NEW MEXICO TECH

STUDENT RESEARCH SYMPOSIUM

APRIL 14TH - APRIL 16TH, 2021

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STUDENT RESEARCH SYMPOSIUM

Dear students, advisors, evaluators, and attendees,

Welcome to the 10th Annual New Mexico Tech Student Research Symposium (otherwise known as the second Special Online Edition)!

"Thou shalt not be boring" was a lesson I learned long ago in creating public presentations. As a scholar, I knew that it could be easy to move toward the less than engaging seminar if I wanted to by being erudite and pedantic. To catch other people's attention was essential. Knowing the audience, and then speaking to the audience in a manner that allowed for engagement was crucial. Simply being a well-informed academic was not enough. Helping others to understand complex ideas in a clear and positive manner was necessary. These lessons become all the more important in these unprecedented times, when vast amounts of business, education, and social interactions are being conducted through various online platforms. Engaging an audience over Zoom can be particularly challenging. Moving the Student Research Symposium online allows students the chance to learn and gain valuable experience presenting in what is an increasingly important format in our changing world.

"Educate to Communicate" has always been the focus of the Student Research Symposium, and our mission to provide a forum for students to share knowledge with their peers, faculty, community, guests, and reviewers continues undeterred by the challenges an online platform presents. Perfecting our presentation is important and vital to the encouragement of others in science and engineering, and we look upon this shift in the structure of the Student Research Symposium as another opportunity for students to practice their presentation skills in a modern world.

In addition to the 3 Minute Speech Competition, oral presentations, and poster sessions which are the hallmarks of the Student Research Symposium, we are introducing a new category this year: Departmental Showcases. These events will allow the various departments of New Mexico Tech to demonstrate the knowledge and research of their students as well as highlighting the hard work and stellar education that takes place at this institution.

I hope you enjoy the information imparted at this year's Student Research Symposium. I also hope you ask presenters questions that deepen your knowledge of the research offered, and seek understanding through the presenter. By doing this, you help the presenter communicate to educate. You also help our world, which needs such powerful engineers, botanists, chemists, computer programmers and technical writers. And, perhaps, you will find a place where you can become excited about science, and learn to present complex ideas with clarity and care.

David E. Cox
Director, Skeen Library and Office of Student Learning (OSL)

EVENT SCHEDULE

Wednesday, April 14th - Friday, April 16th

Wednesday, April 14th

10:00 AM - 12:00 PM: POSTER SESSION 1

1:00 PM - 3:00 PM: BIOMEDICAL SCIENCES SHOWCASE

1:00 PM - 3:00 PM: POSTER SESSION 2

2:30 PM - 4:30 PM: CIVIL & ENVIRONMENTAL ENGINEERING SHOWCASE

5:30 PM - 8:00 PM: ORAL PRESENTATIONS

Thursday, April 15th

10:00 AM - 12:00 PM: POSTER SESSION 3

1:00 PM - 4:00 PM: COMPUTER SCIENCE SHOWCASE

1:00 PM - 5:00 PM: 3 MINUTE SPEECH COMPETITION

Friday, April 16th

9:00 AM - 12:00 PM: TECHNICAL COMMUNICATIONS SHOWCASE

10:00 AM - 12:00 PM: CHEMICAL ENGINEERING: JUNIOR DESIGN SHOWCASE

10:00 AM - 12:00 PM: POSTER SESSION 4

12:00 PM - 2:00 PM: CHEMISTRY SHOWCASE

1:00 PM - 3:00 PM: MECHANICAL ENGINEERING SHOWCASE

1:00 PM - 3:30 PM: CHEMICAL ENGINEERING: SENIOR DESIGN SHOWCASE

2:30 PM - 4:30 PM: MATERIALS ENGINEERING SHOWCASE

POSTER SESSION 1

Wednesday, April 14th, 10:00 AM - 12:00 PM

SRS2021-114 - Ai-Based Damage Assessment Of Buildings After Earthquakes Using Drones

PRESENTER(S): Hamed Momeni
RESEARCH ADVISOR: Dr. Arvin Ebrahimkhanlou

One of the most important tasks after extreme events like earthquakes is evaluating the buildings. This step should be immediately performed to find safe places for immediate occupancy. The existing conventional procedures may take long a few days. Experts commonly perform this procedure visually, walking through streets and evaluate the safety of buildings one-by-one. This study investigates an AI-based methodology to evaluate the structures after the earthquake. First, the regional satellite images are evaluated and compared with previous images from the normal situation. As the initial analysis, buildings are compared with their overall shapes, which are cuboids. Any variation from the cuboid can be interpreted as damage. The buildings that are initially tagged as safe are nominated for further assessment. To this aim, drones are employed and facilitated with high-resolution cameras to stream video. These drones are jointed with an embedded processor to analyze the streaming video. A real-time processing method is developed to simultaneously analyze the videos and control the following maneuvers of the drone. In case the system needs more details, the drone approaches the building to collect higher resolution videos. The embedded processor extracts the crack patterns, and further analysis is performed to assess the extent of the damage. This research focuses on real-time video processing to capture the best dataset and rapidly assess the safety of buildings.

SRS2021-118 - Analysis of Copper Mining Accidents in the United States, 2010-2019

PRESENTER(S): Joaquin Roibal, Braci Chester, Carlha Barreto, Julienne Mamaita Essomba
RESEARCH ADVISOR: Dr. Pedram Roghanchi

Mining is an imperative industrial activity which utilizes heavy machinery and hazardous environments. An increased demand for Electric Vehicles is increasing demand for copper, therefore it is important to study the safety of miners by looking at historical data. The federal agency, Mine Safety and Health Administration (MSHA) was created in order to reduce injuries and maintain a database of workplace injuries and fatalities. MSHA administers provisions of the Federal Mine and Health Safety Act of 1977 to enforce compliance and regulations for mine sites and industry throughout the United States. For this research project, MSHA data of reported injuries will be analyzed to discover trends in safety accidents in copper mining in the United States for the years of 2010-2019. The MSHA database of accidents and injuries will be analyzed according to age, mine experience, geographical location and other variables. Our research determined that the vast number of injuries occurred to miners with less than 5 years of mining experience and resulted in 0 days lost for their work injuries. Miners were split up into three categories: less than 5 years of experience, 5-10 years of experience, and greater than 10 years of experience in order to make a recommendation for safety training of both new and experienced miners. A baseline rate of injury was developed per thousand metric ton of copper mined which can be used to gauge mine safety health practices in the future.

SRS2021-123 - Mitochondrial Genome Architecture and Recombination in a New Zealand Freshwater Snail

PRESENTER(S): Emily Cook
RESEARCH ADVISOR: Dr. Joel Sharbrough

Several bioinformatic techniques and software are used to analyze Potamo estaurarinus mtDNA and inform observations. Mitochondrial genomes in mollusks are highly variable in both structure and nucleotide sequence. Recently, we have discovered the presence of a unique genome structure, an inverted repeat, within the mitochondrial genomes of a pair of New Zealand freshwater snails. Because these inverted repeats are difficult to sequence properly, it is necessary to carefully assemble these genomic structures using complementary datasets. We have taken advantage of short-and-long read DNA sequencing technologies to confirm the presence and nature of the inverted repeats, and have annotated those assemblies using bioinformatic tools like tRNAscan SE and MITOS. We also documented extensive variation in terms of tRNA secondary structure, even between two closely related species. In sum, the assemblies we have produced and validated provide a unique and novel genomic architecture to the molluscan library of mitochondrial DNAs, indicating that structural variation and recombination are rampant in mitochondrial genomes. In contrast to most other eukaryotes, these snails appear to exhibit some degree of biparental inheritance, and as such the use of long-read DNA sequencing technologies is a critical piece of data for assembling such complicated genomes.

SRS2021-128 - Pulsed Laser Diode Driver for Langmuir Laboratory

PRESENTER(S): Ethan Wade, Torin Sammeth, Enrique Najera, Dakota Marquez, Erik Fredrickson
RESEARCH ADVISOR: Dr. Anders Jorgensen

A team of students in NMT's electrical engineering department have been tasked with the development of one pulsed laser diode driver as their senior design project. The driver will deliver controlled pulses of power to a laser diode emitting a certain wavelength of light, while keeping both overall power consumption and physical size to a minimum. The team has been working to implement a solution in the form of a printed circuit board (PCB) that meets timing, hardware, and physical requirements for this project. At this time, the project is ongoing. The team is presenting their project at the Student Research Symposium to discuss their project and their progress in detail.

SRS2021-141 - Data-Constrained Simulations of Lightning Impacts

PRESENTER(S): Michael Taylor
RESEARCH ADVISOR: Dr. Caitano DaSilva

Lighting channels are some of the most difficult phenomena on earth to model. They are unpredictable, violent, and last for only a short period of time. On top of that, lightning strikes and their properties are controlled by a variety of complex equations that require expertise in physics to properly use. In this project, we put three different initial conditions of the lightning channel through a parametric study to determine the accuracy of three different variations of a physics-based model that was created by my research advisor. What we found was that the model is able to loosely reproduce the findings in the data. While the data was not able to be fully reproduced, the simulation is on the right track and only small adjustments need to be made in a future study.

SRS2021-158 - Effects of Physiological Deficits in Pineal Melatonin on Triple Negative Breast Cancer

PRESENTER(S): Primal D. Silva, Ankita Schwarting, Jonnie Woody, Stewart Thompson
RESEARCH ADVISOR: Dr. Stewart Thompson

Background. Triple negative breast cancer (TNBC) is aggressive and treatment resistant. Deficits in melatonin signaling appear to increase TNBC risk: conditions that suppress melatonin increase incidence of TNBC, low melatonin receptor expression correlates with worse prognosis, and high-dose melatonin can inhibit TNBC. Together this suggests that normalizing pineal melatonin could reduce TNBC incidence and/or mortality. Our goal was to determine whether small physiological deficits in melatonin affect TNBC. Methods. The effect of melatonin on 4t1 TNBC cells was measured in vitro and after grafting into mice with intact pineal, or the pineal gland removed. Results. Melatonin had no effect on cell viability or invasion, but did change gene expression, significantly reducing PAM50 Risk of Recurrence score ($P = 0.008$). However, a ~50% reduction in plasma melatonin with pineal removal had no effect on tumor formation or metastasis. Conclusions. Physiological deficits in melatonin do alter the oncogenic status of 4t1 tumor cells but this has only a limited effect on growth and metastasis of a fully developed and aggressive TNBC in vivo. It is possible that any protective effect of melatonin occurs earlier in tumor development than we have tested.

SRS2021-166 - Analytical and Observational Investigation of Colors Effects on Drag Reduction in Penguins

PRESENTER(S): Grace Tenorio
RESEARCH ADVISOR: Dr. Mostafa Hassanalian

All 18 extant species of penguin are strongly countershaded, having dark dorsal and light ventral coloration. In this paper, the thermal effects of this body color in penguins are investigated through analytical and observational analyses. First, a thermal analysis that takes into account the environmental characteristics of penguins' habitats, fluxes and morphology is used to analytically calculate penguin dorsal surface temperature. Next, a turbulent analytical solution for a heated boundary layer over a flat plate is applied to show that the dark color on the top of the penguins' bodies is very effective at skin drag reduction. To verify this result, a 2D model penguin is computationally analyzed at different temperatures, confirming in principle underwater skin drag reduction through color-based surface warming with efficiency savings of up to 30%. Finally, to study how color-based increases in body surface temperatures are maintained through foraging dives, thermal cameras are used to measure the surface temperature of captive penguins before and after dives. This study shows conceptually that dark dorsal coloration in penguins could have a significant influence on in-water drag.

SRS2021-167 - Conceptual Design of a Fueling Mechanism for a UAV with Dynamic Soaring Capability for Titan Exploration

PRESENTER(S): Micaela Olivas, Mariah Gammill
RESEARCH ADVISOR: Dr. Mostafa Hassanalian

The implementation of unmanned aerial vehicles in space exploration has opened new possibilities for exploring planetary bodies more thoroughly than ever before. Space drones have the ability to research both the surface and atmosphere of planets and moons, an undertaking that has yet to be fully accomplished and tested in previous space exploration vehicles. While drones are capable of providing revolutionary data collection within space, the most complex objective is to keep the drones powered as long as possible to support a lengthy data collection mission. With this in mind, a novel idea for fueling a drone on Saturn's moon, Titan, has been devised. Titan is widely known for its vast liquid methane lakes covering over 300,000 miles of the moon's surface. An inspiring new fueling design based on the collection systems of water sampling drones will allow a drone to perform continuous flight around the moon. A fixed-wing drone will use propulsion from the combustion of oxygen and the liquid methane obtained from Titan's lakes to launch itself into the atmosphere. The fueling mechanism utilizes a pump, pipes, filters, and storage chambers to extract, separate, and combust the liquid methane from the moon's lakes with oxygen.

SRS2021-169 - How Light and Heat Affect the Removability of a Reversible Epoxy

PRESENTER(S): Nicole Penners, Samantha Lindholm
RESEARCH ADVISOR: Dr. Youngmin Lee

Epoxies are commonly used as adhesives; unfortunately due to their network structure epoxies are not normally recyclable. To address this reversible group were integrated into the epoxy structure. The reversible epoxy was synthesized using a Diels Alder reaction between furfuryl glycidyl ether and 1, 1'-(Methylenedi-4,1-phenylene) bismaleimide. The reverse Diels Alder reaction was characterized using FT-IR and DSC. The reverse reaction occurred around 110°C. The removability of the reversible epoxy was examined and compared to a regular epoxy resin. The reverse Diels Alder reaction was triggered by heat or light using photothermal nanoparticles. The reversible epoxy was not removable at 100°C but it was removable at 140°C using a strain above 70kN/m^2. The regular epoxy was not removable at 140°C with a strain above 70kN/m^2.

SRS2021-171 - Pre-eruptive Conditions for Rhyolitic Miocene Volcanism in the Socorro-Magdalena, New Mexico area and its Connection to La Jencia Basin Sediments

PRESENTER(S): Kiersten Hottendorf
RESEARCH ADVISOR: Dr. Laura Waters

In a pilot study to understand how sedimentation and burial may affect volcanic plumbing systems, we investigate field relationships between rhyolite deposits and sediments (Popotosa Formation) in the La Jencia Basin. We document the periodicity of ash layers interbedded with basin sediments and sampled tuffs to see the mineralogy of the deposits. The ash layers are all microporphritic and saturated in quartz, plagioclase, sanidine, and a significant amount of biotite; sample modes are most consistent with rhyolites sourced from Squaw Peak. We applied a zircon saturation thermometer to the whole rock chemistry and a hygrometer to plagioclase compositions to obtain pre-eruptive temperatures (687-828°C) and H2O contents (5-8 wt%) of the Squaw Peak rhyolites, which correspond to pressures of 140-300 MPa (~4-9 km) based on a solubility model. The source of the Squaw Peak rhyolites is outside of the La Jencia basin perimeter, thus the field area is not likely to elucidate relationships between sedimentation and pre-eruptive storage conditions. We compare pre-eruptive storage conditions of Squaw Peak rhyolites to those of other Miocene rhyolites in the Socorro-Magdalena area. Rhyolites in the region have pre-eruptive temperatures that are commonly

SRS2021-173 - MD Simulations of Solid-Liquid Interface of Alloys for Additive Manufacturing

PRESENTER(S): Danielsen Moreno
RESEARCH ADVISOR: Dr. Pabitra Choudhury

Additive manufacturing is a way of 3D printing metal alloys layer by layer into usable objects. The goal of this project is to study the solid-liquid interface of an aluminum-zirconium alloy. Additive manufacturing works is by using powdered metals homogeneously mixed in a bed where a high-powered laser melts the metal, quickly solidifying. During solidification different crystalline structures can form, changing the qualities of the alloy, making it susceptible to cracking. In order to understand the solidification process and crystalline structure, simulations in supercomputers calculate the properties at the solid-liquid interface. These experiments are done using supercomputer virtual simulations because the properties being sought out is difficult to quantify in a lab, performing the experiments in person. Using molecular dynamics simulations to run these experiments save time and money for reliable results. We hypothesize that we can create a super alloy metal that is light weight and strong through additive manufacturing to be used in industry. However, the microstructure of the alloy affects the macro characteristics. So, this project studies the microstructure at the solid-liquid interface to understand the macro qualities of the metal alloy.

POSTER SESSION 2

Wednesday, April 14th, 1:00 PM - 3:00 PM

SRS2021-106 - Wireless Communication of mmWave Sensors

PRESENTER(S): Ian Hayhurst, Julianna Khenaisser, Jordan Zayas, Diego Chavez, Mateo Gabaldon
RESEARCH ADVISOR: Dr. Sihua Shao

Presently, the Care Companion consists of a single millimeter-wave sensor from Texas Instruments connected to a single board computer which analyzes the data from this sensor to detect falls and track the user's location, in order to compute an assessment of the user's health. In particular, it registers locations like the bed, bathroom, and kitchen as a hallmark of the user's wellbeing. The goal of this project is to find a way to create a wireless network to facilitate communication between multiple wireless sensors over Bluetooth. This will extend autonomous fall detection capabilities throughout a home, which will be useful for elderly people. Additionally, it will reduce the cost of installation and the invasiveness of the system in the user's home. This project will use CC2640R2 development boards from Texas Instruments to implement wireless communication. These boards feature a programmable microcontroller and additional hardware for Bluetooth communication. The network will use a star topology, with one central collector node. This collector node will contain the single board computer previously described.

SRS2021-111 - Antibiotic Resistance Genes and Bacterial Community Analysis in the Socorro, NM, Wastewater Treatment Plant and Surrounding Environment

PRESENTER(S): Angelica Cave
RESEARCH ADVISOR: Dr. Linda DeVeaux

β-lactam antibiotics are some of the most prescribed antibiotics in the US. These drugs can be degraded by bacterial enzymes called β-lactamases. Extended-spectrum β-lactamases (ESBLs) are able to degrade many types of β-lactam antibiotics, including carbapenems, known as drugs of last resort. The bacteria which produce ESBLs and the genes that encode ESBLs are thought to get into the environment and circulate back into the clinic through wastewater treatment plants (WWTPs). For this project, the presence of 7 ESBL genes (blaNDM, blaIMP, blaVIM, blaOXA-48, blaKPC, blaSPM, and blaGES), 5 of which are actively tracked in the clinic, and β-lactam-resistant bacteria were evaluated at three sampling sites within the Socorro, NM, WWTP (raw sewage, aerobic digester, and treated wastewater) and two environmental sites upstream and downstream from the WWTP. Next, the isolation of bacteria resistant to Meropenem (a carbapenem-class antibiotic) was attempted for each sample. Finally, the taxonomic composition of the bacterial community for each sample was determined using 16S rDNA sequencing. Of the 7 genes, 5 were detected: blaIMP, blaVIM, blaOXA-48, blaKPC, and blaGES (4 of which were the clinically-tracked genes) in various samples, but all of these genes were detected in the treated wastewater. Meropenem-resistant bacteria were isolated from both raw sewage and treated wastewater, however, none of the target genes in this study were detected in those isolates. The taxonomic study showed significant changes in the bacterial community composition between the raw sewage and treated wastewater, with a shift toward bacteria that are more likely to produce ESBLs.

SRS2021-112 - Exploring Surface Water as the Reservoir of CRE Infecting Patients in SE New Mexico

PRESENTER(S): Kasandra Verlarde
RESEARCH ADVISOR: Dr. Linda DeVeaux

Antibiotic-resistant infections are a worldwide threat and have risen because of the complex community networks humans have formed throughout the years. This interconnection between humans and their environment, such as prolonged hospital stays, has caused treating antibiotic-resistant infections increasingly difficult, even ones that were formerly treatable. Once antibiotic resistance is established in a pathogen population, human activities can lead to the transfer of antibiotic resistance genes (ARGs) throughout the environment, including reservoirs such as surface waters. Recently, four cases of CRE (carbapenem-resistant Enterobacteriaceae), an emerging antibiotic resistant infection, have been found in 3 adjacent counties of SE New Mexico. The New Mexico Department of Health could find no identifiable health-care source; the only commonality was the Pecos River that traverses these counties. We sampled river water at five different locations in the affected counties, and screened the bacterial population for the presence of CRE-related genes, particularly the VIM gene common to the four patients. We found the presence of four carbapenem-resistance genes within four out of the five different bacterial communities. VIM was one of the genes present and was only detected in sample site four. Others, such as OXA-48, NDM, and GES were also present within the community. Sample site two did not harbor any of the carbapenem-resistance genes. These findings could help unveil the role the environment plays as a reservoir for antibiotic resistance and give insight on the evolution of emerging pathogens in surface water to predict and control potential outbreaks.

SRS2021-129 - Ancient Agricultural Techniques: The Effect of Lithic Mulch on Soil Moisture Retention

PRESENTER(S): Kathryn Bosley, Sharon Tiernan, Rodrigo Zapata, Daniel Runyan, David Pfender
RESEARCH ADVISOR: Dr. Bruce Harrison

The Anasazi people of New Mexico pioneered lithic mulching—the application of stones to facilitate soil moisture retention in arid farming systems. Given water scarcity in arid climates, mulching allowed Native Americans to farm in otherwise unproductive areas. The ratios of sand, silt, and clay in soils determine the manner in which water will be absorbed into the ground, becoming available for vegetation. Fine soils composed of silts and clays excel at retaining water, but allow excess precipitation to run off. Coarse sandy soils absorb water quickly, but lose it just as fast. This experiment will explore the differences in water retention of these soil types and the impact of lithic mulch when applied to them. Another challenge to desert agriculture is the unrelenting heat, which evaporates water from the soil and overheats crops. Lithic mulch has the potential to both stall evaporation and reduce soil temperatures by acting as a layer of insulation. In theory, the application of lithic mulch to a garden would reduce heat and water stress on plants, allowing for fewer waterings and healthier crops. We will present soil moisture and temperature data to quantify the effectiveness of this method. The temperature and moisture data of the mulched plots will be compared to adjacent unmulched plots, and selective periodic waterings will be implemented to further distinguish the mulch's effectiveness. These findings will help to determine whether or not this recreation of an ancient technique still holds value in agricultural applications.

SRS2021-130 - Characterization and Host Determination of Four Novel Phages for Potential Use in Phage Therapy

PRESENTER(S): Katherine Persinger, Hannah Lamberston, Casia Esparza, Robin Gomez, Leandra Patterson

RESEARCH ADVISOR: Dr. Linda DeVeaux

The overuse and misuse of antibiotics worldwide have resulted in a decrease in efficacy of drugs used to counter bacterial infections. Once easily treated infections now pose a greater risk to human health as the bacteria responsible become resistant to antibiotic treatment. To curb the threat of antibiotic-resistant pathogens, new drug therapies and expanded public attention are increasingly necessary. The bacterium Pseudomonas aeruginosa has been classified by the CDC as a serious threat in their Antibiotic Resistance Threats Report. Multidrug-resistant P.aeruginosa can often cause nosocomial infections and is easily spread to those with cystic fibrosis or severe burns P.aeruginosa produces biofilms that provide the bacteria extensive protection and defense from environmental challenges through properties of the extracellular matrix, such as stress-resistance. Bacteriophages, viruses that target bacteria, have been shown to penetrate and disrupt biofilms. The potential phages have demonstrated against bacterial biofilms suggest that they may be an ideal mechanism for their eradication. The combination of phages, also called a phage-cocktail, may be an effective tool against multidrug-resistant pathogens in a strategy known as phage therapy. However, phages must be characterized before therapeutic application so that phages used are specific to an individual bacterial infection. Here we characterize and determine the host range of four novel phages for their potential inclusion in phage banks. Four novel lytic phages were isolated from sewage and host ranges tested using a CDC panel of antibiotic-resistant P.aeruginosa strains. About 58% of the strains tested were susceptible to infection via two of the novel phages.

SRS2021-136 - Incorporating Titanium Nitride Nanoparticles into Sol-Gel Glass

PRESENTER(S): Idalis Hernandez

RESEARCH ADVISOR: Dr. Sanchari Chowdhury

Alternative plasmonic titanium nitride nanoparticles (TiN) are attractive photothermal agents because of their ability to strongly absorb a broad spectrum of light ranging from visible to near infrared and convert that into heat. Additional advantages of low cost and stability of these refractory nanomaterials make them attractive for different applications ranging from photothermal cancer therapy, to solar energy mediated catalytic reactions. In this work we are developing a method to obtain a stable and monodispersed TiN nanoparticle solutions, which is an important prerequisite for most of their applications. Our main goal it to optimize a sol-gel solution that will successfully encapsulate stable and monodispersed TiN nanoparticles. We are optimizing the drying process of the sol-gel to obtain a uniform well dispersed stable glass or thin film. However, preventing the cracking of the sol-gel has been a challenge. The use of a drying chemical control additive (DCCA) dimethylformamide (DMF) has proven to help the drying process. TiN nanoparticle sol-gel glass can be used for solar thermal and photovoltaic cell applications.

SRS2021-147 - IoT Power Sensor and Predictive Data Characterization

PRESENTER(S): Joshua Ward, Zia Dhawan, Nathan Reynolds, Samuel Herrick, Macleod Adams
RESEARCH ADVISOR: Dr. Rene Arechiga

Power meters are fundamental to the design and performance of modern buildings and sustainability efforts. It is often difficult to determine the changes resulting from the upgrade, replacement, or removal of a particular device from the entire system. Utilizing an IoT power to determine power consumption and the characteristics of either the entire system or a particular connected device allows for faster resolutions of the net improvement, or lack-thereof achieved by changing a device, as well as monitoring the efficiency of either an individual device or the entire system. Usage of this IoT power meter could potentially facilitate prediction of imminent failures due to heat, age, or wear on the device or system. A literature review of existing IoT power tracking methodologies will be conducted to explore the optimal solution to implement a design capable of determining the power usage of a house or building. Following this, a design will be developed, implemented, and tested to determine viability of the design for wider use. The design will be tested by comparing it to the existing power monitoring devices in use around the NMT Workman Center. Additionally, the device will be capable of using the MQTT messaging protocol to transmit data to a Kafka based system for analysis, and will be easily portable. The design will be considered complete when the device is capable of interfacing with the existing Raspberry Pi IoT hubs used by ICASA and is capable of characterizing the gathered data to allow for predictive maintenance.

SRS2021-148 - Bio-inspired Drone Recovery Systems

PRESENTER(S): James Montoya
RESEARCH ADVISOR: Dr. Mostafa Hassanalian

As drones become more and more integrated into everyday life, the need for systems to recover crashed drones becomes apparent. One system that is particularly promising is the use of drones for the recovery of crashed drones. Drones show particular promise in this area due to the following reasons: they can reach areas that are difficult for people to get to, they can be used to recover drones crashed in dangerous environments, and they can be deployed quickly. A major aspect of any drone recovery system is the mechanism used for attaching to a downed drone; by studying how predators grip their prey, several methods for attaching to downed drones can be derived. Methods that predators use to grab their prey can be divided into six major categories; these are: gripping via feet, hand, or claw; gripping via mouth, bill, or beak; gripping via body; gripping via tongue; gripping via arm; and gripping via suction cup. Examples of interest for this study from the six categories include: eagle talons, pelican bills, snake bodies, frog tongues, praying mantis arms, and octopus suckers. From the study of these animals, several bio-inspired gripping systems can be designed for use on a variety of different drone configurations.

SRS2021-161 - Fabrication of a Remote-Controlled Combat Robot and Creation of a Digital Display for a Battlebot Arena

PRESENTER(S): Mason Kasprowicz
RESEARCH ADVISOR: Dr. Curtis O'Malley

To develop a streamlined combat robot design, a configuration was devised around a hobby-grade radio which would control a simple differential steering system involving a LN298 motor driver and two DC motors. The challenge was to integrate the components despite their incompatabilities while minimizing complication. In studying the system, it was found that the radio receiver outputs a standard Pulse Width Modulation (PWM) signal from each channel. However, these inputs cannot be combined in their raw form to produce any meaningful movement, requiring the implementation of an Arduino conversion system. The Arduino must fullfill three purposes: decoding the PWM signal of each channel into standard remote control values, mixing the steering and throttle channels for us in differential steering, and redefining the values back into PWM signals applicable to the LN298 driver. Developing the code to accomplish these tasks required substantial amounts of logic work, tuning, and some basic algebraic calculations. In accordance with the SPARC guidlines, a combat arena must have a system capable of conveying certain information to participants, officials, and spectators. It was theorized that an Arduuino-based display with seven segment digits and indicator lights could display all required countdowns with warnings. This was accomplished by linking each countdown value to an input signal from a particular push button. After developing the time code, functions were integrated into the loops which transmitted the time into signals to display the relevant numbers on the digits. Logical statements had to be developed for pausing, resetting, and switching between tasks.

SRS2021-162 - Potential Applications and Integration of Ground Effects on Amphibious Drones: Shearwaters and Bioinspiration

PRESENTER(S): Brenden Herkenhoff
RESEARCH ADVISOR: Dr. Mostafa Hassanalian

Biomimicry has often been one of the greatest inspirations within modern engineering. Animals have had millennia to adapt and evolve, ever-improving the efficiency of their movements and actions as for them, and it could be the difference between survival and death. In general, people often observe nature with a tendency to take information at face value rather than asking themselves why an animal would do that. It is this question that has led to the development and understanding of new technologies and techniques of operation among many industries. One particular area of interest regarding this notion is aerodynamics. When viewing the flight of large birds, particularly those with high aspect ratio wings, or wide narrow wings, it becomes increasingly apparent they often fly as close to the surface as possible. As previously mentioned, this presents the opportunity to ask why these birds repeatedly undertake what seems like such a difficult action in comparison to flying higher. The ground effect comes into play when a bird flys above a surface no higher than its wingspan, and becomes more apparent the closer to the surface flight occurs This phenomenon is a powerful energy-saving technique and one that could be implemented in autonomous drone system, especially those operating in an aquatic environment such as above an ocean. The use of this technique could greatly improve the mission duration of a drone by cutting its power consumption during flight between points of interest and will be explored in this work.

SRS2021-165 - Cybersecurity Topic Classification Using Community Labelled Internet Text Sources

PRESENTER(S): Elijah Pelofske

RESEARCH ADVISOR: Dr. Lorie Liebrock

Supervised machine learning requires a large amount of labelled data, and the process of manually labelling data is time consuming and costly. In this research, we investigate using community defined, or system defined, labels that already exist in different discussion forums as an efficient but noisy means of gathering large amounts of tagged data for supervised topic classification of text. The topic classification task we consider is classifying text as either cybersecurity related, or not cyber security related. This is an important task for analyzing potential cyber threats in different internet discussion mediums. We gather large amounts of text from various internet sources including Reddit, Arxiv, and Stackexchange. The documents are preprocessed and vectorized so they are suitable for input to machine learning classifiers. Various different classifiers are then trained on this text including deep neural networks. We present a scalable cybersecurity topic classification filtering system that comprises several trained machine learning models.

POSTER SESSION 3

Thursday, April 15th, 10:00 AM - 12:00 PM

SRS2021-101 - Guided Wave-Based System for Cure Monitoring of Composites Using Piezoelectric Discs and Fiber Bragg Gratings (FBGs) of Formula One Vehicles

PRESENTER(S): Grace Tenorio, Marco Lozoya, Justus Engstrom, Isaac Edelman
RESEARCH ADVISOR: Dr. Frank Reinow

Carbon fiber reinforced polymer (CFRP) composites are used as structural components in the aircraft and automotive industry. The use and application of CFRP composites are extensive and growing quickly. A classic example is sports cars such as the Bugatti Veyron of which the entire monocoque is constructed from CFRPs. CFRPs are also in commercial cars such as the BMW i3, an electric car, whose internal structure and body are made from CFRP. As the use of CFRP rapidly increases, quality control is critical and the need to detect defects by monitoring the cure rate is of utmost importance. At NASA Langley, a curing monitor system that measured guided waves through fiber optic sensors was developed making life-cycle monitoring a possibility through the embedment of optical fibers in composites during curing. Using the guided wave-based system for cure monitoring of composites using piezoelectric discs and fiber Bragg gratings (FBGs) in Formula One and in-time commercial vehicles is a particularly significant application as monocoques are used as the main aerodynamic and structural components of the designs they are used in. The ability to monitor them in-situ with the Modular CFRP Sensing System (MCSS) would yield great cost savings and increase the safety of the designs..

SRS2021-105 - A study of Abandoned Mine Lands in New Mexico

PRESENTER(S): Nicholas Harrison
RESEARCH ADVISOR: Dr. Virginia McLemore

Abandoned mine lands (AML) are sites that were mined and left unreclaimed where no individual or company has reclamation responsibility and there is no closure plan in effect. AML sites such as these can pose significant environmental and safety risks. The New Mexico Bureau of Geology and Mineral Resources and the Mineral Engineering Department at New Mexico Tech are conducting research to develop a better procedure to inventory and characterize legacy, inactive, or abandoned mine features in New Mexico. The object of this study was to inventory a number of abandoned mine features in several mining districts throughout New Mexico. Specifically, we wanted to determine whether there was a correlation between the minerals mined at AML sites and their risk of environmental hazard. This inventory was conducted by means of recording field observations according to the procedure already used by the program, soil petrography of composite dump samples, and paste pH analysis of said samples. A field inventory form was designed to collect data on all mine features during the field examination, which were later entered into the New Mexico Mines Database. Composite dump samples were collected and subjected to soil petrography, paste pH analysis, and geochemical testing, for evaluation of major and trace elements. We found that AML sites that have higher concentrations of pyrite are more likely to have a higher acid generation capacity. A few mine sites examined have the potential to generate acid drainage and additional mine sites are physically dangerous and require proper safeguarding.

SRS2021-109 - Investigating Mass Transfer in Symbiotic Stars using the CHARA Optical Interferometry Array

PRESENTER(S): Thomas Gaudin
RESEARCH ADVISOR: Dr. Ryan Norris

Symbiotic star systems are a type of interacting stellar binary in which a red giant star is closely orbited by a white dwarf (WD) or other compact object. These systems are characterized by a long orbital period, wide binary separation, and a dense circumstellar medium produced by mass transfer from giant to WD. The nature and mechanisms of mass transfer within symbiotic systems are currently poorly understood. Research suggests that the best way to test mass transfer models is to measure the Roche Lobe radius of the giant star using an optical interferometer. However, few studies have attempted these measurements and none have used CHARA. The high resolution of CHARA presents an opportunity to measure the geometry of symbiotic giants in unprecedented detail. In preparation for the observation of several symbiotic systems using the CHARA Optical Interferometer, we present the scientific case for our observations and the pre-observation modeling performed. Detailed imaging of the giant will be used to determine the Roche-filling factor of the giants and better constrain mass transfer present in the system.

SRS2021-124 - Mitochondrial Function Across Sexual and Asexual Lineages of a Freshwater Snail

PRESENTER(S): Cameron Steffensen
RESEARCH ADVISOR: Dr. Joel Sharbrough

Potamopyrgus antipodarum is a species of freshwater snail native to New Zealand that features co-existing sexual and asexual lineages within populations. This provides a unique opportunity to study how differences in mode of reproduction affect mitochondrial function, as direct comparisons of mitochondrial function across reproductive modes are possible. Asexual lineages are expected to accumulate deleterious mutations more rapidly than sexual lineage, and mitochondrial genomes of asexual P. antipodarum appear to harbor more harmful mutations than those of sexual lineages. This leads to the expectation that mitochondrial function is reduced in asexuals compared to sexuals but this has not been observed in the limited tests performed, indicating that we need to establish a better understanding of what controls mitochondrial function. We designed a series of reciprocal crosses from four New Zealand lakes to study how mitochondrial background impacts mitochondrial phenotype and function. The hybrids from this cross are expected to experience a decrease in mitochondrial function due to mito-nuclear incompatibilities amongst individuals from different lakes. To test this hypothesis, we optimized a series of mitochondrial functional assays including mitochondrial membrane potential, oxygen consumption rate under stress, ATP production, reactive oxygen species, and citrate activity assays. Together, these assays will be able to identify the extent to which mito-nuclear coevolution contributes to the maintenance of mitochondrial function in this emerging animal model for mitochondrial biology..

SRS2021-132 - Biomimetic and Bioinspired Anti-Predator Drones

PRESENTER(S): Savannah Bradley
RESEARCH ADVISOR: Dr. Mostafa Hassanalian

There are different approaches and mechanisms that animals are employing to avoid predators. In this research, the animals' anti-predator behaviors are discussed and considered as very efficient mechanisms to offer bio-inspired designs for anti-predator drones. This includes, autotomy, molting, camouflage, escaping, and playing dead. These mechanisms are applied by animals to avoid detection and to ward off an attack, fight back, and escape. Moreover, four stages to prey a drone, including detection, tracking, targeting, and attacking, are discussed, and bioinspired solutions have been proposed. These solutions allow for drones to complete their mission and ward off predators. This research can give some outlines for the future design of anti-predator drones.

SRS2021-134 - Developing the Atmospheric Dispersion Correctors for the Magdalena Ridge Observatory Interferometer

PRESENTER(S): Dana Mailani Neal
RESEARCH ADVISOR: Dr. Michelle Creech-Eakman

The Magdalena Ridge Observatory Interferometer (MROI) will consist of ten unit telescopes with baselines ranging from 7.8 to 340 meters and operating at wavelengths between 0.6 and 2.4 microns. As the MROI looks upward to the sky, it will be crucial to implement an atmospheric dispersion corrector (ADC) for each telescope to ensure that the observations taken will be pristine. Light traveling through Earth's lower atmosphere becomes dispersed by water vapour, which ultimately causes different wavelengths of light, also called color, to travel at different speeds. A small angular difference in position of different colors from the same object can lead to a large displacement of the rays after propagation from the MROI telescopes to the beam combiner. Concerns of beam displacements are crucial in order to preserve fringe visibility. Fringe tracking is utilized to stabilize interference fringes when an optical path difference is caused by atmospheric turbulence. The chosen solution to this challenge is to implement an ADC on each telescope. The ADCs for this project will be glass prisms that will correct light dispersion by counteracting the atmosphere's effect by means of realigning the different wavelengths of light to coincide. This project investigates the optimal glass type combinations and the glass geometry to effectively operate the MROI within its performance requirements.

SRS2021-140 - Effect of Surfactant on Saline Water Evaporation and Crystallization

PRESENTER(S): Teresa Trujillo
RESEARCH ADVISOR: Dr. Sanchari Chowdhury

In saline solutions, the separation of dissolved solids from solvent can be energy extensive and increase the operating cost of water treatment facilities. This is due to the presence of the dissolved solids decreasing the evaporation rate of solutions compared to pure water. The addition of surfactants has been seen to decrease the surface tension and subsequently the latent heat of vaporization which, when added to the produced water. When added to the produced water, surfactants could aid in reducing the energy requirement. This project focuses on how the evaporation rate and salt crystallization change in a saturated sodium chloride (NaCl) solution with the addition of the cationic surfactant cetyltrimethylammonium chloride (CTAC). This is done by adding two different concentrations of CTAC to a saturated NaCl solution and evaporating the water to induce crystallization. Two methods for evaporating water were utilized, the first being exposing the solutions to simulated solar light and the second being elevating the solution temperature via a dry bath. From these experiments it's seen that the addition of CTAC result in an increase in salt precipitation due to increased water removal but doesn't significantly affect the evaporation rate of solution. It can also be seen that the amount of time required to see crystals forming in solution is reduced with the addition of surfactant indicating an effect on the nucleation kinetics involving induction time.

SRS2021-152 - Investigations of Ozone Dynamics and Chemistry from Balloon Sounding Data

PRESENTER(S): Jhanene Heying-Melendrez
RESEARCH ADVISOR: Dr. Kenneth Minschwaner

Ozone, is an atmospheric gas that greatly affects the surface ultraviolet radiation, air quality, and climate. In the stratosphere, ozone is considered beneficial as it absorbs ultraviolet light from the sun which reduces the exposure of plants and animals to damaging ultraviolet radiation. Closer to the surface in the troposphere, ozone is detrimental to the environment because it is a strong oxidizer and can attack plant tissue and animal respiratory systems. Ozone is also a powerful greenhouse gas that contributes to global warming. Quantifying observed variations in ozone and potential temperature with altitude allows for the detection of ozone laminae (thin layered features), and thus aids in the identification of the mechanisms that produce or destroy ozone. Data from the National Oceanic and Atmospheric Administration (NOAA) balloon ozonesondes are used along with algorithms in Interactive Data Language (IDL) software to identify spatial patterns in laminar features of balloon soundings. Plots of the measurements taken via ozonesondes will be analyzed for NOAA stations at Boulder, Colorado, and Pago Pago, Samoa, to determine the relationships between ozone and potential temperature at different altitudes in the troposphere and stratosphere. Comparisons of ozone laminae detected at different stations and across different seasons will be presented. Analysis between different periods of time will be done to see if the data is indicative of correlations between seasonality and changing ozone laminae.

SRS2021-153 - Mitochondrial-Nuclear Genomic Stoichiometry in Diploid vs. Polyploid Snails

PRESENTER(S): Mya Martinez-Metzgar
RESEARCH ADVISOR: Dr. Joel Sharbrough

Whole genome duplication events (WGDs) are among the most profound mutational changes cells and organisms can endure, and most eukaryotes (including humans) have experienced one or more such events during their evolutionary history. While much work has investigated the immediate and evolutionary consequences of WGD for the nuclear genome, virtually nothing is known about the effects for the mitochondria, the other genomic compartment within the cell. Mitochondria are essential to eukaryotic energy production, and as a result of a history of gene transfers from the mitochondrial genome to the nuclear genome, the proteins that carry out energy production inside the mitochondria are encoded by two distinct and separately inherited genomes: the nuclear and mitochondrial genomes. Successful molecular interactions between the proteins encoded by these two genomes are therefore essential to eukaryotic health and fitness, and changes to one genomic compartment can have dramatic consequences for the other genomic compartment(s) of the cell.The cellular consequences of WGD tested will determine whether WGDs alter stoichiometric balance between the nuclear and mitochondrial genomes resulting in elevated mitochondrial genome copy numbers per cell. We used next-generation sequencing data to quantify the relative numbers of mitochondrial genomes in diploid vs. triploid. vs. tetraploid Potamopyrgus antipodarum, a New Zealand freshwater snail featuring extensive natural variation in nuclear genome copy number. This project provides the first information collected in an animal about how mitochondrial-nuclear stoichiometry varies in tandem with WGDs in the nuclear genome.

SRS2021-154 - Towards Physics-Based Modeling of the Lightning Return Stroke

PRESENTER(S): Jacob Wemhomer
RESEARCH ADVISOR: Dr. Caitano DaSilva

Despite lighting being one of the most widely-observed natural phenomena on Earth, its fundamental workings remain a mystery for researchers. A lightning strike consists of two parts: the leaders and the return stroke. The return stroke is the most noticeable part of the lightning strike because it ionizes the air, which changes the chemical composition of the nearby atmosphere and releases energy equivalent to one ton of TNT. Even the return stroke, the lightning strike's most widely studied component, remains to be fully described from first principles. Here we propose a model based on the telegrapher's equations, which describe the propagation of electromagnetic waves guided by transmission lines. We discuss how this model can be extended to probe the fundamental plasma physics of the lightning channel.

SRS2021-164 - Influence of Particle Size and Fabrication Parameters on Luminescence Properties of ZnS:Cu,Al Phosphors

PRESENTER(S): John Huckabee
RESEARCH ADVISOR: Dr. Nikolai Kalugin

Mechanoluminescence (ML) is the emission of light by a solid material when stressed or fractured.[2] Recent advancement in the technology has led to the discovery of the elastico-ML phenomenon, which is ML behavior that occurs in the elastic strain domain of the material.[1][2] the elastico-ML phenomenon is used in applications such as pressure sensing and stress monitoring where lower amounts of stress must be measured continuously.[1] ZnS:Cu,Al phosphors, when dispersed in a PDMS matrix, show potential as an elastico-ML compound.[2] In the interest of understanding the tunability of the emission properties of this material, a coprecipitation synthesis procedure was advanced to produce Cu and Al doped ZnS nanoparticles. By adjusting the initial concentrations of the reactants and the speed and duration of the grinding procedure, the effects of the dopant concentrations and particle size of the material were studied. The luminescence of the material was strongest when dopant ions occupied less than 0.075% of available lattice sites. Increasing the particle size was shown to improve the luminescence of the synthesized material, while reducing the size of commercial ZnS phosphors was shown to shorten the wavelength of the emitted light. Acknowledge: NASA EPSCOR program, grant #80NSSC17M0050.

SRS2021-168 - Private Well Installation Trends and Correlation of Borehole Stratigraphy with Groundwater Arsenic Contamination in Kandal Province, Cambodia

PRESENTER(S): Kelsey Romero
RESEARCH ADVISOR: Dr. Michael Schaefer

Arsenic (As) exposure via contaminated drinking water continues to threaten the health of people worldwide. Despite advances in the prediction of As contaminated groundwater and dissemination of the risks of As to human health, wells continue to be installed in regions with known groundwater contamination. In addition, manganese (Mn) exposure through drinking water poses health risks, and often occurs distinct from As contamination in groundwater. We collected stratigraphic data (texture and color) at 3 m depth resolution from >500 wells installed in and near a known As- and Mn-affected region in Kandal, Cambodia, between 2013-2015. Sediment stratigraphy combined with an existing database of groundwater quality shows trends in well installation in areas with known groundwater contamination following government and non-government (NGO) As education and awareness campaigns, providing insight on the effect of As awareness programs on new well installations in a known As-affected region. Further, by combining sediment stratigraphy with groundwater quality data, we also test spatial correlation between sediment color, aqueous redox indicators (e.g. Fe(II) and Eh), and groundwater quality (As, Mn). Our hypothesis was that red, orange, and yellow sediments at the screened interval would be proximal to groundwater low in As and with high (oxidizing) Eh. Conversely, wells screened in blue, black or grey sands would be proximal to higher As concentrations and lower Eh. By incorporating results of intensely studied transects and groundwater flow models in the area with a description of subsurface stratigraphy we test additional sedimentary controls on the distribution of high As groundwater.

POSTER SESSION 4

Friday, April 16th, 10:00 AM - 12:00 PM

SRS2021-102 - Helping Hands

PRESENTER(S): Tiffany Nelson, Ezra Montoya, Seth Sisneros, Patrick Duane, Bethany Gruenig
RESEARCH ADVISOR: Dr. Frank Reinow

Exoskeleton prosthetics have become an effective solution for those with low motor function in their hands. However, Multi-articulating prosthetics - that is prosthetics with multiple joints - tend to be very expensive. Commercialized, this type of technology is potentially beneficial for disabled or handicapped students and employees who require assistance to complete tasks for school and their jobs. But prosthetics in and of themselves are an incomplete solution, as they do not have any integration with remote services, such as wifi video calls. During the pandemic, education and work have become difficult since the majority of it has been by necessity conducted at a distance. A solution for these issues is to use a type of exoskeleton to improve the quality of education and work for those who have lower motor function. This technology would also be beneficial for hand rehabilitation when a physical therapy cannot be attended in person. This could also benefit kinesthetic learners who have had a lower quality education because of distance learning. NASA's Robogloves, designed for the space suit, could be adapted for use on earth to fill these needs. Developing a wireless control protocol linking one glove to another would give the glove greater versatility than the competition. Additionally, the sensors and actuators used in the Roboglove make it more robust than comparable prosthetics. These technologies combined will result in the Helping Hands: a new type of versatile prosthetic integrated with video calling.

SRS2021-108 - Princess Diana

PRESENTER(S): Tiffany Nelson, Joshua Gibbs, Daniel Chanez, Eric Sandoval, Trevor Fields
RESEARCH ADVISOR: Dr. Scott Teare

This team has been tasked by the project sponsor, Spectrohm, to develop a high bandwidth instrumentation amplifier to be integrated with their radio frequency (RF) imaging system. Instrumentation amplifiers are common devices used for isolating noise on differential signals. This amplifier must meet strict specifications, such as: low noise, low capacitance, and high precision differencing capabilities at ultra high frequencies (UHF). Performing this operation with high frequency signals is not as straightforward as using common operational amplifier circuits, and Spectrohm requires a cheaper and more tailored solution than commercially available instrumentation amplifiers. The final design to accomplish this task is the PRINCESS DIANA: the Perfectly Rugged, Ideal and Negligible Capacitance, Especially high frequency Specification, Small Dimension, Instrumentation Amplifier Now Affordable.

SRS2021-115 - Hacker Tracker

PRESENTER(S): Ezra Montoya, Alexander Evelo, Adrian Hernandez, Alexandro Gomez, Luke Pikaart
RESEARCH ADVISOR: Dr. Aly El-Osery

The primary concern that led to this project is the need to detect an individual transmitter with intent to harm or disable critical radio-based systems with signal spoofing or other transmissions. Detecting these attacks is a significant security concern for various reasons and uses in the modern world, especially given the easy access to SDRs(Software-Defined Radios). The project's overall result is to design and build an RF-based tracking system to track and follow malicious transmitters. The tracking system will consist of several identical setups, referred to as nodes, working together to locate a malicious transmitter with respect to time. These setups will consist of hardware and software developed to remain portable and easily carried (each node can easily fit in a backpack). The basic hardware setup will include a processing unit, an SDR channel for GNSS (Global Navigation Satellite System) location, and a separate SDR channel to measure signal strength along with the appropriate antennas. Software setup will include GPS/GNSS software (GNSS-SDR) which will determine the position of the node with concern to time. A GNU Radio flowgraph will sample and log the power of the malicious signal over time. The location and direction of the transmitter will be computed utilizing a multilateration algorithm based on these measurements.

SRS2021-125 - Recombination, Inheritance, and Structural Variation in Mitochondrial Genomes of a Freshwater Gastropod

PRESENTER(S): Bridie Alexander-Lawrie
RESEARCH ADVISOR: Dr. Joel Sharbrough

Mitochondria are widely believed to be strictly maternally inherited; however, deeper investigation in a variety of taxa has found evidence of leaky inheritance systems. Recently, we uncovered evidence of recombinant mitochondrial DNA molecules in a New Zealand freshwater snail, Potamoyprgus antipodarum, suggesting that mitochondrial inheritance may be at least partially biparental in this mollusk. To investigate this observation, we designed a series of crosses among P. antipodarum lineages with divergent mitochondrial DNA. We used long-read sequencing technology to sequence mitochondrial enriched DNA extractions from hybrid offspring of these crosses and tested whether mitochondrial inheritance is strictly maternal. We also documented the extent of structural variation and repeat-mediated recombination. All told, this study provides a rigorous test of maternal mitochondrial inheritance in an emerging animal model for mitochondrial biology.

SRS2021-126 - Evolutionary Dynamics of Rubisco in Allopolyploid Plants

PRESENTER(S): Catherine Batchelder
RESEARCH ADVISOR: Dr. Joel Sharbrough

Ribulose-1,5-bisphosphate carboxylase-oxygenase (Rubisco) is an enzyme found in plants that helps convert carbon dioxide into oxygen and complex sugars during photosynthesis. It is composed of two subunits that are encoded by two separate genomes: nuclear and chloroplast. The physical and chemical interactions between the nuclear-encoded rbcS subunit and the chloroplast-encoded rbcL subunit underlie sugar production in green plants. Improper interactions between the subunits could lead to unhealthy plants. The complex structure of Rubisco, in combination with a history of whole genome duplications, has caused the study of this enzyme to be challenging. However, using bioinformatics programs, I analyzed the rates and patterns of genetic evolution in Rubisco across a diverse set of crop species including wheat, cotton, coffee, tobacco, quinoa, peanuts and their wild relatives. My analyses focus on the copy number, rates of evolution, and recombinational processes across all six crop species to determine if there is evidence that whole genome duplications affect the interactions of the rbcS and rbcL subunits and by extension influence the overall function of Rubisco. Together, these analyses of the plants provide a comprehensive picture of the evolution of Rubisco.

SRS2021-143 - Energy Harvesting Mechanisms for Solar Power Plant Monitoring UAVs

PRESENTER(S): Mariah Gammill
RESEARCH ADVISOR: Dr. Mostafa Hassanalian

With the demand for renewable resources increasing, there has been an increase in demand for solar, wind, and other sustainable resources. Solar energy is one of the most used renewable energy sources worldwide and is increasing every day. The major advantage of solar panels is that they utilize the most abundant resource on Earth: the sun. Harvesting solar energy is often done through the use of solar photovoltaics (PVs). Solar photovoltaics are a technology that converts solar radiation into direct current electricity through the use of semiconductors. With a push for renewable technologies to combat climate change, the photovoltaic solar energy industry is expanding. Therefore, there is a growing interest in the design and implementation of sustained and integrated observing systems for solar power plants to improve their maintainability, availability, operating costs, reliability, and safety. Solar panels can experience a loss in efficiency due to ice, dust, dirt and other debris being deposited onto the panel. These defects result in a change of temperature on the surface of the solar panels. This presentation introduces a drone which is able to fly over large solar farms in order to monitor the condition of solar panels. In particular, the proposed UAV would be able to utilize thermals, caused by a heat island effect produced by solar farms, in order to save energy while performing its duties.

SRS2021-145 - Bioinspired Rolling Robot for Planetary Exploration

PRESENTER(S): Anastasia Western
RESEARCH ADVISOR: Dr. Mostafa Hassanalian

Land rovers have been operating for several decades for space exploration, recording a vast amount of data of atmospheric, geological, and environmental characteristics. The success of a rover's mission is weighted by its capability of withstanding the climate conditions on the targeted solar bodies and utilizing available energy resources. Rough terrain, obstacles, dust storms, and environmental conditions make it challenging for land rovers to explore the surface and cover large amounts of terrain. The main objective of this research is to design and build a team of wind-driven bioinspired small rovers with walking, rolling, and jumping capabilities for surface mapping, localization, geological and climate analysis of lava tubes and caves on different solar bodies. The lava tubes have been the subject of high interest and research, as they provide potential locations of human habitats on those solar bodies. This robot is a novel concept capable of undertaking a wide range of missions on many different bodies in our solar system. This robot can cover a wide area of land, expanding the regions explored by humans. The proposed robot will be designed, built, and tested in a variety of environments and simulations to optimize it and to ensure it will function outside of Earth. Traditional rovers move with the use of wheels or treads. Large obstacles are impossible to maneuver over. The proposed rover will be capable of jumping over these previously impassable objects and will be able to jump while rolling at high speeds for greater clearance.

SRS2021-156 - Boreas: Autonomous System for Drilling in Antarctica

PRESENTER(S): Sara Lanctot, Jessica Cooke, Trent Bjorkman, Eric Nunez, Liliana Figueroa, Brenden Herkenhoff

RESEARCH ADVISOR: Dr. Mostafa Hassanalian

Many studies in earth science begin by collecting various samples from various environments, and Geoscientists spend time traversing the world implementing sensors into the ground for optimal measurements. Some places, such as Antarctica's frozen desert, are inaccessible or hazardous to people making sensor positioning difficult and stunting valuable research. In response, the Boreas project implements autonomous deployment systems to improve efficiency and allow access to more challenging sites significantly. This system would combine Unmanned Aerial Vehicles (UAVs) and Unmanned Ground Vehicles (UGVs)1-3 to assist with geophysical research by having the ability to traverse hazardous terrain and the capability of boring4-5 into ice to install seismic sensors into the ground and later retrieve them. Boreas aims to install an IRIS PASSCAL seismic sensor into remote and inaccessible, extreme parts of Antarctica. This is to reduce cost and harm to the researchers on the base. A hole for the sensor (5Hz Magseis Fairfield ZLand 3C Nodes) can be drilled out in the ice using an auger, light lens, or heated tubing. Drone requirements include: * The ability to operate in Antarctica's severe environment with temperatures of up to -30□C and katabatic winds speeds of 100 km/h. * Drill a 4 in diameter 9 in a deep hole. * Safely install and retrieve the seismic sensors.

SRS2021-163 - Monitoring Artemis's Water Extraction Pipelines against Corrosion and Abrasion by Lunar Dust for Extended Habitation using Acoustic Emissions

PRESENTER(S): Mario Escarcega, Raechelle Sandoval, Meghan Cephus, Kimberly Kelso, Skyler Hughes, Nakii Tsosie

RESEARCH ADVISOR: Dr. Arvin Ebrahimkhanlou

This paper explores the use of acoustic-based structural health monitoring (SHM) in lunar habitats to detect damage and failure in aluminum pipelines used to carry resources across lunar habitats. Acoustic-based SHM on Earth is a well studied field of research. Various studies validate the effectiveness of acoustic-based SHM to detect, locate, and characterize damage in pipelines. To the authors' knowledge, little or no research has been conducted regarding simulated lunar pipelines. In this paper, AE waveforms were collected and analyzed for pipes obtaining damage from simulated lunar conditions. Experiments simulating lunar regolith abrasion, internal galvanic corrosion, and irradiation were conducted on aluminum pipes. Lunar pipelines were constantly exposed to radiation, abrasion, and corrosion, As such, it is important to manage the noise and damage resulting from these lunar hazards. The waveform data was clustered based on hit-driven and time-driven properties. Changes in the wave propagation throughout the tests were observed as clusters in the AE data. These waveform clusters can be used to filter out unnecessary noise and to detect corrosion and abrasion waveforms in real-time. Continually monitoring the AE of common corrosion and damage events using AE sensors will improve the ability to predict and prevent catastrophic pipeline failure.

SRS2021-170 - Measurement of the Density Field Around Supersonic Conical Projectiles Using Quantitative Schlieren Photography

PRESENTER(S): Jason Falls

RESEARCH ADVISOR: Dr. Michael Hargather

The density variation around supersonic projectiles is characterized through the use of quantitative high-speed schlieren photography. The projectiles were 10° half-angle sharp cones fired from a 0.50"-caliber (12.7mm-diameter) Browning Machine Gun barrel. The projectiles were imaged while traveling at approximately 700 m/s, Mach 2. A lens-based schlieren system with a high-speed digital camera recorded images which were used to obtain density fields via the quantitative schlieren calibration process. An inversion algorithm is used to obtain three-dimensional results for density variation from the two-dimensional schlieren projections assuming an axi-symmetric flow. Classical compressible aerodynamics solutions for conical projectiles is presented and used for comparison as a theoretical density profile. Agreement with theory is presented via a vertical line profile taken from the experimental density reconstruction. The experimentally measured density fields are within a 5% error of the theoretical density variation around the conical projectiles. Theoretical agreement with quantitative schlieren images is a validation of the method. The validated experimental methodology can be applied to more complicated flows in the future.

SRS2021-174 - Eruptive Rates of Quaternary Mafic Volcanism in Rio Grande Rift

PRESENTER(S): Ashley Torres

RESEARCH ADVISOR: Dr. Laura Waters

The rates at which magma leaves the Earth through volcanism and is emplaced in the Earth through plutonism is unknown and potentially variable across Earth's tectonic settings. In the Rio Grande Rift (RGR)– a continental rift system– the Earth's crust is pulled apart, allowing for magma to break through the weakened lithosphere and is the source of the widespread volcanic activity in New Mexico. To understand magmatic fluxes from the mantle in the RGR, we calculate volumes for twelve basaltic quaternary volcanic fields using GIS software. Volumes are calculated by subtracting reconstructed initial topography from the flow surface to extract a volume. Flow volumes from individual volcanic fields range from 0.2-46.4 km3 meaning that eruptive volumes increase through time. Eruptive rates, calculated using cumulative volumes of basalt and their eruptive ages, are relatively constant over the past 800 to 50 ky with a flux of 0.0125 km3/ky, but then increase to a flux of 1.1925 km3/ky ~50 kya to present . These eruptive fluxes provide a valuable dataset to determine the proportion of magma erupted from vs. emplaced within the RGR lithosphere. Geophysical and surface deformation studies of the Socorro Magma Body, a 27 kya partially molten 204-340 km3 magmatic system within the crust beneath Socorro, show that the magmatic flux feeding the body ranges between 7-12 km3/ky. These rates suggest that, for every unit of erupted basalt, approximately 5.9 to 10.1 times the amount of basalt is emplaced into the RGR crust.

ORAL PRESENTATIONS

Wednesday, April 14th, 5:30 PM - 8:00 PM

SRS2021-118 - Analysis of Copper Mining Accidents in the United States, 2010-2019

PRESENTER(S): Joaquin Roibal

RESEARCH ADVISOR: Dr. Pedram Roghanchi

Mining is an imperative industrial activity which utilizes heavy machinery and hazardous environments. An increased demand for Electric Vehicles is increasing demand for copper, therefore it is important to study the safety of miners by looking at historical data. The federal agency, Mine Safety and Health Administration (MSHA) was created in order to reduce injuries and maintain a database of workplace injuries and fatalities. MSHA administers provisions of the Federal Mine and Health Safety Act of 1977 to enforce compliance and regulations for mine sites and industry throughout the United States. For this research project, MSHA data of reported injuries will be analyzed to discover trends in safety accidents in copper mining in the United States for the years of 2010-2019. The MSHA database of accidents and injuries will be analyzed according to age, mine experience, geographical location and other variables. Our research determined that the vast number of injuries occurred to miners with less than 5 years of mining experience and resulted in 0 days lost for their work injuries. Miners were split up into three categories: less than 5 years of experience, 5-10 years of experience, and greater than 10 years of experience in order to make a recommendation for safety training of both new and experienced miners. A baseline rate of injury was developed per thousand metric ton of copper mined which can be used to gauge mine safety health practices in the future.

SRS2021-149 - Absorption Coefficient Measurements and their Relation to Air Quality and Climate Change: Intercomparison of a Photometer and Aethalometer

PRESENTER(S): Charlotte Dungan

RESEARCH ADVISOR: Dr. Christian Carrico

Atmospheric aerosols (suspensions of particles) derive from multiple human and natural sources. They contribute to climate change by alternately enhancing or masking greenhouse gas warming depending on aerosol properties. Aerosols' effect on climate is currently the single largest physical uncertainty in climate modeling efforts as it ultimately impacts cloud feedbacks. Aerosol absorption is the dissipation of radiant energy as it passes through a particle resulting in the heating of the particle and surrounding air. Based on the refractive index, a particle will absorb, reflect, or transmit radiant energy. The absorption coefficient (babs), measurable at multiple wavelengths in typical units of 1/Mm, quantifies warming from particles. Measurement techniques are diverse; here we focus on the Tricolor Absorption Photometer (TAP) and MA200 mini-Aethalometer (MA200). The TAP and MA200 measure light attenuation due to aerosol deposited on a filter. The TAP has 3-wavelengths (375, 525, and 625 nm) while MA200 has 5 wavelengths (375, 470, 528, 625, and 880 nm) spanning the UV, visible, and IR spectrum. Here the instruments are compared with continuous measurements of ambient aerosols at NMT. Our focus is comparing (1) temporal trends, (2) wavelength dependence, and (3) the overall accuracy of both instruments. Measurements show peaks in absorption coefficients between 8:00 PM to midnight in winter months, likely a function of wood-burning. Early results show a strong statistical correlation between the instruments and general agreement on wavelength dependence. MA200 has, however, has an absorption coefficient larger by a factor of 1.2-1.7 than the TAP which is under investigation.

SRS2021-150 - How Lipid Changes in Breast Tumor Cell Membranes May Influence Radiation Therapy Outcomes

PRESENTER(S): Qi Wang
RESEARCH ADVISOR: Dr. Sally Pias

Breast cancer is the most common cancer in American women, except for skin cancers. Cancerous tissues often experience low-oxygen conditions (hypoxia). However, the effectiveness of tumor radiation therapy relies on oxygen inside the tumor cells. Oxygen enters cells by diffusing across phospholipid bilayer membranes, and our group is interested in understanding how the membrane composition affects oxygen access. The membranes of breast tumors contain unusually high levels of newly synthesized lipids, which differ in chemical structure from common membrane lipids. Specifically, more advanced and aggressive tumors have higher levels of long-chain saturated phospholipid tails. Here, we investigate the effects of several common newly synthesized lipids on the rate of oxygen diffusion across model lipid bilayer membranes by a physics-based modeling technique known as atomistic molecular dynamics simulations. Based on the data, newly synthesized lipids which have diverse chain lengths do affect oxygen permeability. In particular, long-chain saturated phospholipid tails show decreased oxygen permeability. Therefore, these newly synthesized lipids might contribute to tumor cell hypoxia if their effects on oxygen permeability are preserved in real (complex) biological membranes. The insights gained from this work may lead to new strategies for personalized radiation therapy treatment..

SRS2021-172 - Analyzing Gas Tax Alternatives and Phasing Out Flex Fuels Techniques for Decarbonizing Transportation

PRESENTER(S): Britney Green
RESEARCH ADVISOR: Dr. Claudia Wilson

This study is being conducted at the request of the New Mexico Department of Transportation Research Bureau to support Governor Michelle Lujan Grisham's Climate Action Team's efforts to decarbonize New Mexico's transportation. The New Mexico Tech research team are working on two significant tasks: 1. developing a computable general equilibrium model to quantify proposed efforts and 2. analyzing the best decarbonization practices such as incentivizing electric vehicle purchases, electrifying public transit, exploring gas tax alternatives, and phasing out flex fuel vehicle incentives. The presentation will focus on gas tax alternatives and the phasing out of flex fuel incentives by different states. The gas tax's flat-rate, per-gallon charge is growing obsolete with vehicles improving their fuel efficiency. Vehicle miles traveled programs, toll roads and public-private partnerships were determined to be viable gas tax alternatives, as reported from other states' actions. The second issue addressed relates to flex fuels. In 1992, the United States government passed the Energy Policy Act (EPAct) which provides credits for state, federal, and alternative fuel fleets who acquire alternative fuel vehicles (AFVs). AFVs are vehicles that do not run on traditional petroleum fuel such as flex fuel vehicles (FFVs). FFVs are the most popular acquired vehicle under EPAct despite being less sustainable compared to other AFV options such as electric vehicles. Many state acquisition incentives are expiring and have no indication for renewal. The research team is developing a survey to assess the efforts of other states to determine best practices for decarbonizing transportation in New Mexico.

SRS2021-177 - A Gate-to-Gate Life Cycle Assessment for the CO2-EOR Operations at Farnsworth Unit (FWU)

PRESENTER(S): Anthony Morgan
RESEARCH ADVISOR: Dr. William Ampomah

A Greenhouse gas (GHG) emission related to the Farnsworth Unit (FWU) carbon dioxide enhanced oil recovery (CO2-EOR) operations was accounted for through a gate-to-gate life cycle assessment (LCA) for a period of about 10 years since start of injection to 2020 and predictions of 18 additional years to the economic limit of the CO2-EOR operation. A cumulative amount of 4.76*106 metric tons of oil has been recovered through the injection of 1.49*106 metric tons of purchased CO2 of which 92% was stored during the 10-year period. An LCA analysis conducted on the various unit emissions of the FWU process yielded a net negative (positive storage) of 1.187*106 metric tons of CO2 equivalent representing 79% of purchased CO2. An 18-year forecasted analysis with optimized conditions, the future CO2 injection with minimal flaring/venting estimated 86% storage of the forecasted 2.91*106 metric tons of purchased CO2 with an equivalent 2.63*106 Metric tons of crude oil produced by 2038. Major contributors to emissions were flaring/venting and energy usage for equipment. Improvements on energy efficiency of equipment would reduce emissions further but this could be challenging. However, improvement on injection capacity and elimination of venting/flaring or fugitive gas are more sure ways of reducing net emissions as was the case for the optimized scenario in this work. This LCA illustrated the potential for the CO2-EOR operations in the FWU to store more CO2 with minimal emissions.

3 MINUTE SPEECH COMPETITION

Thursday, April 15th, 1 PM - 5 PM

SRS2021-114 - AI-based Damage Assessment of Buildings After Earthquakes Using Drones
PRESENTER(S): Hamed Momeni
RESEARCH ADVISOR: Dr. Arvin Ebrahimkhanlou

SRS2021-118 - Analysis of Copper Mining Accidents in the United States, 2010-2019
PRESENTER(S): Braci Chester
RESEARCH ADVISOR: Dr. Pedram Roghanchi

SRS2021-121 - Crack Filler Robot and Digital Twinning
PRESENTER(S): Melinda Stevens
RESEARCH ADVISOR: Dr. Arvin Ebrahimkhanlou

SRS2021-137 - Swinging Electrons For A Better Future
PRESENTER(S): Keeniya-Gamalage-Gehan De Silva
RESEARCH ADVISOR: Dr. Sanchari Chowdhury

SRS2021-138 - The Mechanisms and Importance of DNA Repair in Halobacterium
PRESENTER(S): Hannah Lamberston
RESEARCH ADVISOR: Dr. Linda DeVeaux

SRS2021-144 - These Boots Are Made For Walking: Astronaut Boots That Improve Moon Walks
PRESENTER(S): Sarah Lanctot
RESEARCH ADVISOR: Dr. Mostafa Hassanalian

SRS2021-150 - Effects of Lipid Changes on Membrane Oxygen Permeability in Breast Cancer
PRESENTER(S): Qi Wang
RESEARCH ADVISOR: Dr. Sally Pias

SRS2021-159 - Evolution of an Explosively Driven Product Gas Cloud Interface
PRESENTER(S): Christian Peterson
RESEARCH ADVISOR: Dr. Michael Hargather

SRS2021-175 - Using Molecular Simulations to Interpret Electron Paramagnetic Resonance Oximetry Measurements in Cells
PRESENTER(S): Hansen Dube
RESEARCH ADVISOR: Dr. Sally Pias

SRS2021-177 - A Gate-to-Gate Life Cycle Assessment for the CO2-EOR Operations at Farnsworth Unit (FWU)
PRESENTER(S): Anthony Morgan
RESEARCH ADVISOR: Dr. William Ampomah

DEPARTMENTAL SHOWCASES

Wednesday, April 14th - Friday, April 16th

Wednesday, April 14th

1 PM - 3 PM: BIOMEDICAL SCIENCES

1:00 PM - 1:30 PM: BMS 496: ENGINEERING DESIGN

1:45 PM - 2:15 PM: BMS 301: GENETIC ENGINEERING

2:30 PM - 3:00 PM: BMS 495: COURSE-BASED UNDERGRADUATE RESEARCH EXPERIENCE

2:30 PM - 4:30 PM: CIVIL AND ENVIRONMENTAL ENGINEERING

Paving the Wave - Alexis Angeles, Julian Brittain, Jesus Chavira, Douglas Hood, Jessica Misla, Daniella Sanchez, Sudip Thapa

This study is being conducted at the request of the New Mexico Department of Transportation Research Bureau to support Governor Michelle Lujan Grisham's Climate Action Team's efforts to decarbonize New Mexico's transportation. The New Mexico Tech research team are working on two significant tasks: 1. developing a computable general equilibrium model to quantify proposed efforts and 2. analyzing the best decarbonization practices such as incentivizing electric vehicle purchases, electrifying public transit, exploring gas tax alternatives, and phasing out flex fuel vehicle incentives. The presentation will focus on gas tax alternatives and the phasing out of flex fuel incentives by different states. The gas tax's flat-rate, per-gallon charge is growing obsolete with vehicles improving their fuel efficiency. Vehicle miles traveled programs, toll roads and public-private partnerships were determined to be viable gas tax alternatives, as reported from other states' actions. The second issue addressed relates to flex fuels. In 1992, the United States government passed the Energy Policy Act (EPAct) which provides credits for state, federal, and alternative fuel fleets who acquire alternative fuel vehicles (AFVs). AFVs are vehicles that do not run on traditional petroleum fuel such as flex fuel vehicles (FFVs). FFVs are the most popular acquired vehicle under EPAct despite being less sustainable compared to other AFV options such as electric vehicles. Many state acquisition incentives are expiring and have no indication for renewal. The research team is developing a survey to assess the efforts of other states to determine best practices for decarbonizing transportation in New Mexico.

Rainwater Catchment and Treatment for Presbyterian Medical Services in Cloudcroft, NM - Angela Hail

Rainwater catchment and treatment has become a viable solution to potable water scarcity in dry, desert areas. Among many other arid environments, Cloudcroft, New Mexico has experienced times of severe drought. The drought conditions in the early 2000s inspired the idea of this project to harvest and treat rainwater for some facility in the town that has a high drinking water demand. During the crisis, the city hauled water from a nearby town, which cost in terms of water unit price, fuel, vehicle maintenance, distribution, etc. Harvesting and treating rainwater both conventionally and innovatively for Presbyterian Medical Services would save the community time and money in the event of another crisis. Alternatives to the catchment area, structure, and treatment system were considered. The process of selecting alternatives to investigate involved designing for multiple techniques used in conventional and advanced water treatment. The optimal solution was narrowed down using a Leopold Matrix.

Design and Development of a Drone-Assisted Seismic Survey - John Ryan Himes, Isabel Morris, Akram Mostafanejad, and Mostafa Hassanalian

In Civil engineering, active source reflection seismic surveys can determine soil composition as well as identify underground utilities and infrastructure. However, each geophone requires meticulous placement and calibration. Additionally, one survey, depending on its scale, can require tens or hundreds of geophones. To alleviate the tedious installation process and expand the use of active source reflection seismic surveys for Civil engineering-scale projects, this senior design aims to design and test a working prototype of a drone system with the ability to properly install a prefabricated geophone in a predetermined location and record accurate and precise data. To ensure the design is adequate, the drone will be designed based upon its payload, flight characteristics, battery life, and landing mode. For a larger survey, the drone will be able to communicate with multiple drones so that multiple geophones can be installed simultaneously. Additionally, the geophone case, the sole connection between the geophone and the drone, will be designed for a typical wireless seismic node and will be analyzed under three failure modes (reactions at bolt connections, bending, and shear) for three scenarios (landed, take off/midflight, and landing).

Attribute Analysis of Construction Materials with Ground Penetrating Radar - Estela Salinas

The purpose of this project is to develop a program that gives a labeled map of the locations of construction materials based on attribute analysis from Ground Penetrating Radar (GPR) scans. Attribute analysis is advantageous because it allows researchers to study more than one characteristic about a material or structure that is not visible from the surface. Attributes are characteristics of the GPR data that can identify material composition and are calculated from GPR scans of a site. The chosen attribute is attenuation. Attenuation is the rate at which a signal travels or decays through a material. The program is based on a binary classification system that locates different materials based on their attenuation. The binary system allows for more attributes or materials to be added to the program while still being able to locate them properly. We present an application of attribute analysis and classification of GPR scans from Corvin Castle (Hunedoara, Romania), which is composed of many different materials from a number of restorations and expansions since the 13th century. Categorizing materials based on their attributes can improve damage detection techniques. By establishing what range of attribute values correspond to different materials and displaying the resulting classification, the program will provide a visual overview of the locations of the different materials. The information gained from this project can aid restoration and preservation efforts.

Earth Sheltered Residential Design - Jonathan Taylor

This project covers the design of an earth sheltered residential structure. The building was designed for a client in central Pennsylvania. The main structure of the building utilizes a partially composite steel beam with concrete deck. The walls have been designed with concrete masonry units and the columns are HSS. The building is earth sheltered to utilize passive annual heat storage which creates a large dead load for the walls and roof structure. The architecture was a collaboration between the designer and the client.

Absorption coefficient measurements and their relation to air quality and climate change: Intercomparison of a photometer and aethalometer - Charlotte Dungan

Atmospheric aerosols (suspensions of particles) derive from multiple human and natural sources. They contribute to climate change by alternately enhancing or masking greenhouse gas warming depending on aerosol properties. Aerosols' effect on climate is currently the single largest physical uncertainty in climate modeling efforts as it ultimately impacts cloud feedbacks. Aerosol absorption is the dissipation of radiant energy as it passes through a particle resulting in the heating of the particle and surrounding air. Based on the refractive index, a particle will absorb, reflect, or transmit radiant energy. The absorption coefficient (babs), measurable at multiple wavelengths in typical units of 1/Mm, quantifies warming from particles. Measurement techniques are diverse; here we focus on the Tricolor Absorption Photometer (TAP) and MA200 mini-Aethalometer (MA200). The TAP and MA200 measure light attenuation due to aerosol deposited on a filter. The TAP has 3-wavelengths (375, 525, and 625 nm) while MA200 has 5 wavelengths (375, 470, 528, 625, and 880 nm) spanning the UV, visible, and IR spectrum. Here the instruments are compared with continuous measurements of ambient aerosols at NMT. Our focus is comparing (1) temporal trends, (2) wavelength dependence, and (3) the overall accuracy of both instruments. Measurements show peaks in absorption coefficients between 8:00 PM to midnight in winter months, likely a function of wood-burning. Early results show a strong statistical correlation between the instruments and general agreement on wavelength dependence. MA200 has, however, has an absorption coefficient larger by a factor of 1.2-1.7 than the TAP which is under investigation.

2021 Steel Bridge - Brayden Fletcher, Drew Krajeck, Elisabeth Quan, Hamza Syed, Ryan Vallejos

As a part of the Bachelor of Civil Engineering Degree, undergraduate students at the New Mexico Institute of Mining and Technology (NMT) complete a Senior Design project. Five undergraduates chose to participate in the American Institute of Steel Construction (AISC) Student Steel Bridge Competition (SSBC). This project focused on the design of a steel bridge, analyzing it under lateral and vertical loads, and sequencing it for construction.

The AISC SSBC coincides with the American Society of Civil Engineers (ASCE) Rocky Mountain Regional Conference, which hosts the ASCE Concrete Canoe competition. Traditionally, both of these events are held in person at the same region-specific host school, and competing teams travel to participate in various conference events and festivities. Historically, participants in the SSBC physically construct their bridge on-site, where it is rated according to aesthetics, construction speed, lightness, stiffness, construction economy, structural efficiency, and cost estimation. The teams with the highest overall performance go on to compete in the AISC
National Competition.

The impacts of the COVID-19 pandemic led AISC and ASCE officials to cancel all in-person events for the 2021 Rocky Mountain Regional Conference in order to preserve the safety and welfare of all participants. This decision was made after many competing teams, including that from NMT, had already begun planning and scheduling bridge designs. In lieu of an in-person competition, AISC provided students with the option to either compete from campus or participate in a supplemental competition. The former option was very similar to the traditional in-person competition, with trained faculty members from each respective university acting as competition judges. The latter option was an entirely novel competition and involved the design and analysis of a bridge that complied with the same structural specifications as those followed by the “compete from campus” option. Rather than physically constructing a bridge, teams competing in the supplemental competition were required to create a detailed, step-by-step construction procedure. The supplemental competition also required a comprehensive paper outlining the methods and techniques used for design, analysis, and construction.

The 2021 AISC SSBC Rules outline all specifications for the bridge. This section outlines the critical stipulations defined by AISC. Non-compliance with these requirements results in immediate disqualification from the competition. The bridge must be constructed of only magnetically attractive steel nuts, bolts, and members. Each member must be completely rigid and may have dimensions no larger than 3’-6’’ x 6’’ x 4”. Bolts cannot exceed 3” in length and nuts must be hexagonal. The bridge may have only two stringers, each with a length of at least 20’. The top chord of the stringers may not have any large gaps or elevation changes and must be between 1’-7” and 1’-11” above the ground surface at all locations along the span of the bridge. The bridge is to be constructed with the stringers at a prescribed 1’-6’’ offset, as shown in Figure 1. Each of the four footings shall be 1’x1’ and are considered fixed connections. The floor space within these footings is the only place in which any bridge component may touch the ground, and the length of the bridge must be confined within the footing areas. The width and height of the bridge may not exceed 5’ and the total length of the bridge must be less than 22’-6”. The bottom of the stringers must also be no lower than 7-½” above the surface of the ground. The decking of the bridge must be wide enough to accommodate a 3’-6” decking plate at any point between the two footings and must provide a straight clear passageway.

Thursday, April 15th

1 PM - 4 PM: COMPUTER SCIENCES & ENGINEERING

Learning Algorithm For Circuit Classes Without High Entropy Pseudorandom Functions - Eric Binnendyk

Friday, April 16th

9 AM - 12 PM: TECHNICAL COMMUNICATIONS

9 AM - 10:30: SENIOR THESIS PRESENTATIONS

No Bull: Making a Case for Presenting Pandemic Risks Like Raging Buffalo - Jeremy Tarr

Self-Assesment: A Tool For Understanding and Emotion in Graduate Students Writing Dissertations - Kyrie Selph

10:30 AM - 12 PM: NMT TC ANNUAL CORPORATE BOARD ADVISORY COMMITTEE MEETING

10 AM - 12 AM: CHEMICAL ENGINEERING: JUNIOR DESIGN

10:05 AM: **Predicting Silica Nanoparticle Sizes from the Traditional Stöber Process– John Dofflemeyer, Mario Marquez, Brandon McReynolds**

10:25 AM: **Biomaterial Tissue Mimic for Dolphin Hearing – Destiny Crawford, Jennifer Gamboa-Gil, Catherine House, Monica Ramirez**

10:45 AM: **Biogas to Syngas Scale Up – Madeline Finale, Muriel Olander, Jalen Salas, Kaoru Shimada**

11:00 AM: **Dispersion of Titanium Nitride Nanoparticles in a Transparent Monolithic Silica Glass - Taylor Le, Arscenia Lucero, Bianca Perez-Nunez, Shane Risolio**

11:20 AM: **Optimization of Poly(3-alkylthiophene) Crystallinity Through Alkyl Side Chain and Annealing Temperature – Chase Kennard, James Ruff, Hunter Wilkinson**

12 PM - 2 PM: CHEMISTRY

1 PM - 3:30 PM: CHEMICAL ENGINEERING: SENIOR SHOWCASE

1:00 PM – **Insulin Production Plant - Connor Cole, Chase Ferrone, Kilkee Flynn, Kavon Mojtabai, Cameron Zielinski**

1:30 PM – **Synthesis of Dimethylamine from Methanol and Ammonia – Kamryn Gordon, Christopher Lafferty, Danielsen Moreno, Ian Roberson**

2:00 PM – **Industrial Production of Hydrogen Peroxide: Anthraquinone (AO) Process – Santana Floe, Christopher Catanach, , Idalis Hernandez, Adam Lopez**

2:30 PM – **Direct Hydration of Propylene to Isopropanol – Brian Ortiz, Aaron Plant, Sorcha Sterrit Madelyn Rich**

3:00 PM – **Nitrobenzene by the Nitration of Benzene – Morelia Cuevas, John Davies, Nicole Penners, Dalton Wright**

1 PM - 3 PM: MECHANICAL ENGINEERING

BREAKOUT ROOM 1

1:00 PM & 2:00 PM **Space Payload**

1:10 PM & 2:10 PM: **Baja SAE Project**

1:20 PM & 2:20 PM: **BattleBots1**

1:30 PM & 2:30 PM: **BattleBots2 - Joshua Crepeau, Salomon Chavez, Frank Maldonado, Amanda Massey, Donovan Caruso, Cesar Miss**

1:40 PM & 2:40 PM: **Corrosion Monitoring - Luke Strebe Mario Escarcega, Savannah Bradley, Parker Randall, Gabriel Campos**

1:50 PM & 2:50 PM: **Crack Filler - Melinda Stevens, Samuel Arellano, Diego Rodriguez, James Wilson, Noah Trudell, Zady Gutierrez**

BREAKOUT ROOM 2

1:00 PM & 2:00 PM: **Prosthetic Hand - Marco Lozoya, Rodrigo Cervantes, Megan Richardson, Lorena Velasquez, Leandra Patterson, Elizabeth Carrillo, Israel Gabaldon, Karl Schneller**

1:10 PM & 2:10 PM: **SAE Aero - Ethan Feuer, Syndey Engler, Trung Le, Michael Narum, Hosman Carveo-Macias, Jonathon Gaston, William Martin, Micah Sulich**

1:20 PM & 2:20 PM: **Amphibious Drone**

1:30 PM & 2:30 PM: **Spherical Drone**

1:40 PM & 2:40 PM: **Gravitational Device Model - Tyler Matthews, Marianne Lara, Samuel Baca, Dustin Vigil, Matthew Houghton, Andrew Wagg, Leonor Meriono Osnornio**

1:50 PM & 2:50 PM: **Sandia Labs Competition**

BREAKOUT ROOM 3

1:00 PM & 2:00 PM: **Cryo Composite Test - Kailene Strebe, Jett Emms, Raechelle Sandoval, Kanisha Phillips, Eric Schroeder**

1:10 PM & 2:10 PM: **Owens Corning - Hunter Von Unschuld, Nathan Paul, Keilah South, John Racette, Jonathon England, Samuel Upham**

1:20 PM & 2:20 PM **Sounding Rocket - Victoria DuPriest, Lukas Peterson, Seth Sisneros, David Avalos, Austin Petring, Chris Padilla, Melanie Deeble, Casper Huang, Brad Williams**

1:30 PM & 2:30 PM: **Fatigue Test Device - Deise Garcia, Jason Presley, Adam Murrell, Stephen Maes**

1:40 PM & 2:40 PM: **3D Structure - Jack Rains, Alex Sandhorst, Adam Shannon**

1:50 PM & 2:50 PM: **Library Catalog Storage - Alyssa Clark, Mariah Thompson, Luis Garcia, Marcos Lopez, Brandon Comiskey-Lucero**

2:30 PM - 4:30 PM: MATERIALS ENGINEERING