IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

Opening Session

Session time	Friday, 09:00 am until 10:00 am
Location	EB Event Space

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

S1T1: Session 1, Track 1

Session time	Friday, 10:20 am until 12:20 pm
Location	126 MARB
Talk time	20

10:20 am: *Indirect Tensile Strength of Clayey Soils Treated With Cement or Lime*

Melissa Adams Cowley (Brigham Young University, USA); W. Spencer Guthrie (Brigham Young University, USA)

Abstract: The objective of this research was to evaluate the sensitivity of the indirect tensile strength (ITS) test to stabilizer type, stabilizer concentration, and curing time for multiple clayey soils having varying plasticity indices (PIs). The scope of the research included treatment of three clayey soils with cement or lime at three concentrations each and identification of cases in which a minimum proposed ITS threshold was attained. The data indicate that the ITS test is sensitive to stabilizer type, stabilizer concentration, and curing time for the three clayey soils studied in this research. Differences in ITS among the soils were largely attributable to differences in PI, which can influence pozzolanic reactivity. A cement or lime concentration that was equal to or 2% above the lime concentration indicated by the Eades and Grim test was typically required for a minimum ITS value of 207 kPa (30 psi) to be attained.

10:40 am: *Qualitative Comparison of Sampling Methods for Determining Chloride Concentrations of Concrete*

Jared Murri (Brigham Young University, USA); W. Spencer Guthrie (Brigham Young University, USA)

Abstract: The objective of this research was to compare the method of removing concrete cylinders using a coring machine with the method of removing concrete powder using a rotary hammer for chloride concentration determination; a special focus was given to these methods as they relate to sampling of concrete bridges, where chloride concentration test results commonly inform bridge management decisions. Criteria for comparing the two sampling methods were subdivided into the categories of feasibility and accuracy, where feasibility was evaluated based on location, depth, concrete quality, and speed and accuracy was evaluated based on contamination, spatial resolution, and distortion. This qualitative comparison indicates that the powder drilling method is preferred over the coring method with respect to every criterion except spatial resolution, for which a preferred method was not apparent. Additional research is recommended to quantitatively compare the accuracy of the two methods.

11:00 am: *Long-Term Modulus Values of Microcracked Cement-Treated Base Layers in Utah*

Patrick McDivitt (Brigham Young University, USA); Melissa Adams Cowley (Brigham Young University, USA); W. Spencer Guthrie (Brigham Young University, USA)

Abstract: The objectives of this research were to determine long-term modulus values of cement-treated base (CTB) layers constructed in Utah using microcracking and analyze the correlation between the backcalculated modulus values and 7-day unconfined compressive strength (UCS) values. Testing was performed at five sites in northern Utah, where reconstruction with full-depth reclamation was performed from August 2008 to October 2020. UCS data for the CTB material were collected during each reconstruction project and compiled in this research. Modulus values were determined from the portable falling-weight deflectometer test in December 2022 using backcalculation software. The average 7-day UCS values ranged from 2.52 MPa (366 psi) to 3.85 MPa (559 psi), and the CTB modulus values ranged from 290 MPa (42 ksi) to 2,989 MPa (433 ksi). A correlation between the backcalculated modulus values and 7-day UCS values was developed for estimating the long-term modulus values of microcracked CTB layers constructed in a seasonally cold climate, such as northern Utah.

11:20 am: *On the Optimization of Two-Level Thermoelectric System for Pavement Energy Harvesting*

Ehsan Rohani (Utah Valley University, USA)

Abstract: In this paper we design and optimize a two-level thermoelectric pavement energy harvesting system. The optimization is applied on the cost per unit of energy ($/J) as the target function. The idea behind two-level thermoelectric system is to use thermoelectric power generator (TEG) modules on different depth of the pavement to maximize the heat exchange between temperature grandnieces created by both day and night temperature profile. As the temperature difference is the driving force for the flow of thermal energy through TEG device and the TEG device is turning a certain percentage of thermal energy flow to electrical energy the two extremums created by day and night temperature profile have the most potential to generate electricity. Since, the generated energy is entirely dependent on the temperature profile and thermal exchange within different elements of the device and between device and environment below the surface, we had to develop the proper tools that are able to provide an accurate analysis of these exchanges. In addition we had crated an accurate temperature profile by extrapolating the existing geological information. We calculate the associated cost and change in total generated energy for each change in the design parameters using our evaluated model and determine their effect on the target function.

11:40 am: *Passive Thermal Performance of Earth-Sheltered Thin-Shell Concrete Dome Structures*

Daira Sofia Velasco Vega (Brigham Young University, USA); Kendrick M Shepherd (Brigham Young University, USA); W. Spencer Guthrie (Brigham Young University, USA); Andrew South (Brigham Young University, USA)

Abstract: The objective of this research was to evaluate an insulated concrete thin-shell dome structure for thermal flux with various depths of soil coverings. Computational thermal analysis was performed to model temperature fluctuations inside a representative section of an experimental concrete dome structure during typical winter and summer seasons in northern Utah. The results are compared against the baseline of a traditional insulated wood-framed building envelope and indicate that thermal flux is significantly reduced in the earth-sheltered concrete dome structure with foam on the outside of the concrete. The addition of soil dampens the amplitude of the flux and increases the time lag between maximal exterior and interior temperatures.

12:00 pm: *Compressive Strength and Rapid Chloride Permeability Testing of Concrete Comprising Silica Fume*

Nicholas Day (Brigham Young University, USA); Madelyne Bleazard (Brigham Young University, USA); W. Spencer Guthrie (Brigham Young University, USA); Taylor J. Sorensen (Brigham Young University, USA); Amanda C Bordelon (Utah Valley University, USA)

Abstract: The objective of this research was to evaluate the effects of currently available sources of silica fume on the compressive strength and chloride permeability of concrete mixtures proportioned to be similar to that used in the decommissioned Salt Lake City Airport parking garage. The procedures for this research involved mixture design and materials acquisition, batching of four concrete mixtures, measuring properties of the fresh concrete, casting and curing of concrete specimens, and measuring properties of the cured specimens. Regarding strength, the results indicate that, at 7 days and 28 days, the compressive strengths of concrete mixtures comprising silica fume were 29% to 52% higher and 12% to 28% higher, respectively, than those of the control mixture without silica fume. Regarding chloride permeability, the numbers of coulombs passed by concrete mixtures comprising silica fume were 55% to 74% lower than that of the control mixture. These results demonstrate the benefits of concrete comprising silica fume for future projects, where maximizing the service life of concrete structures is important.

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

S1T2: Session 1, Track 2

Session time	Friday, 10:20 am until 12:20 pm
Location	128 MARB
Talk time	20

10:20 am: *Inverse Design of a 2x2 Coupler*

Elise Bangerter (Brigham Young University, USA); Ryan Camacho (Brigham Young University, USA)

Abstract: Density-based topology-optimization can be used to design photonic components that are more compact and broadband than their traditionally designed counterparts. In this paper, a 90° 2x2 coupler is designed using MIT's Electromagnetic Equation Propagation (Meep) software's adjoint variable method. The design was optimized over the wavelengths 1500nm-1600nm in a 4µm x 4µm design region. The final design meets the design rule constraints (DRC) of minimum linewidth and line spacing for a standard electron beam lithography process. It also has an insertion loss of less than 0.085dB for all wavelengths and a port imbalance of less than 1%.

10:40 am: *Neural Network Self Driving Car: A Platform for Learning and Research on a Reduced Scale*

Andrew W Sumsion (Brigham Young University, USA); Shad Torrie (Brigham Young University, USA); Joshua Broekhuijsen (Brigham Young University, USA); Dah-Jye Lee (Brigham Young University, USA)

Abstract: We present a self-driving car platform using vision-based neural networks for controls as a guide to those developing their own platforms. As the self-driving car industry continues to make improvements, it is crucial that the learning platforms also continue to develop to keep up with state of the art methods. In this paper, we discuss our platform: our car, our driving "city," our simulator, our reinforcement learning framework for steering within the lane, and real time object detection. All of them perform on a smaller scale than real world using remote control (RC) cars with NVIDIA Jetson TX2s onboard, although other edge computing may be used in its place. We provide our code for our project at: https://github.com/byu-rvl/BYU_ECEN_Racer_Sample_Code

11:00 am: *Deep and Machine Learning-Based Methods for Defect Classification in Jet Engines*

Marco P Schoen (Idaho State University, USA); Marcel Oettinger (MTU Aero Engines AG, Germany); Dajan Mimic (Leibniz Universität Hannover, Germany)

Abstract: In this paper, the utility and accuracy of Machine Learning (ML) and Deep Learning (DL) methods are investigated for detecting defects in civil aircraft engines. Rather than to disassemble jet engines, the approach investigated in this study utilizes images of the exhaust of jet engines and infers defects in the turbine and burner section. While the proposed DL methods make use of one or two cameras, the ML methods depend on data

obtained by extracting the density fields of the Hot Gas Path (HGP). The HPG data are computed from images acquired by an array of cameras. The corresponding ML features are crafted from these density fields. The proposed algorithms employ optimized hyperparameters and separate training as well as validation data sets. The study illustrates the potential of DL methods and the resulting simplification in the necessary instrumentation to accomplish near perfect defect classification outcomes.

11:20 am: *Exploration and Object Detection via Low-Cost Autonomous Drone*

Branden Pinney (UVU, USA); Ben Stockett (UVU, USA); Mohammad Shekaramiz (Utah Valley University, USA); Masoum Mohammad A. S. (Utah Valley Univ, China); Abdennour Seibi (UVU, USA); Angel Rodriguez (UVU, USA)

Abstract: This research presents an initial study on developing an autonomous drone path-planning solution to locate and inspect wind turbines in a wind farm. Here, we demonstrate the results of an offline exploration solution to identify and approach targets with unknown locations in the area of interest. Our investigation aim at comparing the effectiveness of two non-decompositional area exploration algorithms through their battery usage, time to complete the pattern, distance traversed, and the time required to detect several targets placed in the area of exploration. The targets in this study consisted of metallic pedestal fans acting as a surrogate for full-size wind turbines. A low-cost drone was used for small-scale laboratory experiments indoors. The targets are identified via object detection and an attached QR code at the base of the pedestal fans for target verification.

11:40 am: *Hyperparameter Tuning of Support Vector Machines for Wind Turbine Detection Using Drones*

Jordan Miller (UVU, USA); Colton Seegmiller (UVU, USA); Masoum Mohammad A. S. (Utah Valley Univ, China); Mohammad Shekaramiz (Utah Valley University, USA); Abdennour Seibi (UVU, USA)

Abstract: With the increase in demand for renewable energy and high maintenance costs caused by equipment and parts failure, the need for advanced monitoring technologies in this field is essential. Of specific concern are the frequent failures of wind turbine blades due to occasional inspections using conventional techniques and slow maintenance. One of the important steps to address these concerns and reach autonomy is to use drones to detect the wind turbine for inspection. This becomes crucial when the drone must fly a long distance to reach the wind turbine or wind farm. More specifically, as the drone is reaching the vicinity of the wind turbine, real-time GPS information may not necessarily lead the drone to reach right in front of the desired turbine. To resolve these issues, we use support vector machines (SVM) to classify the wind turbine images from those images that do not contain the wind turbine. The implemented SVM as a machine learning model is further enhanced by various hyperparameter methods to ensure the highest accuracy possible. GridSearch, RandomSearch, and Bayesian Optimization with Hyperband tuning are used, and the accuracies \emph{vs} training times are compared. The proposed model can be ultimately used in an automated system using a drone and aerial images to detect the wind turbine for blade inspection.

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

S1T3: Session 1, Track 3

Session time	Friday, 10:20 am until 12:20 pm
Location	108 MARB
Talk time	20

10:20 am: *Enhanced Image Captioning Using Deep Learning Model*

Fatima Yousif Rustamani (Mehran University of Engineering and Technology MUET Jamshoro, Pakistan); Samiullah Kalhoro (Mehran University of Engineering and Technology, Jamshoro, Pakistan); Mariam alias Alwaz Kazi (Mehran University of Engineering and Technology MUET Jamshoro, Pakistan); Qasim Arain (Faculty at Mehran University of Engineering and Technolgy, Pakistan)

Abstract: The fusion of computer vision and natural language processing has recently received much interest, thanks to the advent of deep learning. This field is exemplified by image captioning, which teaches a computer to comprehend an image's visual information using one or more phrases. For meaningful descriptions of high-level images, it is necessary to examine the objects' states, properties, and relationships in addition to their recognition and the scene they are in an image. Although image captioning is challenging and intricate, numerous academics have made substantial advancements. In this study, we primarily use deep neural networks to develop our image captioning model, specifically, a framework based on a convolution neural network (CNN)-recurrent neural network (RNN) with Inception V3 as the CNN architecture and Gated Recurrent Unit (GRU) [1] as the RNN architecture. Details of these are examples of their work and a description of their evaluation metrics.

10:40 am: *Exploring the Virtual Space in the Metaverse: A Case Study Analysis*

Mohamad Izani (Higher Colleges of Technology, United Arab Emirates); Aishah Razak (Multimedia University, Malaysia); Abdulsamad Alkhalidi (University of Sharjah, United Arab Emirates); Fauzan Bin Mustaffa (Multimedia University, Malaysia)

Abstract: Metaverse platforms, such as Second Life, VR Chat, and Sansar, have gained significant popularity as immersive, customizable virtual environments. This study aimed to analyze and compare these platforms based on immersion, customization, and user experience, utilizing a mixed-methods approach, including personal experience, observation, data collection from journals, research proceedings, and available documentation. The findings reveal that each platform has unique strengths and weaknesses, including performance and stability issues, limited customization options, complex interfaces, cost and accessibility, realism, and community and social features. The study proposes several potential future improvements, including enhancing realism and immersion, improving customization options, enhancing social and community aspects, examining potential uses and applications, and

investigating ethical and societal implications. In conclusion, this study provides valuable insights for designers, developers, and researchers seeking to enhance user experience in virtual environments. The proposed future improvements have the potential to enhance the functionality and design of Metaverse platforms, leading to a better user experience. These findings can contribute to the development of high-quality virtual environments, with implications for a wide range of applications, including education, entertainment, and social interaction.

11:00 am: *Evaluating the Effectiveness of Obfuscated Instruction Codes for Malware Resistance*

Lucas L Ritzdorf (Montana State University, USA); Colter Barney (Montana State University, USA); Christopher M Major (Montana State University, USA); Tristan Running Crane (Montana State University, USA); Hezekiah Austin (Montana State University, USA); Benjamin Macht (Montana State University, USA); Clemente Izurieta (Montana State University, USA); Brock LaMeres (Montana State University, USA)

Abstract: Malware and maliciously crafted user input represent serious threats to modern computer systems. Many attacks begin with difficult-to-prevent vulnerabilities, such as code injection or memory corruption, usually achieved by exploiting known bugs in specific programs. We introduce a novel processor architecture which utilizes obfuscated hardware in order to effectively detect altered memory contents before they can be executed. This detection system also uses hardware reconfigurability to its advantage, providing the flexibility to counteract other attack vectors relying on code execution and demonstrating significant resistance to brute-force attacks. In addition, we present a prototype architectural implementation as an initial demonstration of feasibility.

11:20 am: *Co-Design of Transimpedance Amplifiers and Photonic Quantum Random Number Generators*

Benjamin J Fisher (Brigham Young University, USA); Benjamin Arnesen (Brigham Young University, USA); Tyler Stowell (Brigham Young University, USA); Jared Marchant (Brigham Yong University, USA); Christian J Carver (Brigham Young University, USA); Ryan Camacho (Brigham Young University, USA); Shiuh-hua Wood Chiang (Brigham Young University, USA)

Abstract: We investigate the photonic and electronic elements of a quantum random number generator based on vacuum state homodyne detection. We account for photodiode responsivity, optical beam splitting ratio, and optical path length in balancing the detector's photocurrents. Finally, the quantum to classical noise ratio is increased through the design of an operational amplifier, including its common mode rejection ratio, bandwidth, gain, and classical noise. A quantum to classical noise ratio of .064 is achieved and the result is analyzed for improvement in future work.

11:40 am: *On the Crucial Role of Information Theory in the Metaverse*

Morteza Shoushtari (Brigham Young University, USA); Farah Arabian (Brigham Young University, USA); Willie K Harrison (Brigham Young University, USA)

Abstract: In recent years, the development of social media and virtual worlds, such as the Metaverse, has transformed human interaction and created new opportunities for digital experiences. As the Metaverse becomes more complex and immersive, a vast amount of data will be transmitted and processed in real time, making information theory crucial to its development. This paper explores the key concepts in information theory and investigates the potential applications of information theory in the Metaverse. The applications discussed include privacy protection, security, data storage, transmission, visualization, and user behavior. Continued research is

essential in each of these areas to develop a more comprehensive information-theoretic framework that can effectively address the diverse challenges in the Metaverse.

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

S1T4: Session 1, Track 4

Session time	Friday, 10:20 am until 12:20 pm
Location	109 MARB
Talk time	20

10:20 am: *Immersion, Presence and Transference: Bringing Story Thinking to Simulation Design*

Nicole Kosoris (Georgia Tech Research Institute, USA); Maribeth Gandy-Coleman (Georgia Institute of Technology, USA)

Abstract: Simulation has been used for training since the 1970's. The ability to use skills gained in one simulation outside of that simulation is called transference. Immersion is an important element of transference. Traditional psychological and simulation research defines immersion via fidelity. Gaming literature approaches immersion from a storytelling perspective, and thus focuses on emotional responses which can be reliably measured by physiological signals. Leveraging this game research enhances the simulation researcher's ability to make performance predictions based on simulated results. In this paper, researchers designed an intentionally stressful simulation environment and then tested different display configurations within both stressful and non-stressful environments. Researchers saw a significant difference in responses to display configurations when tested in a stressful environment.

10:40 am: *Using Sparse Coding as a Preprocessing Technique for Insect Detection in Pulsed Lidar Data*

Connor R Zsidisin (Montana State University, USA); Trevor C Vannoy (Montana State University, USA); Joseph A Shaw (Montana State University, USA); Bradley M Whitaker (Montana State University, USA)

Abstract: This research proposes using sparse coding as a preprocessing technique on insect lidar based data. This preprocessing technique will be used in conjunction with the AdaBoost, RUSBoost, and neural network algorithms to automatically detect insects. The project aims to increase the effectiveness of these algorithms by using new images created by sparse coding. The K-SVD algorithm will be used to train a dictionary on images that contain the majority class (non-insects). This trained dictionary will be used along with the Orthogonal Matching Pursuit algorithm to reconstruct all lidar images. The difference between the original image and the reconstructed image will be taken and processed by the feature extraction function and then used to train and test the models. Using overcomplete and complete dictionaries, our results are able to detect insects at a higher rate. Using an overcomplete dictionary we are able to classify 93.18% of insect-containing images in the testing dataset. Using the complete dictionary we were able to maintain 99.70% of non-insect images while increasing the percentage of insects classified to 84.09%.

11:00 am: *Insect Identification in Pulsed Lidar Images Using Changepoint Detection Algorithms*

Nathaniel Sweeney (Montana State University, USA); Caroline Xu (University of Michigan, USA); Joseph A Shaw (Montana State University, USA); Toby D. Hocking (Northern Arizona University, USA); Bradley M Whitaker (Montana State University, USA)

Abstract: Noninvasive entomological insect monitoring often utilizes a variety of tools such as lidar to gather information without interfering with the insects in their habitat. These collection methods often result in large amounts of data that can be tedious and lengthy to interpret and analyze. Machine learning has been previously used in the past in order to analyze lidar images to detect insects, but often suffers from pitfalls such as long training times and large computational power requirements. In an attempt to offer an alternative that takes little to no training on the data and much less computational power, this paper looks at the use of changepoint detection algorithms to analyze lidar images containing insects. By analyzing the rows or columns of a lidar image, the algorithms should be able to detect abrupt changes in the image that would represent the insects. While not as accurate, the changepoint detection algorithms give comparable results to a machine learning algorithm tested on the same dataset without the need for supervised training.

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

1st Day Lunch

Session time	Friday, 12:20 pm until 01:40 pm
Location	Engineering Building Event Space

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

S2T1: Session 2, Track 1

Session time	Friday, 01:40 pm until 03:00 pm
Location	126 MARB
Talk time	20

01:40 pm: *Freezing Optically Clear Microdroplets in a Laboratory Setting*

Kimi S Wright (College of Engineering, USA); Parker A Awerkamp (College of Engineering, USA); David Hill (College of Engineering, USA); Brandt Bashaw (College of Engineering, USA); Dean Van Woerkom (College of Engineering, USA); Davin T Fish (Brigham Young University, USA); Greg Nordin (Brigham Young University, USA); Ryan Camacho (Brigham Young University, USA)

Abstract: Ice is a common substance, important to environ- mental, biological, geological, and extraterrestrial fields, and yet it is still poorly understood. Ice is underutilized in the optics field partly due to the disclarities often found in ice This paper presents a method of creating frozen microdroplets for use in the optics field, in particular optical resonators.

02:00 pm: *Long-Range Bluetooth Smart Stake System for Soil Sensing*

Samuel J Craven (Brigham Young University, USA); James M Subieta (Brigham Young University, USA); Coby B Sandholtz (Brigham Young, USA); Daniel K Nelson (University of Utah, USA); Alison Langford (Brigham Young University, USA); Brian A Mazzeo (Brigham Young University, USA)

Abstract: Precision agriculture depends on accurate spatial soil information to efficiently deploy resources. While remote sensing can provide high coverage, some soil properties must be measured in situ. The design of a low-power, long-range system for soil surveillance is outlined. Sensor nodes consist of battery-powered transmitters with temperature sensors at various soil depths. Nodes measure temperatures and broadcast data intermittently using Bluetooth long-range protocols and unacknowledged advertisements. A high-gain antenna connected to a receiver captures broadcasts from nodes. A prototype system was deployed outdoors for several weeks. Received data from transmitter nodes were used to reconstruct soil thermal histories at each node location. Good correlation with local weather data validates the data captured by the system.

02:20 pm: *Modeling Axial Compressor Systems Using Deep Learning Methods*

Kellie N Wilson (Idaho State University, USA); Marco P Schoen (Idaho State University, USA)

Abstract: Studying the characteristics of complex nonlinear systems and designing control strategies necessitates the development of computationally efficient methods. In particular, compressor systems will benefit from accurate models that capture the nonlinear dynamics. In this paper, an overview of neural networks is given with a focus on Long-Short Term Memory (LSTM) networks for dynamic systems. A simple test system is presented for verifying the LSTM approach for single input single output (SISO) systems. An axial compressor system is used to simulate its nonlinear dynamics using the Toolbox for the Modeling and Analysis of Thermodynamic Systems (T-MATS). The proposed LSTM approach is demonstrated for the multiple input multiple output (MIMO) axial compressor model. The proposed approach indicates that LSTM based modeling for highly nonlinear MIMO systems can yield accurate model characterizations.

02:40 pm: *Measuring Pavement Smoothness From the Perspective of E-Scooters*

Dylan Apelu (Brigham Young University, USA); Gregory S Macfarlane (Brigham Young University, USA); W. Spencer Guthrie (Brigham Young University, USA); Nicole Adams (Brigham Young University, USA); Brian A Mazzeo (Brigham Young University, USA)

Abstract: As e-scooter rental services have become a popular transportation mode in many cities, pavement quality data are needed for e-scooter paths. The objectives of this research were to develop and demonstrate a device for measuring pavement smoothness along e-scooter paths using commercially available equipment, including an e-scooter and a mobile phone with accelerometer and geolocation features. A method of data processing was developed to produce a pavement smoothness metric from the acceleration measurements. The results of data collection and analysis suggest that the instrumented e-scooter is able to efficiently measure and quantify pavement smoothness for bike lanes and paths, where observed differences in pavement smoothness were clearly correlated with differences in pavement distress. Because e-scooters available through typical shared mobility programs are already equipped with sensors like those utilized in this study, the possibility exists for e-scooter rental services to collect useful pavement quality data from their riders' information and provide it to cities, where the data could inform master plans related to infrastructure improvement.

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

S2T2: Session 2, Track 2

Session time	Friday, 01:40 pm until 03:00 pm
Location	128 MARB
Talk time	20

01:40 pm: *Simulating a Time-Varying Communications Channel*

Todd Moon (Utah State University, USA); Brandon Lemon (Utah State University, USA)

Abstract: In this extended tutorial, we study the motion of a transmitter and receiver and moving reflectors in a channel and the artifacts this motion introduces into a received signal, including Doppler frequency shifts and change in pulse durations. For continuous-time signals we consider these artifacts from a variety of perspectives, including simple linear motion, and arbitrary positioning of transmitter, reflectors, and receiver. The development is from a signals perspective, rather than a physics-based perspective. We consider sampled bandlimited signals in time-varying channels. An efficient way of performing the computations is presented. These results may be useful, for example, in determining the performance of a communication signal in a time-varying channel.

02:00 pm: *On Polarization Diversity in 5G and Beyond Internet-Of-Things Networks*

Michael Rice (Brigham Young University, USA); Riley Kirkwood (Brigham Young University, USA); Laura Landon (Brigham Young University, USA); Preston Walker (Brigham Young University, USA); Willie K Harrison (Brigham Young University, USA)

Abstract: Propagation measurements in the recently allocated 3.7--3.98 GHz band that incorporate polarization state information are described and analyzed. Co-located cross-polarized received antennas show large variations in received signal strength as a function of the polarization state of the transmitter. Combining or selection must be applied to these antenna outputs. The circularly polarized outputs of a hybrid coupler show much smaller variations. Cross polarization discrimination analysis suggests that potential diversity gains exist for combining the two circularly polarized hybrid coupler outputs.

02:20 pm: *System Identification of a Mobile Robot With Motion Capture Data*

Douglas Isenberg (Embry-Riddle Aeronautical University, USA)

Abstract: This paper describes how to perform a system identification for the equations of motion of a differential drive mobile robot using data obtained from a motion capture system, and presents the results of carrying out this identification process. In contrast to the exiting work, the model used for identification is derived by considering the robot to be a multibody system, and it includes the actuator dynamics along with viscous and Coulombic friction.

This model is linear in the parameters, and therefore a linear least-squares solution is utilized to calculate the parameters. In order to construct the overdetermined linear system of equations necessary to do this, high-quality measurements of wheel velocity and angular velocity are required. These values are obtained from high-speed motion capture data and the paper describes how the position of point markers on the robot is transformed and filtered into these required values. Additionally, an overview of the experimental hardware and software, that makes use of Robot Operating System is also described in detail. Cross-validation results indicate that the identified equations of motion, with knowledge of only the applied motor voltage duty cycles, can provide an estimate of robot position that is almost equivalent to that obtainable with conventional odometry over time scales of up to half a minute.

02:40 pm: *Two Stage Soft-Detector Integer Forcing Receiver Using Slowest-Descent Method for IEEE 802.16e*

Ehsan Rohani (Utah Valley University, USA)

Abstract: We present a Integer Forcing receiver for multiple-input multiple-output (MIMO) system. We introduce two low complexity soft demapping methods that are able to provide the approximate log likelihood ratios (LLRs) for QAM mapping in IF detectors. In addition we compare the packet error rate performance versus channel noise of the IF detector with zero forcing (ZF) and minimum min square of errors (MMSE) detectors as well as the list sphere decoding depth first search (LSD-DFS) detector in a 4×4 IID (independent identically distributed) MIMO channel and 16 QAM modulation testbed. In addition, the required precision of IF detector is presented at the end.

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

S2T3: Session 2, Track 3

Session time	Friday, 01:40 pm until 03:00 pm
Location	108 MARB
Talk time	20

01:40 pm: *Redesigning the Introduction to Electrical & Computer Engineering for COVID-19*

Ehsan Rohani (Utah Valley University, USA); Mona Milani (UVU, USA)

Abstract: Traditionally in most colleges and universities, in the Electrical and Computer Engineering department students must take the Introduction to ECE during their first year. In 2020, the COVID-19 pandemic forced colleges and universities to move their courses online while faculty, administrators, and staff worked remotely in order to protect millions of students and themselves. At the height of the pandemic, online learning became a necessity for many. Recognizing the need for Online real-world hands-on experience for first year students in ECE department we create a self-project-based course to introduce students to the fundamentals of ECE and make them familiar with basic concepts such as MATLAB, Circuit design, Micro processing etc. This new course is organized around 3 important concepts: 1) creating fun, interesting projects for students 2) Connection with real world projects 3) Practicing online hands-on experience. In this paper, we focused on the importance of a fun Online ECE course and successful achievements of the course.

02:00 pm: *Impact of Undergraduate Research Activities on Engineering Students' Persistence*

Khaled Shaaban (UVU, USA); Alaa Alsarhan (Utah Valley University, USA)

Abstract: To understand the effect of different research activities on the persistence of undergraduate engineering students, data for undergraduate students enrolled in research activities at Utah Valley University were collected and examined. The findings showed a strong correlation between student persistence in the next semester and their involvement in undergraduate research. Undergraduate research participants had a 2.71 times higher persistence rate than non-research participants. Additionally, a significantly significant predictor of students' perseverance was their cumulative GPA. Persistence rates among students increased by 1.86 times for every point higher cumulative GPA. Additionally, demographic factors were not predictive after controlling for research and GPA levels. In particular, student level, race, and gender did not reliably predict students' perseverance.

02:20 pm: *Entrepreneurial Mindset Project Amenable to Introducing Undergraduate Students to Machine Learning Classification*

Bradley M Whitaker (Montana State University, USA)

Abstract: This paper describes a 4-week group project designed to encourage the development of an entrepreneurial mindset (EM) in junior-level Signals and Systems students. EM-based projects encourage students to develop curiosity, make connections, and create value. The open-ended project is amenable to teaching basic machine learning concepts in an undergraduate setting. The project requires students to develop an algorithm that can successfully distinguish audio recordings of English speakers saying either "yes" or "no." A small A/B test (N = 23) compared students who participated in the project against a control group of students who individually completed lab assignments directly related to four signal processing topics. The groups were compared to see whether participating in the project affected (1) their understanding of topics associated with the ‘missed' labs as measured by their performance on specific final exam questions and (2) their growth in EM, as measured by a pre- and post- survey. Results show that the mean performance on the four relevant final exam problems was worse for the experimental group but these students reported, on average, greater increase in EM. However, when analyzing the groups using a two-sample t-test, neither result is statistically significant at a p-value of 0.1.

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

S2T4: Session 2, Track 4

Session time	Friday, 01:40 pm until 03:00 pm
Location	109 MARB
Talk time	20

01:40 pm: *Improving COVID-19 Predictions With Multimodal Neural Networks*

Isaac P Boyd (Montana State University, USA); David Hedges (SelectHealth, USA); Benjamin Carter (Billings Clinic, USA); Bradley M Whitaker (Montana State University, USA)

Abstract: In 2020, COVID-19 underscored the vulnerabilities of the healthcare system. Supply lines and hospital capacities presented unrealized complications in dealing with the virus's sudden outbreak. Being able to anticipate an influx of COVID-19 patients would allow for targeted responses by healthcare providers and policymakers. In this work, we present a method for predicting COVID-19 case counts on a county-level granularity using neural networks. Utilizing multimodal network architectures, incorporating convolutional and LSTM layers, we were able to outperform a feed-forward estimation of COVID-19 case counts. We test our network's performance on a variety of historical and geographical inputs, utilizing static anthropogeographic inputs, and retraining the network on a span of historical positions. Our results indicate the models well are suited to forecast the spread of COVID-19 on a county-level basis, but our model is best utilized for targeted local applications preventing its overall portability on a national scale.

02:00 pm: *Too Legal; Didn't Read (TLDR): Summarization of Court Opinions*

Aashish Ghimire (Utah State University, USA); John M Edwards (Utah State University, USA); Raj Shrestha (Utah State University, USA)

Abstract: Access to justice remains one of the fundamental principles of the rule of law. United States Institute of Peace declares "Access to justice consists of the ability of individuals to seek and obtain a remedy through formal or informal institutions of justice for grievances" . The original US constitution was four pages and a few thousand words long. But with new additions to laws and bills every year, understanding legal texts or navigating through them in itself requires very specialized training and skills. Moreover, most legal processes and arguments rely on precedents from the past and the previous interpretation of laws. Because of this, having access to the last case documents is very important. Unfortunately, these case documents are often very long, and parsing through them is time-consuming. Case summaries are written to aid people, mainly professionals in legal services, to quickly parse through many legal documents by highlighting essential information in court opinions.

02:20 pm: *Metadata in Tweets: Broadcasting a Lot More Than What You Tweet*

Aashish Ghimire (Utah State University, USA); John M Edwards (Utah State University, USA); Rita Ghimire (Utah State University, USA)

Abstract: With the increasing misuse of Twitter, it is essential to examine the privacy expectations of its users. In this study, we examine whether metadata can be used to identify the location of the author of a tweet. We explore different classification techniques and evaluate their performance in identifying the author's location. Our results show that Twitter metadata can be used to identify the author's location with an accuracy of above 90%. We identified followings and followers as the most important metadata for such prediction. These findings have significant implications for privacy concerns and highlight the need for greater awareness of the potential risks associated with using social media platforms such as Twitter.

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

IndDem: Poster/Industry

Demonstration

Session time	Friday, 03:00 pm until 04:00 pm
Location	Engineering Building Event Space

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

Posters: Poster/Industry

Demonstration

Session time	Friday, 03:00 pm until 04:00 pm
Location	Clyde Building Step Down Lounge

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

S3T1: Session 3, Track 1

Session time	Friday, 04:00 pm until 05:40 pm
Location	126 MARB
Talk time	20

04:00 pm: *Comparison of Saturated Headways in Mixed Traffic Conditions at Signalized Intersection*

Mohammad Shareef Ghanim (Ministry of Transport, Qatar); Khaled Shaaban (UVU, USA); Ghassan Abu-Lebdeh (American University of Sharjah, United Arab Emirates)

Abstract: Traffic headways in saturated conditions are an important aspect of traffic engineering. Intersection's capacity and passenger car equivalency factors are derived from analyzing those saturated headways as queues are discharged. However, limited studies investigated the effect of the type of preceding vehicle on headways. This study aims to compare the headways of two main vehicle classes, passenger cars, and heavy trucks, and to examine if the preceding vehicle class has an impact on those headways. Saturated headway data were collected from a signalized intersection that experiences significant heavy truck demand. Statistical tests with a 95% confidence level are considered for the headways comparison. As expected, the results show that their average headway for passenger cars is different from the heavy trucks. Contrary to the expected, and for the same vehicle type, the results show no statistical difference between headway, regardless of the type of the preceding vehicle.

04:20 pm: *Modeling of Severity in Red-Light-Running Crashes Using Deep Learning Recognition*

Khaled Shaaban (UVU, USA); Mohammad Shareef Ghanim (Ministry of Transport, Qatar)

Abstract: One of the main factors that contribute to the high number of crashes at signalized intersections is noncompliance with traffic signals or in other words, cutting the red-light signal. Analyzing red-light-running crashes (RLR) and their related factors is of great importance in developing evidence-based platforms for establishing effective traffic regulations and road safety programs. The purpose of this study is to understand the factors affecting the severity of RLR related crashes using a sample from the State of Florida in the United States. All crashes used in the analysis were verified to ensure that the main contributing cause was the red-light violation. The crash severity classification was conducted using deep learning neural networks. The impact of improving lighting conditions, road surface, signal visibility are examples of some factors that the deep learning recognition model can be used to evaluate their improvement in reducing crash severity. The model shows a good recognition ability, where the success rate is higher than 77%. It should be noted that Florida has a tropical climate where annual temperature, sunshine hours, and rainfall do not extremely vary throughout the year. Conducting similar studies using data from other states would be beneficial to validate the results obtained.

04:40 pm: *Measuring Seat Belt Compliance Among University Students*

Khaled Shaaban (UVU, USA); Steven Taylor (Utah Valley University, USA)

Abstract: The seat belt use data were collected for 845 students and 286 staff at Utah Valley University (UVU). The results indicated that the seat belt use rate was 88.9%, which is similar to the Utah State average seat belt use of 89.0%. The results also indicated that drivers of small trucks had the lowest rates of seat belt use. Truck driver seat belt use rates were 70.2%. Male drivers had lower use rates than female drivers (86.9% compared to 91.8%). This study helps UVU identify groups to target for remediation efforts. Different solutions were recommended including increased enforcement, marketing campaigns, and permanent signage.

05:00 pm: *Measuring Traffic Noise for Different Types of Vehicles*

Khaled Shaaban (UVU, USA); Abdelrahman Abouzaid (Qatar University, USA)

Abstract: Noise is a major cause of annoyance in urban areas. One of the major sources of noise is motor vehicles. In this study, noise generated from different types of vehicles was investigated by collecting and analyzing relevant field data. The results indicate that heavy trucks generate the highest noise followed by buses and trucks. On the other hand, pickup trucks and sedan vehicles generate the lowest sound levels. This study showed a direct correlation between vehicles' speed and their noise level and an inverse relationship between distance and noise. The study found noise level values generated by vehicles in the second lane are 2.64 dBA, on average, a lower value than that of vehicles in lane one.

05:20 pm: *An Artificial Intelligence Approach to Estimate Peak Hour Travel Time*

Mohammad Shareef Ghanim (Ministry of Transport, Qatar); Khaled Shaaban (UVU, USA); Abdulla Siam (Qatar University, Qatar)

Abstract: Average delays are an example of traffic network performance measures. They can be measured at intersections to estimate the average delay per vehicle at various levels, such as intersection, approach, or lane group. On the other hand, average delays at a given route are implicitly measured by estimating the difference between free-flow travel time to the observed ones. Different methods are used to estimate travel time for a given route, such as floating car, average speed, and vehicle tracking methods. This paper focuses on developing an artificial neural networks (ANN) model to predict travel time for specific routes based on field travel time measurements and other easy to measure characteristics, that are related to geometric layouts, peak-hour periods, posted speed limits, and route lengths. Travel time data for 75 different segments located in the State of Qatar were studied. Directional travel time data were measured in three different peak periods. A total of 450 travel time values were collected and analyzed. An ANN model was trained to estimate travel time. The results show that the ANN model was able to provide a reasonable estimation of travel time using limited information. The slopes of the regression plots between observed and predicted travel time values show a clear linear trend, with slopes around 0.85, and an intercept that is around 2.0.

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

S3T2: Session 3, Track 2

Session time	Friday, 04:00 pm until 05:40 pm
Location	128 MARB
Talk time	20

04:00 pm: *Pulsatile Impedance Monitoring Circuit*

Sharisse Poff (Brigham Young University, USA); Daniel Tebbs (BYU, USA); Robert C Davis (Brigham Young University, USA); Shiuh-hua Wood Chiang (Brigham Young University, USA)

Abstract: The ability to monitor a varying impedance has a range of applications, including the measurement of biological properties using bioimpedance analysis. For this type of impedance monitoring, the human heartbeat plays a role, motivating a desire to monitor pulsatile impedance changes. A four-point circuit for pulsatile impedance monitoring is designed, simulated, and built on a PCB. The circuit design is described. The circuit's ability to measure constant impedance across frequency and extract lumped element values is characterized. Using a photoresistor setup, the circuit's response to pulsatile impedance variation ranging from 500 Ω to 70 kΩ is measured and analyzed. The measured circuit settling time for an impedance change as large as 70 kΩ is 40 milliseconds, sufficient speed for heartbeat-rate pulsatile impedance monitoring.

04:20 pm: *Evaluation of Decision Tree for Predicting Patients' Length of Stay After Arthroplasty Surgical Procedures in the Rural Healthcare*

Nejc Sitar (Montana State University, USA); Faraz Dadgostari (Montana State University, USA); Bradley M Whitaker (Montana State University, USA); Bernadette McCrory (Montan State University, USA)

Abstract: Predicted inpatient length of stay (LOS) after total joint arthroplasty (TJA) is important information that sets the expectation for the post-surgical recovery period, which helps hospital management plan, and manage surgical resources as efficiently as possible. In this study, the accuracy of prediction models for predicting patients' LOS in a rural community hospital was conducted in the Northwest United States of America. Data were collected from 181 patients for hip, knee, and shoulder surgeries. A decision tree (DT) prediction model was compared with the National Surgical Quality Improvement Program (NSQIP) calculator for predicting LOS of TJA. The DT model (RMSE = 0.67) provided a more accurate LOS prediction than the NSQIP calculator (RMSE = 1.18). Furthermore, a greater level of interpretability of the decision-making process makes the DT model very applicable in "high stakes" environments like healthcare.

04:40 pm: *Supine and Lateral Recumbent Posture Recognition for Improving Automatic Respiratory Measurements*

Siddat Nesar (Montana State University, USA); Bryce Hill (Montana Tech University, USA); Ryan Stapley (Montana Technological University, USA); Bradley M Whitaker (Montana State University, USA)

Abstract: Lidar can be a useful tool in monitoring human postures and can be helpful in healthcare facilities. For this study, subjects were lying on the bed either on their back (supine) or side (lateral recumbent). Previous work utilizes this data to calculate the respiratory rate and tidal volume. However, any unwanted movements will give erroneous results as they are invalid data. This work explores approaches for automatic posture recognition, which can be used to improve the accuracy of respiration rate and tidal volume calculations by detecting invalid data. We extract features from the lidar data for traditional machine-learning classification. We also explore deep learning-based image classification. Our preliminary results are promising with a small dataset, and we plan to do rigorous testing with more subjects' data.

05:00 pm: *Classification System of Breast Cancer Using Machine Learning on Hu Moment Invariants and GLCM Features*

Yessi Jusman (Universitas Muhammadiyah Yogyakarta, Indonesia); Rika Nursanthika (Universitas Muhammadiyah Yogyakarta, Indonesia); Anna Nur Nazilah Chamim (Universitas Muhammadiyah Yogyakarta, Indonesia)

Abstract: Breast cancer is a devastating disease with a high mortality rate. In most cases, women are the ones suffering from breast cancer. Mammogram screening is the most prevalent method to diagnose this disease. The mammogram images are manually examined by radiologists. Machine learning can help medical personnel and reduce the possibility of misdiagnosis. The Hu moment and Gray Level Co-occurrence Matrix (GLCM) were employed for feature extraction. Moreover, Support Vector Machine (SVM) and K-Nearest Neighbors (KNN) were utilized for breast cancer classification. The mammogram images in this study were taken from the Curated Breast Imaging Subset of Digital Database Screening Mammography (CBIS-DDSM). GLCM combined with Weighted KNN depicted the highest accuracy of 97.8%.

05:20 pm: *Study on the Sanitization Efficacy for Safe Use of 3D-Printed Parts for Food, Engineering, and Medical Applications*

Matt A Thomas (UVU, USA); Israd Jaafar (Utah Valley University, USA); Abdennour Seibi (Utah Valley University, USA); Abolfazl Amin (Utah Valley University, USA)

Abstract: Sanitization efficacy for safe use of 3D-printed parts for food and medical applications has been established in a 4-month lab study and controlled tests. The present study examined the continued use of sanitation techniques across 3 more months of testing and experimentation. Multiple specimens of the most common thermoplastics for Fused Filament Fabrication (FFF), were printed with a range of settings to test for bacterial/biofilm, masking (hiding) in the layer lines, gaps, and other imperfections of said prints. This study investigates methods of sanitation and cleaning to reduce or eliminate pathogens along with its biofilms from the defects and interstitial spaces that naturally occur in FFF printing. Results from various testing methods used in labs, indicate that 3Dprinted parts of PLA/PLA+ (Polylactic Acid), and PETG (Polyethylene terephthalate glycol) can be cleaned to safe levels using warm water (120 °F), and non-concentrated dish soap. Examination and verification of cleanliness were completed via Petri dish preparations, and protein residue testing. It was found that Colony Forming Units (CFU) and Plaque Forming Units (PFU) had been reduced by 90%. Experimental results indicate that baking soda, when used with soapy water, may eliminate biofilms by chemical and physical action. It was also found that a 2-minute room temperature bleach water soak (200ppm), after a wash and rinse with soapy water, dissolved biofilms and pathogens to safe levels when tested by surgical technicians. It is noted to the reader that sanitation in

this context refers to the method of bringing a surface or object to safe levels of cleanliness for food or medical preparation and storage.

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

S3T3: Session 3, Track 3

Session time	Friday, 04:00 pm until 05:40 pm
Location	108 MARB
Talk time	20

04:00 pm: *Teachers' Perception and Experiences of Computer Science Education in K-8 Schools*

Vaibhav Anu (Montclair State University, USA); Sumi Hagiwara (Montclair State University, USA); Katherine Herbert (1 Normal Ave & Montclair State University, USA); Kazi Zakia Sultana (Montclair State University, USA); Minsun Shin (Montclair State University, USA); Rebecca Goldstein (Montclair State University, USA); Patricia Virella (Montclair State University, USA)

Abstract: Supported by a state grant, our team of researchers (consisting of both Computer Science faculty and Teacher Education faculty) is offering a series of Professional Development sessions to K-8 teachers. These Professional Development (or PD) sessions are meant to help K-8 teachers develop their understanding of core computing concepts (such as algorithms, programming, data analysis, and networks) and thereby develop strong computer science programs for their students. In order to offer effective and meaningful Professional Development (PD) sessions, our research team first intended to understand the perceptions and experiences of K-8 teachers about Computer Science (CS) and Computational Thinking (CT) education. This paper presents the results of a K-8 teacher survey that we conducted as a pre-cursor to our PD series. The results of this survey provided valuable insights about elementary and middle-school teachers' perceptions of computer science education, self-perception of their ability to teach and learn CS, and understanding of CS discipline and those who typically engage in CS activities. The impact of teachers' perceptions impact how leaders in education and the CS industry can meet the needs of teachers, who in turn can meet the growing demand of CS education in K-8 schools.

04:20 pm: *Digital Storyboards: Making CS Elementary*

Scott Bartholomew (Brigham Young University, USA); Jessica M Yauney (Brigham Young University, USA); Veronica Wuthrich (Brigham Young University, USA); Katie Wolfley (Brigham Young University, USA); Emerson Elya (Brigham Young University, USA); Peter Rich (Brigham Young University, USA); Steven Shumway (Brigham Young University, USA); Geoff Wright (Brigham Young University, USA)

Abstract: The Utah Computer Science Education Master Plan (UCSMP) called for significant increases in the CS offerings in K-12 schools, accordingly over $10 million was allocated to Computer Science (CS) Education in Utah in 2020. Sadly, many teachers have not been provided with sufficient training to integrate CS principles into their classes. The Digital Storytelling project is a design- based research project which began to address this need by training both current and future teachers in CS education. Undergraduate teacher education students were

partnered with elementary teachers to facilitate a unit focused on designing, building, and coding "digital storyboards." These storyboards incorporate electronics and coding. Students are given 10 weeks of guided instruction in storytelling, wiring, coding, and building. Student data from pre/post surveys related to their interest in, and aptitude for, computer science was collected, and both students and teachers were interviewed. While efforts are ongoing, the results after working with 8 classrooms show positive results in how projects such as this can help promote CS training and learning for students and teachers.

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

S3T4: Session 3, Track 4

Session time	Friday, 04:00 pm until 05:40 pm
Location	109 MARB
Talk time	20

04:00 pm: *Vulnerability of Prime Based Cryptosystem*

Jingpeng Tang (Utah Valley University, USA); Wenguang Xu (Southwest Jiaotong University, China)

Abstract: It is practically impossible to break a cryptosystem like RSA if the key is large enough with the prime numbers are randomly distributed. Recent research shows prime numbers show a certain distribution pattern. This makes it practically possible to break such systems by solving the factoring problem. By computing the distribution probabilities and finite field incremental changes of connected prime numbers, we have validated Robert J. Lemke Oliver and Kannan Soundararajan's study findings on trailing prime numbers. We proposed and developed ranked selection algorithm on prime number distribution. We developed a number of applications, including proposing one for fast factoring the product of two large prime numbers, also known as the factoring problem.

04:20 pm: *Programmer Cognition Failures as the Root Cause of Software Vulnerabilities: A Preliminary Review*

Darsh Patel (Montclair State University, USA); Hetkumar Patel (Montclair State University, USA); Kazi Zakia Sultana (Montclair State University, USA); Vaibhav Anu (Montclair State University, USA)

Abstract: The causal analysis of software vulnerabilities can be an effective way for building and evolving a dependable and reliable software system. Vulnerable source code can be leveraged by the attackers to break the system. Assisting the programmers so that they can avoid writing vulnerable code can cut down the effort and cost of protecting the software from security incidents. Security vulnerabilities can be prevented by identifying those programmer behavior related root causes that are the recurring reasons for the security bugs. Such repeated erroneous behavioral patterns have been coined as human cognition failures or human errors. In the case of software development, these erroneous behavioral patterns can lead the programmers to write vulnerable code. The goal of this research is to explore the available literature to identify frequently occurring programmer human errors in software implementation so as to provide programmers a handy list of cognitive issues that can be avoided by just being aware of them. Our literature review identified eight papers from where we extracted 20 human errors by programmers that have the potential to lead to writing vulnerable code.

04:40 pm: *Membership and Participation in Object Oriented and Procedural Paradigms*

Grant J Nelson (Gianforte School of Computing, Montana State University & Workiva, USA); Clemente Izurieta (Montana State University, USA); Derek Reimanis (Gianforte School of Computing, Montana State University, USA)

Abstract: Analyzing technical debt (TD) periodically with software tools is an important activity to help mitigate maintenance issues and sustain high levels of quality in software. Software written in Object Oriented languages (OO) have more dedicated TD analysis tools than software written in Procedural languages (PL) since many of the analysis techniques describe metrics that implicitly use a method's membership to a class in their calculations. The research described in this paper provides the conceptual foundation for using a membership matrix (used in current TD analysis techniques) and a participation matrix in TD analysis. Our early-stage research work proposes the participation matrix as a superset of the membership matrix and defines the mathematical requirements that must be met by a participation matrix constructed by any procedure. The participation matrix is defined as a fuzzy estimate of memberships and can be used to leverage TD analysis designed for OO to analyze PL programs. The operational implications of this work can allow practitioners to significantly benefit from improved TD tools that are also available in PL software.

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

S4T1: Session 4, Track 1

Session time	Saturday, 09:00 am until 11:00 am
Location	126 MARB
Talk time	20

09:00 am: *Reducing the Carbon Footprint of Concrete by Expanding the Use of Supplementary Cementitious Materials*

Matthew W Evans (13491 Zarthan Ave S & Brigham Young University, USA); W. Spencer Guthrie (Brigham Young University, USA)

Abstract: Within the concrete industry, a viable approach for decreasing the carbon footprint of concrete projects is the use of supplementary cementitious materials (SCMs) to replace a portion of portland cement. While a variety of SCMs have been identified and used in concrete, renewed efforts to reduce carbon dioxide emissions may require development of new sources of SCMs. The objective of this research was to summarize information about several potential SCMs and propose new research that should be conducted to address current and future needs. Specifically, information about fly ash, volcanic materials, glass, and agricultural waste products is presented.

09:20 am: *Canal Embankment Stabilization Using Cementitious Slurry Injection*

Lance Guthrie (Timpview High School, USA); Eliza Jenkins (Timpview High School, USA); W. Spencer Guthrie (Brigham Young University, USA); Robert Stevens (Brigham Young University, USA); Amy McElwee (Infrastructure Research, LLC, USA)

Abstract: The objective of this paper is to document a residential project in which canal embankment stabilization was performed using injection of cementitious slurry. Concerns about the possible breaching of the embankment between the residential property and the canal were addressed through the implementation of a solution involving injection of a cementitious slurry into a portion of the embankment to fill subsurface voids and bind the soil particles together, with the desired outcomes of decreasing the permeability of the soil and increasing the strength of the embankment. Because the procedure involves improving the existing soil rather than replacing it, continuous functionality of the embankment is ensured during the slurry injection process. A slurry mixture consisting of approximately 60 percent portland cement, 20 percent fly ash, and 20 percent lime by weight was batched on site at a minimum water-cementitious materials ratio of 0.50. Plasticizer and hydration stabilizer were added to provide improved consistency and sufficient working time, respectively. While water from the canal will naturally continue to permeate the embankment during each irrigation turn, the injected slurry now restricts and/or controls water movement from the canal into the property.

09:40 am: *Smartfoam Based Pressure Mapping*

Jake D Sundet (Brigham Young University & Nano Composite Products, USA); Stephen Schultz (Brigham Young University, USA); Jake Merrell (Employer, USA); Trevor Christensen (Co-worker, USA); Maxwell Tree (Co-worker, USA)

Abstract: Pressure injuries cause pain both physically and financially. By creating a comfortable and comparatively less expensive pressure mapping system, pressure injuries can more easily be prevented, and a large expenditure avoided. Before full body pressure mapping systems can be made, a smaller scale model provides proof of concept while filling a different need in the rehabilitation and physical therapy industry. Nano composite piezoresistive foam (NCPF) is an inexpensive foam that can be used to measure a static load while still providing a comfortable interface. As the foam compresses, the impedance changes, correlating directly to the change in strain. Using the NCPF enabled pressure mapping system a pressure measurement with an r-squared value of 0.956 was shown. By using the physical rehabilitation system described in this paper, those with lower body injuries will gain a greater opportunity for faster healing and improved performance.

10:00 am: *Fire-Induced Charring of Common Residential Siding Types*

Makenzie Wilson (Brigham Young University, USA); Thomas H. Fletcher (Brigham Young University, USA); Taylor J. Sorensen (Brigham Young University, USA)

Abstract: The increase in the number and severity of wildfires over recent years due to the recent expansion and growth of rural areas has led to an increased risk of wildfire damage for structures at the Wildland-Urban Interface (WUI). This paper investigates the feasibility of permanent passive fire protection to protect homes and communities from the damage caused by wildfires using flame-resistant materials easily applied during new construction or installed in retrofitting existing structures. This proposed method of protection would provide continuous protection without any lengthy set up required for immediate wildfire protection and would limit fire damage to the most external and easily replaceable components of a structure. Small scale models were tested using five different flame-resistant materials and three types of siding including: wood siding, vinyl siding, and hardie board. Thermocouples were placed in 9 different locations of the models, and the percent difference in temperature between thermocouples on the exterior and interior of the front facing walls was calculated to compare the performance of the different types of siding. An evaluation of char was also conducted to analyze the effectiveness of each type of siding against direct flame contact. Preliminary results show that hardie board provided the most protection in the event of a wildfire because it prevented charring of the internal components of the model and minimized change in internal temperature.

10:20 am: *Establishing Connectivity for Isogeometric and Hybrid FEA/Isogeometric Analyses With Multiple Parts Through Beam Element Projection*

Brian Shawcroft (Brigham Young University, USA); Kendrick M Shepherd (Brigham Young University, USA)

Abstract: This paper introduces a simple method to establish connectivity information for isogeometric assemblies given potentially erroneous beam-based connectivity data through projecting endpoints of beams onto target spline surfaces using techniques already available in most computer-aided design software. The proposed method is simple, readily implementable, introduces minimal deviations from original connectivity information, and is shown to be suitable for analysis input in LS-DYNA.

10:40 am: *An Analysis of the Structural Performance of Cross and Chevron Diagrid Structural Frame Configurations and Cost-Effectiveness of Buoyant Foundation System Incorporated Into an Amphibious House Design*

Angelo R. Sayson (Mapua University, Philippines); Rose O. Cabrera (Mapua University, Philippines); Dante Silva (Mapúa University, Philippines)

Abstract: The Philippines, a country belonging to the Pacific ring of fire, experiences many natural disasters frequently. These natural disasters include typhoons, volcano eruptions, heavy flooding, and very high seismic activity, which inflict massive amounts of damage on the country's socioeconomic, environmental, and, most importantly, infrastructural aspects. The recent typhoon Ulysses alone, which made landfall in the country last November 8, 2020, has dealt with approximately 20.8 billion pesos in infrastructural damages. In Provident Village in Marikina City, flood depths rose to 6 meters at the height of typhoon Ulysses causing damage to properties such as houses and cars as well as thousands of people being displaced. In this study, the goal was to design an amphibious residential building based on the hazard parameters of this village, which mitigates inundations caused by intense rains brought by typhoons, as well as the lateral forces acting on a structure due to massive earthquakes and heavy-blowing winds. This proposed house design comprises the Diagrid structural system, a very efficient frame that resists the said lateral forces, and the buoyant foundation system, which enables flotation of the whole house, mitigating most, if not all, flood damages. To achieve this goal, the researchers compared the two primary diagrid framing configurations that can be applied on a house, chevron, and cross configurations with 15 height samples each in terms of structural performance criteria: lateral stiffness, drift, and displacement, to determine the framing type for the proposed design. In the end, the cross frame is better and more efficient than the chevron frame by an average of 74% less frame displacement, so it was chosen to be the primary frame in the proposed design. As for the evaluation of flood mitigation, the researchers determined the flood depth data from various locations near the village and found that the proposed design was cost-effective in some areas. Flood depth predominantly affects how the cost-effectiveness of the buoyant foundation system is evaluated, with higher flood depths up to 4 meters, leading to larger Loss Avoidance Ratios (LAR), wherein a LAR greater than 1.00 is considered to be cost-effective. Keywords- Diagrid Structural System, Chevron and Cross Frame Configuration, Buoyant Foundation System, Amphibious Residential Building, Loss Avoidance Analysis

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

S4T2: Session 4, Track 2

Session time	Saturday, 09:00 am until 11:00 am
Location	128 MARB
Talk time	20

09:00 am: *Conformal Open-Air Electroplating of Through-Wafer Vias*

Dillon R Jensen (Brigham Young University, USA); Madeline Thompson (Brigham Young University, USA, USA); Topher Johnson (Brigham Young University, USA, USA); Gregory Nielson (Nielson Scientific, USA); Stephen Schultz (Brigham Young University, USA)

Abstract: A method is described for depositing high-density metal in through-wafer vias. This method requires that the cathode end of the via be left open to the air to facilitate electrolyte diffusion, especially in the early stages of the electroplating process. An open-air electroplating process is of value in high aspect-ratio settings. The process is demonstrated by electroplating copper through a crack with an aspect ratio of 6.8.

09:20 am: *Speeding Up Direct-Write Laser Ablation Process for Microstructures*

Bradley E Ferguson (Brigham Young University & Nielson Scientific, USA); Ryan S Lee (Nielson Scientific, USA); Joseph Eddy (Brigham Young University, USA); Jared E Payne (Brigham Young University, USA); Gregory Nielson (Nielson Scientific, USA); Stephen Schultz (Brigham Young University, USA)

Abstract: The process of ablating a substrate directly with a highly focused femtosecond laser allows for the creation of microstructure features on the order of one micrometer. The small ablation spot size trades precision for speed, thus methods for speeding up the ablation process are explored in this work. Combining a galvanometer with a 3-axis stage allows fast ablation times on arbitrarily large-sized substrates. Depending on the geometry, experimentation in this work shows increases in fabrication speed of over 120x.

09:40 am: *Verification of Metal-Mesh Filter Response via ANSYS HFSS Simulation*

Hunter Stevenson (Brigham Young University, USA); Jared E Payne (Brigham Young University, USA); Joseph Eddy (Brigham Young University, USA); Bradley E Ferguson (Brigham Young University &

Nielson Scientific, USA); Ryan T Beazer (Brigham Young University, USA); Gregory Nielson (Nielson Scientific, USA); Stephen Schultz (Brigham Young University, USA)

Abstract: Metal Mesh Filters (MMFs) are advantageous for use in the THz regime. An MMF was previously fabricated using a novel laser ablation technique. To validate the fabricated filter's response, and thus the fabrication technique, a model of the filter is created in ANSYS HFSS and the transmission response simulated. The model matches the geometry and material properties of the fabricated filter, making use of boundary conditions to simplify computation. The model simulation shows similar response to the measured filter's response, validating the fabrication technique. Considerations for future use and development of the simulation are discussed.

10:00 am: *Optimized Free Space Emission From Layered Diamond Microdisk Resonators*

Helaman R Flores (Brigham Young University, USA); Benjamin Szamosfalvi (Brigham Young University, USA); Yuqin Duan (Massachussetts Institute of Technology, USA); Ian Hammond (Massachussetts Institute of Technology, USA); Ryan Camacho (Brigham Young University, USA); Dirk Englund (MIT, USA)

Abstract: In this work we utilize topology optimization to design and simulate an etching pattern for a layered diamond microdisk for efficient coupling from a nitrogen vacancy center emitter to free space. Other methods of coupling a waveguide to a quantum emitter are also explored in simulation.

10:20 am: *Using Reflected Light as a Measure of Best Focus and Control Variable in an Ablation-Focused Optical System*

Joseph Eddy (Brigham Young University, USA); Bradley E Ferguson (Brigham Young University & Nielson Scientific, USA); Gregory Nielson (Nielson Scientific, USA); Jared E Payne (Brigham Young University, USA); Stephen Schultz (Brigham Young University, USA); Hunter Stevenson (Brigham Young University, USA)

Abstract: We use a femtosecond laser with a high numerical aperture to ablate precise sections of a metallized polymer for various purposes. For best performance, the focus of the laser must always remain as close to the surface as possible. Here we detail a control system that uses the light reflected from the metallized surface to ensure the focus remains within 1.77 micrometers of the surface, resulting in uniform ablation behavior across a relatively large area of the sample. We achieved an ablated metal-mesh filter with 86% accuracy on the first pass with this approach.

10:40 am: *Low-Cost, Open, Citizen Science With IoT and TinyML*

Srihari Yamanoor (Self, USA); Narasimha Sai Yamanoor (Self, USA); Satyakanth Thyagaraja (Self, USA)

Abstract: Citizen scientists are helping expand the reach of science through volunteers who collect data, analyze data, or do both. Fields of research range from biology to weather, astronomy, and beyond. The Internet of Things (IoT) is a tool that will expand data collection, while machine learning assists with predictive analytics and where applicable, edge solutions. Citizen Science projects have the best chance of success when they enhance participant recruitment and retention. The current work demonstrates that low-cost and efficient IoT solutions can be implemented alongside innovative machine learning tools, specifically TinyML, while positively impacting participation. . A specific implementation of a conference badge design, that uses low-cost design elements and sensors, aimed at citizen science for data collection and analysis is described in the current work.

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

S4T3: Session 4, Track 3

Session time	Saturday, 09:00 am until 11:00 am
Location	108 MARB
Talk time	20

09:00 am: *Early Submission of Project Analysis Milestones Correlates Positively With Student Project Performance; Incentives for This Early Project Analysis Positively Changes Student Behaviors*

Jaxton Winder (Utah State University, USA); John M Edwards (Utah State University, USA); Erik Falor (Utah State University, USA)

Abstract: Students submitting project milestones early correlates with better performance on project submissions as a whole. In our study, these milestones correlate with the creation of documentation for analyzing the project they are to work on. These milestones are submitted at least 5 days before a project is due during a nearly 2 week assignment period. There is statistical significance in positive correlation between assignment performance and early submissions of these project milestones for analyzing a project's requirements. Additionally, there is statistical significance that incentivizing students with "grace points" for doing this early analysis changes student behavior, leading to earlier work on projects.

09:20 am: *Implementing a Competency-Based Education Curriculum in a Semester Format Across Individual and Group Courses*

Paul Cheney (Utah Valley University, USA); Daniel Hatch (800 West University Parkway & Utah Valley University, USA); Eric Oliver (Utah Valley University, USA)

Abstract: This paper presents how competency-based education principles have been used in the Web Design and Development program at Utah Valley University and how this approach may transfer to a semester-based college/university setting. Self-paced individual student competency learning is compared against that of student group-based learning and how to make equivalent curricular experiences across several teaching modalities. Individual-paced classes afford an easy transition to online or live-streaming modalities. Team-based classes don't easily allow for either an online or live-streaming experience.

09:40 am: *Activity During High-Repetition Practice of Syntax*

Stephanie Gonzales (Utah State University, USA); Hillary Swanson (Utah State University, USA); John M Edwards (Utah State University, USA)

Abstract: Recent work has shown that repetitive, low cognitive load exercises may have benefits in gaining mastery of computer programming language syntax as well as positive scaffolding effects when learning problem solving. This paper presents results from a qualitative think-aloud study that explores two questions relating to what types of activities students engage in while completing syntax exercises and how the distribution of those activities changes with practice. We coded, with high temporal resolution, activities that study participants engaged in while completing syntax exercises. We find that students can gain mastery of simpler syntactic constructs through practice, while learning of more complex constructs can benefit from debugging and referring to previously completed exercises. In all cases, however, students appear to achieve proficiency in writing constructs after surprisingly few exercises. Our results suggest that a high-repetition learning framework for syntax meets stated goals of a safe and productive environment for students to learn syntax. We expect that our results will be generalizable to other settings in which practice is utilized as a pedagogical tool.

10:00 am: *Diagnose Digital Skills Gap Between Professional and Academic Sectors in Architecture Discipline - Jordan Case Study*

Anwaar Mohammed Banisalman (Alexandria University, Egypt); Ibrahim Maarouf (Alexandria University, Egypt); Ali Abu Ghanimeh (University of Jordan, Jordan); Amira Fathi (Alexandria University, Egypt)

Abstract: There are many studies and actual observations that there are changes in our world and rapid trends towards digitization, the newly graduated engineer has a way of thinking, currency, and outlook on engineering work. Research on the ability of universities to graduate qualified architects for the professional market has become necessary to bring about changes in teaching methods and link them to digital programs.This paper is looking at if there is a consensus between the opinion of professionals and academics about digital skills, trying to integrate urgent digital skills needed by the labor market in the Architecture education study plans. Mixed between quantitative and qualitative research methods researchers analyze the study plan of 12 universities, using the CMM method, and conduct a questionnaire for academics and professionals.Accordingly, we prove the gap between the profession and academic world in the discipline, there is no agreement between them about the digital programs needed, and provide a matrix expressing the relationship between the digital courses and the AE courses in away to connect the two .

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

S4T4: Session 4, Track 4

Session time	Saturday, 09:00 am until 11:00 am
Location	109 MARB
Talk time	20

09:00 am: *A Comparative Analysis on Load Balancing and gRPC Microservices in Kubernetes*

Katherine Nieman (Utah Valley University, USA); Sayeed Sajal (Utah Valley University, USA)

Abstract: In this work, observations and insights on load balancing in gRPC microservices in Kubernetes using Go. gRPC holds a single client-server connection until the connection completes, making it tricky to load balance gRPC requests across multiple server resources. This also means that, without careful configuration, scaling the server resources may not provide any help in handling loads of client RPC requests. Luckily, Go's gRPC library has some built-in functionality for load balancing using round-robin logic. However, this involves bypassing some of the features in Kubernetes by making the server a headless Service. A maximum connection age can also be configured in gRPC servers to reduce connection times and give the client more chances to reconnect, which can create some balancing as well. To make these observations, we created and deployed multiple gRPC microservices in a Kubernetes cluster, and adjusted many aspects of their configurations to observe the behavior changes. The source code for this project is located on GitHub.

09:20 am: *The Art of RFID Hacking*

Kolin Nielson (Utah Valley University, USA); Sayeed Sajal (Utah Valley University, USA)

Abstract: Many places use cards or badges to gain access to secure areas. These areas can be server rooms, and control centers, and are even used to gain access to your hotel room. These cards carry an RFID(radio frequency identification) specific to what the card reader is looking for and gives you access when the correct ID is read. These cards/badges are actually pretty easily hacked, and their stored data is copied to be used by the hacker whenever they please. The hacker doesn't even have to steal your card to copy it; they simply need a device such as the Tastic RFID Thief. The Tastic is a device that can copy an RFID from feet away. Someone just needs to be in your proximity, and they can have the necessary information to gain access to anything that card/badge allows. As seen this is a massive problem that not many people know about, and it needs to be addressed. One solution would be to eliminate those RFID cards in general and the problem would disappear. However, for places such as hotels, this system is a handy and convenient way to give keys to their guests. So, another solution to protect the data on these cards would be to have some jammer. This jammer would block any unwanted source from obtaining its data but would allow the ID to be read by the appropriate door scanner. This might be impossible or require a battery to keep the jammer active. This, of course, means the card would have to be charged which is another issue. For a third solution, the card could also store a digital signature that couldn't be copied and, if tried, would be slightly different

from the actual signature. With this solution, only the cards with the correct signatures and IDs would allow access by the reader.

09:40 am: *AI in Cybersecurity*

Mary Corbett (Utah Valley University, USA); Sayeed Sajal (Utah Valley University, USA)

Abstract: Huge strides have been made recently in AI generated media. Writing, videos, audio and images are being created bearing more and more resemblance to work created by humans. There is still a way to go, but if things continue at the current rate, the Turing Test may be passed trivially. AI's continued development will cause a litany of new innovations and security issues alike. This research details the impact of this development so far, and the impending changes soon to come. The objective of the research is to evaluate the ability of implementations of AI to either bypass or reinforce preexisting security measures. This is exploratory research that will focus on qualitative research. AI has already had a lot of impact on the implementation of new security measures. AI leads to new levels of data analysis and detecting unusual behavior of all kinds across an entire network, which can rapidly increase security response times. There will also be more proactive AI that attempts to locate security vulnerabilities so that they can be secured. However, there are a number of new threats from AI. Attacks which use AI to perfectly mimic a voice means phishing attacks will rise in complexity and begin training algorithms, and when AI becomes able to simulate realistic conversation all on its own, this will lead to a number of growing security risks. AI itself will also become a new target for threats, for which entirely new security features will need to be generated.

10:00 am: *The Offshore Power Portal: A Web-Based Repository to Improve Offshore Wind Knowledge Dissemination*

Alexandra Reyes (Montclair State University, USA); Vaibhav Anu (Montclair State University, USA)

Abstract: Offshore wind is an emerging industry in the renewable energy domain. Multiple government and other agencies in the United States are increasingly trying to improve the awareness of general public on the topic of offshore winds. Moreover, although there are several offshore wind farms in other countries, the U.S. has only just begun to implement offshore wind farms off their coasts. Without proper knowledge of the benefits of these new giant wind structures there may be great opposition from several groups which may result in slower progress of this industry. In order to prevent opposition, it is imperative that the citizens of the U.S., especially those along the coast, have a full understanding of what offshore wind is, its benefits, and why it is important. To that end, a web-based knowledge portal, called the Offshore Power Portal, is being developed to educate the general public about all aspects of offshore wind in an easily accessible, ubiquitous, and simple-to-understand website. In the current paper, we describe some of the most important design elements of the website. This paper also presents the results from a user interface (UI) evaluation survey of our Offshore Power Portal. The UI evaluation was conducted using a survey consisting of 15 participants. Overall, our initial user interface evaluation of the website showed that the survey responders had a positive view of the website and found that the website will be effective in disseminating knowledge about offshore wind power.

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

Closing: Closing Session and Awards Presentation

Session time	Saturday, 11:15 am until 12:20 pm
Location	Engineering Building Event Space

IETC 2023: 2023 Intermountain Engineering, Technology and Computing (IETC)

2nd Day Lunch: Closing Lunch

Session time	Saturday, 12:20 pm until 01:40 pm
Location	Engineering Building Event Space