wearable data that relate to mood. The main challenges were the small dataset, uneven mood labels, and the personal nature of self-reports. With more participants, longer tracking, and stronger models, this approach could support easier and earlier mental health monitoring.

From Ladder Logic PID to Generic PID: Developing a PLC-Based Control Testbed

Washkewicz College of Engineering

Student Researcher: Keroles Beshay

Faculty Advisor: Zhiqiang Gao

Abstract

Industrial proportional–integral–derivative (PID) controllers are ubiquitous in process control due to their simplicity and effectiveness[1]. However, tuning PID loops for optimal performance can be challenging – many control loops remain poorly tuned or operate in manual mode, leading to suboptimal performance[2]. This paper presents a methods-driven design and implementation of multiple PID controller variants on a programmable logic controller (PLC) testbed, with a focus on transparency and reusability of control logic. Using Rockwell Automation Studio 5000, a conventional PID control was first implemented via ladder logic, followed by the use of Rockwell's enhanced PID function block (PIDE) in a function block diagram, and finally a custom PID algorithm written in Structured Text. A temperature control loop (heating element) served as the primary test process for PID and PIDE tuning. Additionally, a two–mass spring–damper system plant model was developed using a Texas Instruments (TI) microcontroller board to prepare a testing environment for a next-generation "Generic PID" (GPID) control algorithm. MATLAB was integrated via RSLinx OPC for real-time data visualization and logging. While the GPID controller was not fully implemented within the project timeframe, the framework established in this work provides a reusable bench for future testing. The results emphasize design and implementation insights rather than final performance, laying groundwork for comparative evaluation of traditional PID and advanced GPID controllers in ongoing research.

**Supported by the McNair Scholars Program*

Underwater Drone Design to Utilize Optical Relay Networking for Swarm Applications

Washkewicz College of Engineering

Student Researchers: Douglas Nuti and David Stack

Faculty Advisor: Mehdi Rahmati

Abstract

Underwater wireless networking is an emerging field for exploration and monitoring, enabling real-time data transmission and communication with both static sensors and submersibles. This project presents the design and development of a low-cost, untethered underwater drone optimized for optical communication and mobility. The primary housing was constructed from a 3-inch acrylic tube to balance strength, light transmission, and internal space for electronics. The modular body includes a sealed cone for battery storage, a tail section for servo-mounted thrusters, and a custom circuit mounting board with integrated mirrors and photodetectors for signal transmission and reception. The modular nature of the design was to allow for future changes and adaptations, such as new internals for interchangeable use cases in future development. Key propulsion elements include racing drone motors paired with waterproofed high-torque servos and toroidal propellers for efficient thrust. PETG filament was selected for 3D-printed components due to its durability and resistance to cracking under pressure, with sealing methods such as annealing and rubberized coatings applied to ensure water resistance. This design was ultimately decided upon based on its ability to have unimpeded light transmission, unlike most other designs on the market today, as this was the most important factor, since optical communications are utilized, it needed to have clear views for both the photo detectors and the LED. To improve the field of view, a set of mirror plates was introduced to increase light transmission angles. To further enhance movement capabilities, other systems would need to be included in later models, such as flight controllers or GPS, to allow movement data to be properly tracked and to allow for true swarm-style movement.

Underwater Adaptive Relay Optical Wireless Networking

Washkewicz College of Engineering

Student Researchers: David Stack and Douglas Nuti

Faculty Advisor: Mehdi Rahmati

Abstract

Underwater wireless networking is an emerging field for exploration and monitoring, enabling real-time data transmission and communication with both static sensors and submersibles. Current approaches focus on the use of acoustics. The use of optics for this purpose has been known to have several challenges that have prevented it from being considered as a better alternative. This study proposes that utilizing optics in an adaptive relay wireless network configuration can overcome its primary limitation of line-of-sight. A network consisting of four nodes constructed with the ability to read and send on-off keyed blue light, fit for extended submersion in water, meant to represent a hypothetical aquatic drone swarm, was developed and programmed to follow adaptive relay logic. This network was able to demonstrate adaptation to obstructions in the line-of-sight and maintained communication through configurations in which the sender and intended recipient were otherwise unable to directly communicate. This finding allows the advantages of optical communications to be further explored for aquatic applications, primarily its higher potential data rate, which is inherently productive to a swarm.

**Supported by the McNair Scholars Program*

Modeling and Simulation of AGV-Based Parcel Sortation Systems

Washkewicz College of Engineering

Student Researcher: Charles Strickland

Faculty Advisor: Wenbing Zhao

Abstract

The rapid growth of e-commerce in recent times has increased the demand for parcel sortation systems that are both efficient and adaptable. Traditional conveyor-based solutions are often rigid and costly to expand, making Automated Guided Vehicles (AGVs) an ideal alternative. This study applies modeling and simulation (M&S) to evaluate the performance of AGV-based sortation systems and explore design optimization. A conceptual queueing model was developed where parcels arrive according to a Poisson process, wait for AGV assignment, and undergo pickup, transport, and deposit with associate service and travel times. An event-driven simulation developed with Python was used to capture system dynamics, including queueing delays and AGV travel paths. Key performance indicators included throughput, parcel queue wait times, and amount of pathfinding calculations per AGV. Optimization algorithms (specifically a genetic algorithm and brute-force algorithm) were tested to maximize throughput while minimizing computational load from AGV pathfinding. Results indicate that simulation-driven approaches can identify effective trade-offs between throughput and pathfinding complexity, offering insights into efficient design parameters for scalable and flexible parcel sortation systems. This work demonstrates how M&S can guide logistics system design and highlights the potential of AGVs for meeting growing parcel delivery demands.

Process Parameter Optimization of 17-4PH Stainless Steel Processed by Additive Manufacturing (3D Printing) for Energy Applications

Washkewicz College of Engineering

Student Researchers: Matthew Atienza and Sambhaji Kusekar

Faculty Advisor: Tushar Borkar

Abstract

Conventional manufacturing of SAE 630 stainless steel for the oil and gas sector faces challenges such as material wastage, limited design flexibility, prolonged production lead times, and poor corrosion resistance in harsh environments. Additionally, energy-intensive processes and difficulties in customization and repair increase operational costs and environmental impact. This study explores additive manufacturing (AM) as a solution to these limitations by evaluating the corrosion behavior, mechanical properties, and microstructural evolution of AM-fabricated SAE 630 stainless steel. A comparative analysis with conventionally manufactured counterparts will be conducted by optimization strategies, and potential applications in critical oil and gas components. By addressing these objectives, this study aims to establish AM as a viable alternative for enhancing performance, efficiency, sustainability, and reducing material waste and lead times in oil and gas operations.

Additive manufacturing of fully dense structures of pure Ti and Ti-hBN for biomedical applications

Washkewicz College of Engineering

Student Researchers: Ainsley Good and Satyavan Digole

Faculty Advisor: Tushar Borkar

Abstract

To improve microstructural isotropy and mechanical performance of pure titanium (Ti) for biomedical applications, hexagonal boron nitride (hBN) was incorporated into a Ti matrix using selective laser melting (SLM). Microstructural characterization confirmed the in-situ formation of TiB_2 and α(Ti,N) phases, resulting from reactions between Ti and hBN. These in-situ precipitates, uniformly distributed along grain boundaries and within grains, promoted grain refinement and the development of a more equiaxed microstructure. As a result, the hBN-reinforced composites demonstrated substantial improvements in strength, hardness, corrosion resistance, and wear behavior. In addition, porous structures with varying porosity levels (20%, 40%, and 60%) were fabricated via SLM. Among them, the 20% porous Ti-hBN structure exhibited an optimal balance of strength and an elastic modulus (~30 GPa), closely matching that of human cortical bone. These findings highlight the strong potential of SLM-processed Ti-hBN composites for next-generation implant applications.

An In-Depth Analysis of Porosity: Utilizing Porosity for Fluid Flow Channels in Stainless Steel 316L Using Selective Laser Melting

Washkewicz College of Engineering

Student Researchers: Rocco Sladky and James Elder

Faculty Advisor: Tushar Borkar

Abstract

Additive manufacturing through parameterization is a method which involves creating a structure by only altering the parameters given by the software of the machine. Through this process, many complex structures are possible. One of which being samples with channels that connect throughout the entirety of a sample to allow for fluid flow. The application of these samples range from structural support in pipes, wicking, and flow alteration. A total of 7 parts were printed and tested ranging from 300µm to 900µm with a 100µm deviation. The samples were run through several tests including density measurements, fluid flow, and capillary pressure. The density measurements were used to find the total isolated and connect porosity throughout each sample to know how well the channels formed. The fluid flow test sought out to see the effects the samples had on the flow based on the amount of loss. Finally, the capillary pressure test found the water absorptivity coefficient of each sample which shows how effective a sample is at pulling water vertically through the channels. An alternative factor that was taken into place was the VED (volumetric energy density) of each sample and how efficient it was to print. Each one of the samples exhibited success in at least one of these tests. Overall, the 500µm sample performed the best all around, but was especially great in terms of capillary pressure. The 800µm and 900µm excelled at minimizing loss in the system as well as lower VED's due to their larger channels. The 400µm sample served as a base line for creating the desired channels. For the remaining samples, 300µm, 600µm, and 700µm, the vertical channels were not formed properly due to either melt pool thickness or a printer compensation error.

Optimizing Printing Parameters and Mechanical Performance of AISI M2 Tool Steel via DED, Binder Jetting, and SLM

Washkewicz College of Engineering

Student Researchers: Ryan Rudolph and Amit Choudhari

Faculty Advisor: Tushar Borkar

Abstract

High-speed steels are essential in applications demanding long tool life under elevated temperatures, such as high-speed machining and heavy-duty cutting. Among them, AISI M2 tool steel offers an effective balance between performance and affordability. Conventional manufacturing limits the geometric complexity of such cutting tools, whereas additive manufacturing (AM) enables the fabrication of dense, hard tools with intricate features, including conformal cooling channels, thereby enhancing performance and service life. This study investigates the additive manufacturing of AISI M2 tool steel using three techniques: Binder Jetting (BJ), Selective Laser Melting (SLM), and Powder-Direct Energy Deposition (Powder-DED). The research primarily focuses on Powder-DED, where samples were produced at varying energy densities to determine the optimal processing parameters. A comprehensive evaluation of density and hardness was performed, supported by microstructural analysis. Results revealed that Powder-DED demonstrated favorable mechanical properties, achieving an average relative density of 99.76% and hardness values up to 730 HV. Notably, an energy density of 25 J/mm² produced the highest combination of hardness and density. Furthermore, anisotropy was observed, with XY-oriented samples consistently outperforming XZ-oriented ones in both density and hardness. These findings highlight the strong potential of Powder-DED for fabricating high-performance M2 tool steel components suitable for industrial applications. Future work will expand this investigation to include tensile and compressive testing, providing deeper insight into the mechanical behavior and validating the suitability of AM-fabricated M2 tool steels for real-world use.

Machine Learning-Based Forecasting of Wind and Solar Resources at Variable Spatiotemporal Resolution

Washkewicz College of Engineering

Student Researcher: Zachary Jackson

Faculty Advisor: Navid Goudarzi

Abstract

Accurate forecasting of wind speed and solar irradiance is critical for the reliable operation of renewable energy systems across applications such as EV charging, smart cities, advanced air mobility, and high-performance buildings. This project examines the application of machine learning (ML) models, particularly long short-term memory (LSTM) networks, to predict wind and solar resources across varying time intervals and geographic scales. Temporal windows from 10-minute to monthly forecasts are explored, while spatial domains span from individual sensor locations to multiple deployment sites across the Cleveland metropolitan area. A comparative analysis with persistence models reveals that while persistence performs well for short-term forecasts, LSTM models significantly improve prediction accuracy over longer horizons. To enhance accessibility and usability, a PySide6-based graphical user interface was developed to allow users to load data, select forecasting intervals, define spatial coverage, and visualize results interactively. This integrated platform enables context-aware forecasting tailored to user-defined spatiotemporal configurations. By unifying advanced ML models with interactive tools and real-world data, this work supports the development of intelligent, resource-aware forecasting systems for resilient and sustainable energy planning.

Integration of Wind and Solar Hybrid Systems in Electric Vehicle Charging Infrastructure

Washkewicz College of Engineering

Student Researcher: Adam Elkhatib

Faculty Advisor: Navid Goudarzi

Abstract

The Hybrid EV Charging Station project, developed at Cleveland State University, addresses the increasing demand for sustainable EV infrastructure by combining wind and solar energy with traditional grid power. Using a Distributed Energy System (DES) framework, the project aimed to demonstrate the feasibility, scalability, and cost-efficiency of hybrid energy for EV charging applications.

A small-scale prototype was constructed, integrating a 100W solar panel and a 400W wind turbine, both installed on the rooftop of Cleveland State University. Real-time environmental and electrical performance data—including solar irradiance, wind speed, voltage, current, and battery state-of-charge were collected using custom Arduino and Raspberry Pi programs. This codebase enabled continuous monitoring and logging, providing essential insights into energy generation, storage, and system responsiveness.

Testing was conducted under both simulated and real-world conditions. Indoor trials used grow lights and hand spun to replicate environmental inputs, while outdoor data collection captured the system's behavior under actual weather variability. A dynamic power coupling system was developed to allocate energy based on source availability and demand. Cost analyses revealed meaningful long-term savings and reduced operational costs compared to natural gas alternatives.

This project successfully validates a functional model for hybrid EV charging, highlighting both environmental and economic advantages. It serves as a proof of concept for expanding hybrid energy systems into larger-scale commercial applications.

Design and Sizing of a Renewable Microgrid for 24-Hour EV Fleet Charging Using Xendee Microgrid Toolkit and Sensor Data

Washkewicz College of Engineering

Student Researcher: Chelsea Miller

Faculty Advisor: Navid Goudarzi

Abstract

This project leverages the Xendee techno-economic platform and ESAP (Energy Systems Analysis Platform) to evaluate system configurations that meet demand reliably while remaining cost-effective across the project lifespan. We explored how energy storage integration, component sizing and operational strategies affect system performance and cost under varying load profiles. This work directly supports the broader goal of creating scalable, replicable microgrids that alleviate stress on centralized grids, enhancing delivery fleet flexibility and reducing operational emissions. This research experience is directly translated to real world tools and workflows used in microgrid planning and improved skills in system modeling, scenario analysis and sustainability planning. The outcome will contribute to an evolving body of work on decentralized solutions for transportation electrification and urban energy resilience.

3D Printing Microfluidic Spheroid Generators for the Creation of Alginate Microgels

Washkewicz College of Engineering

Student Researchers: Alec Suehrstedt and Layan Hamidi Nia

Faculty Advisors: Liqun Ning and Jan Claesen[5]

Abstract

Hydrogels are very useful in biomedical engineering, often used as versatile scaffolds for guiding cell growth or as a protective shell around cells, bacteria, or medicine. The Ning Lab frequently uses hydrogels for the former purpose and is interested in expanding its capabilities to the latter.

This project focuses on creating a system for the production of sodium alginate microgels, forming spheroids in the low hundreds of microns in diameter that can form such shells. Through the development of several key design techniques, we have been able to utilize an SLA 3d printer to create several suitable microdroplet generators. These design techniques include positioning all microchannels at a 45° angle to the build plate, placing small circular cavities at bottom corners, and modeling all channels 120 microns larger than desired to account for resin overcuring.

We utilized a flow-focusing design, using mineral oil to separate sodium alginate into microdroplets, to then be crosslinked into microgels. These microdroplet generators have proven capable of consistently producing alginate droplets of approximately 325-350 microns in diameter, or smaller droplets as low as 25 microns interspersed with these larger ones, depending on the flow rates used. This system will enable the Ning Lab to produce microgels for internal use, as well as in collaboration with the Jan Claesen Lab at the Cleveland Clinic, helping enable their own research by providing a delivery vehicle for bacteria capable of withstanding the harsh environment of the stomach.

[5]*Cleveland Clinic Lerner Research Institute*

Investigating Electrospun PCL Conduits to aid in Bile Duct Regeneration

Washkewicz College of Engineering

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Abstract

Bile Duct Injuries (BDIs) can present serious complications for patients ranging from strictures to bile leakage and obstructions; these complications can result in high morbidity and mortality [1]. Classic surgical techniques such as T-tube drainage and Roux-en-Y bile duct jejunostomy can be associated with high frequency of postoperative complications and high recurrence rates of stenosis [2]. With the advancements in tissue engineering and bioengineering, research is being focused on developing artificial bile ducts (ABDs) [2]. There are multiple additive manufacturing processes that can be utilized for tissue engineering. For the application involving bile duct regeneration, electrospinning has been a common focus as the process allows for cell adhesion, migration, and proliferation [3].

This work utilizes the manufacturing process of electrospinning to create conduits for ABDs composed of polycaprolactone (PCL). The objective was to optimize the process to create consistent, reproducible conduits that could be used in further testing. As there are a multitude of parameters that affect the electrospinning process, the primary parameter studied was the tip to collector distance (TCD) of the nozzle to the collector drum. Previously, it had been observed that the fiber diameter thins the further the TCD; however, the fibers were also observed to produce beads once the TCD had grown too large, likely due to jet instability [4]. Trials were conducted to determine the most effective TCD to be utilized with the polymer solution consisting of a 3:1 formic acid to acetic acid ratio by volume with 15% w/w PCL. Results were studied using scanning electron microscopy (SEM). Later trials were conducted to determine the effects of different spin durations on the mechanical properties. By obtaining these baselines, other parameters can be further explored. Future work would involve studying perfusion of the conduits, determining the best collector drum rotation speed to impact fiber alignment and thus mechanical properties, and to better the hand-rolling process to ensure conduits are rolled as consistently as possible.

*1. de'Angelis, N, et al. World Journal of Emergency Surgery, **16**, 30, 2021*
*2. Sun, Q, et al. Materials, **14**, 7468, 2021*
*3. Li, P, et al. JGH Open, **9**, e70254, 2025*
*4. Thompson, C.J, et al. Polymer, **48**, 6913–6922, 2007.*