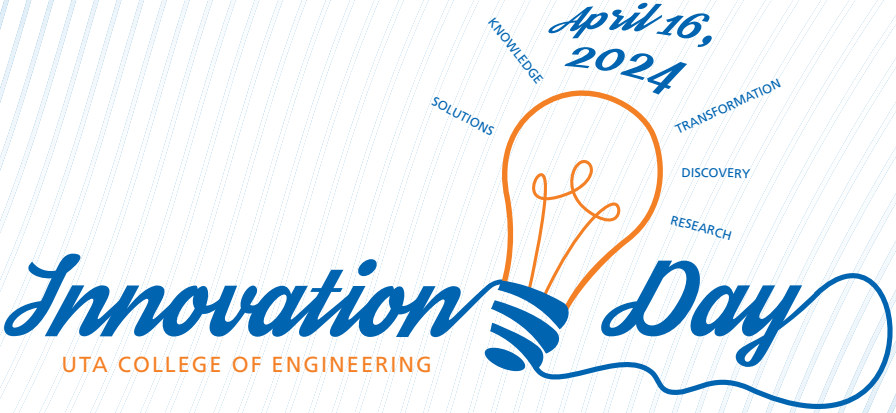

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1 – Developing Post-Pandemic Telecommuting Expectation Models (TeEMs)

Aiswarya Acharath Mohanakrishnan
Advisors: Melanie Sattler, Kate Hyun, Victoria Chen and Arpita Bhatt
Civil Engineering Department

Telecommuting, increasingly prevalent in today's workforce, has gained significant momentum amid the pandemic-induced shift towards remote work. This evolution prompts a reevaluation of worker travel behavior, necessitating adjustments in travel demand modeling to optimize transportation planning and service provision. This project aims to develop Post-Pandemic Telecommuting Expectation Models (TeEMs) for Metropolitan Planning Organizations nationwide. These models will integrate telecommuting into travel demand and emissions modeling frameworks, elucidating community-level mobility impacts. Employing supervised machine learning algorithms, the study predicts individual telecommuting choices and frequencies using post-pandemic data. A case study in the Dallas Fort Worth metroplex, utilizing variables from the 2017 National Household Travel Survey dataset, demonstrates TeEMs' application. Subsequently, a Transportation Impact scenario analysis examines telecommuting's effects on transportation, particularly changes in vehicle miles traveled, accounting for rebound effects pre- and post-pandemic. By comprehensively analyzing telecommuting's impact, this project contributes to informed transportation planning and policy-making in the evolving post-pandemic landscape.

2 – Anaerobic Digestion of Food Waste Components: Modeling Biogas Production

Opeyemi Adelegan and Sabu Jesly
Advisors: Melanie Sattler and Victoria Chen
Civil Engineering Department

Anaerobic digestion (AD) emerges as a key solution for managing commercial food waste, offering environmental benefits over traditional landfill disposal. The process saves valuable landfill space, accelerates food waste degradation and enables efficient biogas capture, thereby minimizing methane emissions. Estimating biogas production from food waste is complex due to varying compositions. This study developed predictive models for biogas production from different food waste categories in AD systems, considering the synergistic effects of co-digestants like sewage sludge, yard waste, fats/oils/grease (FOG), and paper waste. Batch tests conducted in laboratory reactors were analyzed for impact of waste composition and temperature on gas generation rates. This analysis will help in developing models based on laboratory-scale data, which can predict the methane generation rate constant (k). The experimental design used Latin hypercube with 6-factor mixture design and 4-factor mixture design. Data was collected to develop statistical models to predict gas generation from lab-scale reactors with different waste compositions. Reactors were operated as wet ADs at 90% moisture content and mesophilic temperature (30°C). Sewage sludge and green waste were chosen as co-digestants because they are two of the most common available waste, Preliminary experiments have shown certain waste combinations demonstrating enhanced gas generation.

3 – Termite Gut Microbe (TAV5) Application to Pulp and Paper Waste and Sugarcane Bagasse to Enhance Lignin Degradation and Boost Methane Production during Anaerobic Digestion

Doreen Ntiamoah-Asare
Advisor: Melanie Sattler
Civil Engineering Department

Pulp and paper and bagasse contain high levels of cellulose and hemicellulose, a biomass which is a potential source of renewable energy that can be accessed through anaerobic digestion to produce biogas. However, these wastes contain high levels of lignin, which is recalcitrant to biodegradation due to its structure. Hard wood has lignin content of 28-30%, soft wood contains 32-42%, and bagasse contains 17-23%. Not only is lignin recalcitrant to biodegradation, it also shields cellulose and hemicellulose, making them inaccessible to microbial degradation. To achieve anaerobic degradation of lignin in pulp and paper and bagasse wastes, this research used a novel approach: seeding with termite-gut microorganisms (TAV5), a bacterium strain of the family Opitutaceae from Termite-Associated Verrucomicrobium, isolated from the hindgut of Reticulitermes flavipes, containing genes coding for enzymes that structurally modify lignin. The goal is to investigate the use of TAV5 to biodegrade lignin and boost methane production from anaerobic digestion of the two waste streams. Specific objectives are to determine the optimal addition of TAV5 to enhance methane production from pulp and paper and bagasse wastes and to determine optimal pH levels for TAV5 degradation of pulp and paper and bagasse wastes.

4 – Flying Sensors: Using a Drone to Detect Micro-Urban Heat Islands

Junaid Ahmad
Advisor: Jessica Eisma
Civil Engineering Department

Satellite observations are extensively used to monitor land surface temperature (LST) changes owing to their global coverage. However, satellite observations are unable to capture small variations of LST because of their coarser spatial resolution. This can cause underestimation of urban heat islands, which is the difference in LST between urban and rural areas, occurring at a micro-scale within heterogeneous land uses in a metroplex. As an alternative, drones can be effectively used to detect micro-urban heat islands (MUHIs) by capturing LST at a high spatial and temporal resolution. We used a thermal camera onboard a drone to detect MUHIs in two seasons in a diverse location in the Dallas-Fort Worth Metroplex having two residential neighborhoods, one industrial area, and a natural park. A maximum MUHI of 25 °C and 15 °C was detected in the summer and fall seasons, respectively. Landsat satellite observations severely underestimated the MUHI in both seasons. The hotspots of severe LST were identified in the study area. Such studies can aid urban planning and design to reduce thermal discomfort and protect urban dwellers from the negative impacts of intense MUHIs on their health during heat waves.

5 – Evaluating an Elbow Exoskeleton for Reducing Work-related Musculoskeletal Disorders Risk: An Interdisciplinary Study

Eshwara Prasad Sridhar and Veysel Erel
Advisors: Mahmudur Rahman and Muthu Wijesundara
Industrial, Manufacturing and Systems Engineering Department

This study aimed to evaluate the effectiveness of an elbow exoskeleton in mitigating the risk of Work-related Musculoskeletal Disorders (WMSDs). WMSDs continue to pose significant health and economic challenges in occupational settings, particularly in tasks involving repetitive or forceful motions. Thirty percent of all days away from work cases in the U.S. are attributed to WMSDs. The elbow exoskeleton, developed by UTARI, offers a potential solution by providing assistive motion, aiming to reduce muscle strain and enhance task efficiency. To assess the elbow exoskeleton's efficacy, three occupational tasks were simulated: (a) a weightlifting task, (b) an assembly task with basic tools (no vibration), and (c) an assembly task with power tools (vibration). Seven participants from the university student population were recruited to perform the tasks with and without the exoskeleton. Metrics, including muscle activation (using electromyography) and user-perception were captured and analyzed. The results found that the exoskeleton reduced muscle activation, perceived workload, and fatigue, suggesting its potential to assist arm and hand movements across various work scenarios. The findings of this study will contribute to the growing field of wearable robotics aimed at enhancing occupational safety.

7 – Predictive Insights into User Satisfaction of a Parking App

Sai Sneha Channamallu and Apurva Pamidimukkala
Advisors: Sharareh Kermanshachi and Jay Rosenberger
Industrial, Manufacturing and Systems Engineering Department

Digital tools are pivotal in urban transportation, and understanding and predicting user satisfaction with these tools, particularly a parking finder app, is indispensable. This study explores the determinants of user satisfaction with such an app on a college campus, seeking to unravel the complex factors that shape user experiences with digital urban mobility solutions. This research could influence the development of user-centric applications and improve the overall effectiveness of urban transportation systems. Employing regression analysis on a dataset comprising over 500 user responses, we examine various factors to predict user satisfaction. This analytical approach is crucial for identifying which elements most significantly impact user experiences and satisfaction levels. The findings reveal noteworthy predictors of user satisfaction. Ease of parking stands out as a fundamental determinant, highlighting the importance of user convenience in the app's design. Moreover, the study uncovers that specific demographic groups have distinct preferences which significantly shape their satisfaction with the app. These insights are invaluable for app developers as they provide a data-driven foundation for refining functionalities to better align with user needs. Additionally, urban planners can leverage this information to integrate user preferences into smart city initiatives, thereby enhancing the overall efficiency and satisfaction of urban commuting experiences.

8 – Investigating the Impacts of Integrating Automation and On-Demand Mobility

Deema Nabeel Almaskati and Apurva Pamidimukkala
Advisor: Sharareh Kermanshachi
Industrial, Manufacturing and Systems Engineering Department

The convergence of autonomous vehicles (AVs) and on-demand transportation as shared autonomous vehicles (SAVs) can considerably alter travel behavior, and subsequently the ecological and societal aspects of the transportation sector. On-demand autonomous mobility is a promising transportation mode, but further research is required to analyze its various aspects and implications. We the effects of SAVs on the environment, public transportation, land use, vehicle ownership, and public acceptance. The impacts of each category was determined, classified according to their causes, and ranked according to their frequency of citation. The study demonstrated that SAVs can have a positive or negative impact on the categories and can potentially reduce mobility barriers and transportation inequity if policymakers use this technology to develop a better transportation system by initiating effective policies that regulate the four impacted areas. Additionally, we developed a list of policy recommendations to avoid the unfavorable effects of SAVs by optimizing their benefits and lowering their associated risks. The results of this study will be beneficial to AV manufacturers, transportation professionals, and especially policymakers, who have a significant influence on how society benefits from SAV technology.

9 – Evaluating the Root Causes of Parking Citations: A UTA Case Study

Atusa Javaheri and Apurva Pamidimukkala
Advisors: Sharareh Kermanshachi and Jay Rosenberger
Industrial, Manufacturing and Systems Engineering Department

Effectively managing parking on university campuses is a complex task, particularly when attempting to predict and understand the factors influencing the issuance of parking tickets. Insufficient communication and a lack of comprehensive awareness regarding parking guidelines contribute to a higher frequency of parking violations. This lack of understanding about parking rules and regulations impedes the university's capacity to efficiently manage parking and address the root causes of violations. This study aims to develop a machine learning model that not only predicts the number of parking tickets on the UTA campus but also identifies potential patterns or trends indicative of communication gaps or other issues contributing to these violations. Various features, such as time of day, day of the week, and campus events, were considered to enhance the model's accuracy. Beyond numerical predictions, the model uncovers insights into the reasons behind ticket issuances. This approach not only validates the model's predictive capabilities but also provides actionable insights for administrators to foster a more informed and compliant parking environment. The random forest model demonstrated promising

results, accurately forecasting the number of tickets issued on campus. The analysis revealed significant correlations between certain factors, such as peak class hours and ticket frequency.

10 – Exploring the Revenues of a University Parking Lot

Hao Wang and Apurva Pamidimukkala
Advisors: Sharareh Kermanshachi and Jay Rosenberger
Industrial, Manufacturing and Systems Engineering Department

The integration of technology into daily life has become ubiquitous, and its role is particularly pronounced in urban mobility solutions like parking finder apps. This research delves into the impact of such an app, specifically designed for a college campus, on improving parking revenues. This study uses the data of two parking lots, on a university campus and the data comes from three data files. If the app can increase revenue, then the residual of the forecast data after September 1, 2023, and the real data will be directional. An artificial neural network was used to build the model. The results revealed that the model resulted in a good mode fit and had a better R-squared value when compared to the predicted data with the real data on the training set and validation set. Therefore, it is concluded that the revenue of the parking lot increased after the app was launched.

11 – Micro Grid

Sanjeev Joshi, Sathya Narayanan Madabushi Sundararajan and Rahull Ganesan
Advisor: Erick C. Jones Jr.
Industrial, Manufacturing and Systems Engineering Department

Our project explores the repurposing of Nissan Leaf electric vehicle (EV) batteries within micro-grid systems, emphasizing their "second life" utility. As electric vehicle adoption rises, the potential to extend the lifespan of EV batteries beyond automotive use becomes increasingly attractive. Integrating these batteries into microgrids offers a sustainable and cost-effective solution for enhancing energy storage and grid stability. This abstract discusses the technical feasibility, economic viability, and environmental benefits of employing Nissan Leaf EV batteries in microgrid applications. By repurposing these batteries, microgrid operators can optimize their performance while reducing the environmental impact of battery disposal. The abstract also addresses key considerations, challenges, and potential strategies for effective implementation, underscoring the importance of collaboration between the automotive and energy sectors in driving the transition towards a more sustainable energy ecosystem. Overall, repurposing Nissan Leaf EV batteries for microgrid applications presents an opportunity to unlock additional value from existing resources while advancing the goals of sustainability and energy resilience.

12 – Machine Learning-Assisted Analysis and Design of Tow-Steered Composites

Bangde Liu
Advisor: Xin Liu
Industrial, Manufacturing and Systems Engineering Department

Tow-steered composites, featuring curvilinear fiber paths, promise enhanced mechanical performance in lightweight structures. However, the lack of specialized commercial design tools for these composites and the associated high computational costs present significant barriers to developing innovative structures in real-world applications. To address the first challenge, we developed a user-friendly Design tool of Advanced Tailorable Composite (DATC) as a plug-in code for widely used commercial finite element (FE) software packages Abaqus and MSC.Patran/Nastran. DATC offers an integrated design framework inside commercial FE codes so that users can easily define complex design settings and perform optimization analysis of tow-steered composites. To alleviate the computational costs of design optimization, we developed several neural network (NN) models to replace the expensive FE analysis. Additionally, to mitigate the training cost of the NN model, we introduced mixed-fidelity and transfer learning models, leveraging varying mesh densities within FE modeling to construct coarse (low-fidelity) and fine (high-fidelity) datasets. Case studies are performed to study the accuracy and efficiency of the NN-based optimization. Our findings demonstrate the improved efficiency of the NN-based models. Furthermore, the mixed-fidelity and transfer learning models achieve comparable accuracy to the high-fidelity FE models while significantly improving efficiency over the single-fidelity NN models.

13 – Electronic Exam Pad (EePad)

Meghana Chevva
Computer Science and Engineering Department

The Electronic Exam Pad (EePad) redefines the examination process with an eco-friendly, efficient, and secure solution. Serving as a digital question booklet, each student accesses personalized questions while professors control a centralized timer for synchronized exams. EePad's automated upload to a secure cloud eliminates paper waste, fostering environmental sustainability. Leveraging AI algorithms, the system provides instant, accurate grading, freeing educators from manual corrections. Biometric security, including face recognition, enhances the integrity of exams by preventing identity fraud. The EePad offers immediate feedback to students, enabling timely intervention and personalized learning support. Its scalability accommodates diverse academic settings, from small classrooms to large lecture halls. By addressing paper waste, manual corrections, and security concerns, EePad not only modernizes examinations but also contributes to a more efficient, sustainable, and secure educational ecosystem.

14 – Enhancing Robustness of Indoor Robotic Navigation with Free-Space Segmentation Models Against Adversarial Attacks

Qiyuan An
Advisor: Filia Makedon
Computer Science and Engineering Department

Endeavors in indoor robotic navigation rely on the accuracy of segmentation models to identify free space in RGB images. However, deep learning models are vulnerable to adversarial attacks, posing a significant challenge to their real-world deployment. In this study, we identify vulnerabilities within the hidden layers of neural networks and introduce a practical approach to reinforce traditional adversarial training. Our method incorporates a novel distance loss function, minimizing the gap between hidden layers in clean and adversarial images. Experiments demonstrate satisfactory performance in improving the model's robustness against adversarial perturbations.

15 – Human-Robot Interactive System for Warehouses using Speech, SLAM, and Deep Learning-based Barcode Recognition

Ayon Roy and Sama Nikanfar
Advisor: Fillia Makedon
Computer Science and Engineering Department

This paper presents an initial investigation of a speech-based human-robot interaction system for locating items in a warehouse environment. The system uses a 2D SLAM map and visual servoing with deep learning-based barcode recognition to identify and locate items based on user speech commands. The system was tested with and without item location in the SLAM map and achieved a 100% success rate in identifying and localizing items. The average speech processing time was recorded at 9.28 seconds, and the system demonstrated a best-case timing of 15.46 seconds and a worst-case timing of 3 minutes for identifying items on different tables. The proposed system has the potential to improve the employment opportunities and experiences of blind or visually impaired workers in the warehouse industry. Future work will focus on testing the system in real-world environments and improving its performance in cluttered and dynamic settings.

16 – Living Datasets: Towards Data-Centric AI Explainability and Bias Mitigation

Akib Zaman
Advisor: Cesar Torres
Computer Science and Engineering Department

In the existing landscape of machine learning and AI, much attention has been focused on the development of increasingly complex models. However, the datasets that serve as the foundation for these models have not received equivalent scrutiny, leaving a critical research gap. Most current approaches treat datasets as static entities, lacking the dynamism to adapt to changes in data, biases, or evolving requirements. This neglect undermines the models' adaptability, transparency, and ethical considerations, necessitating a new perspective on how datasets are created, managed, and interpreted. To address this gap, I introduce the concept of Living Datasets as dynamic, adaptable ecosystems that evolve in real-time, guided by ecological methods. This new paradigm treats datasets not as fixed archives but as living entities that interact symbiotically with machine learning models. With this approach, I aim to forge a tighter, more harmonious relationship between data and models. The principal ecological method applied in this thesis is the Tag-and-Release annotation technique. By shifting the focus towards living datasets and ecological methods, I aim to identify, understand, and mitigate inherent biases in the data. This ecological approach also increases the explainability and accountability of AI models, advocating for a more ethical, transparent, and robust machine learning ecosystem.

17 – Testbed Design for Robot Navigation Through Differential Ray Tracing

Michelle Samson
Advisor: Debashri Roy
Computer Science and Engineering Department

In recent years, there has been a surge in interest towards the refinement of autonomous systems, with a specific focus on advancing robot navigation through the effective utilization of sensing data. However, this heightened focus has brought forth significant privacy concerns. To address these issues and concurrently harness the advantages of sensing-based robot navigation, this project introduces a testbed, designed to facilitate robot navigation via the application of a Differential Ray Tracing (DRT) approach. We delineate a systematic pipeline for constructing such a testbed, employing Lidar sensors from commercially available handheld devices. The acquired data is integrated into NVIDIA's Sionna tool. This integration process serves to enable the formulation of Radio Frequency (RF) propagation models tailored for mobile robots operating within indoor environments. This paper represents a significant stride toward the practical implementation of robot navigation by employing the RT-generated RF propagation of the environment. Through our proposed testbed, we contribute to the development of a robust and privacy-preserving approach for robot navigation in autonomous environment.

18 – Algorithm Development for Analysis of Optical Trapping Time-Series Data Generated by a Bimodal Optical-Electrical Nanopore Sensor

Yu Shiuan Huang
Advisor: George Alexandrakis
Bioengineering Department

This thesis focuses on developing algorithms to process optical signals from the Self-induced Back Action Nanopore Electrophoresis (SANE) biosensor. The SANE sensor detects transmitted optical intensity step-changes when it traps a molecular-sized entity. The amplitude of those steps enables calculating the entity's size. Here, an algorithm was created that automatically segments those

step changes. The algorithm was tested on 20 nm silica beads trapped by the sensor (positive signal change – upward step) and, after a few seconds, escaping the sensor (negative signal change – downward step), thus creating pedestal-like signatures of different durations. The algorithm, still in development, utilizes segmentation and convolution techniques to enable the isolation of individual pedestal-like features. The core of this algorithm entails the convolution of the actual data with a series of reference pedestal-like features of different durations to estimate the time when a positive step change occurred and its duration. Importantly, this algorithm is a first step towards analyzing ligand-receptor interactions by detecting different optical signal step-changes and durations that reflect binding durations. Therefore, this work is a first step towards creating an open-source algorithm, offering researchers a tool to analyze protein-ligand interaction in optical single-molecule sensing more efficiently.

19 – Reverse Engineering the NASP X-30

Cody Harris, Ian Maynard and Tony Medina
Advisor: Bernd Chudoba
Mechanical and Aerospace Engineering Department

The National Aero Space Plane (NASP) program was the culmination of decades of research and development towards hypersonic and space launch vehicle design. With the challenge of being the world's first horizontal takeoff and landing single-stage-to-orbit aircraft, the NASP aimed to be a major step forward in aerospace technology and vehicle capability. With the program's cancellation in the early 1990s due to technical challenges and budget restrictions, the idea of a single-stage-to-orbit vehicle has seemed out of reach ever since with few developments being made. The goal of this research project is to complete the conceptual design of the original NASP (and update attributes when necessary) to demonstrate the difficulties and challenges of designing a space access vehicle and show a potential solution with today's technology.

20 – A Situational Assessment on the Resurgence of Combined Cycle Engine-Vehicle Development

Jose Medina
Advisor: Bernd Chudoba
Mechanical and Aerospace Engineering Department

Space and air transportation are ramping up efforts aimed at reusability, high flight rates, and reduced payload costs. The potential capabilities of these new aerospace transports represent a stark comparison to the current generation of space access vehicles, such as the Space Launch System, Falcon 9, and Starship. Combined cycle propulsion systems are a key enabling technology that meets the demanding multi-mode missions of space access vehicles and high-speed transports alike. Thus, combined cycle engines represent the next major engine evolution that will emerge in the coming decade to compete with the existing industry capability. A situational assessment is conducted to support the development and operation of combined cycle engines for future aerospace transports. This scoping assessment aims to provide visibility and context to the broad kinds of combined cycle engine and vehicle concepts that can be leveraged for future efforts. The assessment concludes by emphasizing the need for advanced flight vehicle synthesis tools to conduct systematic vehicle design studies and defines the specifications of a prototype called Configuration Propulsion Compendium. The methodology is demonstrated on the NASP X-30 case study to support decision-makers select the proper combination of combined cycle engine and vehicle configuration.

21 – Bio-inspired Design for Impact Tolerant Multi-material Composites

Mahatab Bin Rashid
Advisor: Shiyao Lin
Mechanical and Aerospace Engineering Department

Natural protective materials such as seashells offer tough, lightweight armor inspiration due to their hierarchical structure. However, mimicking their intricate cross-lamellar structure has proven challenging in terms of manufacturing and experimental characterization. This study tackles this hurdle by introducing a multi-material 3D-printed biomimetic conch shell prototype. Combining 3D printing, drop tower testing, and nondestructive evaluation, we investigated the mechanism for the improved damage tolerance: its hierarchical architecture. Notably, adding a second phase of material to this hierarchy boosts impact resistance and shows improved damaged results, demonstrating its immense potential. The key lies in creating pathways that divert cracks, offering a valuable blueprint for the future of protective gear like helmets and body armor. This provides a promising direction for bio-inspired design for tougher structures.

22 – Xenon-Arc Flash Lamp's Characterization for Automated Fiber Placement (AFP) Manufacturing of Thermoplastic Composites

Sandesh Amgai, Devang Tavkari and Vishnu Ganeshan
Advisors: Paul Davidson and Ankur Jain
Mechanical and Aerospace Engineering Department

In this research project, we present an approach to combining digital fabrication and cooking to embrace the user experience. While digital fabrication is well known in human-computer interaction (HCI) with rapid design and a wide range of applications of different materials, most of the design was focused on the design process rather than the fabrication process and the joy of the activities. Using this tool, we investigate how a new type of interactive tool could support and collaborate with novice and expert users to improvise the making experience. We present a novel interactive tool designed for cake decorating and the fabrication practice of joinery. We combine the sensing technique and output control of airflow by using programmable inflatable hardware. We describe the making process of our tool with their technical details and show example artifacts produced by the tool and a discussion about the results from the user study.

23 – Design and Analysis of Reinforced I-Beam Lattice with Enhanced Energy Absorption

Twinkle Kothari
Advisor: Xin Liu
Mechanical and Aerospace Engineering Department

Materials with high energy absorption capabilities are essential for enhancing safety and durability in various applications. In this study, we focus on developing a new class of lattice materials with customized mechanical behavior to improve stiffness/strength-to-weight ratio and increase energy absorption simultaneously. These lattice materials are built on top of the body-centered cubic (BCC) lattice structures using beams with I-shape cross-sections and with joint reinforcements. The new lattices are fabricated using additive manufacturing technique and quasi-static compression tests are carried out to study the crushing behaviors of the lattices. Additionally, multiscale modeling is performed to understand the mechanisms of the improved stiffness and strength of the lattices. The finite element-based crushing simulations are also conducted to study the overall deformation and energy absorption of the lattices. The results show that the I-beam lattices improve the bending stiffness of the beams and reduce the stress concentration at beam joint compared to conventional BCC lattices. Additionally, the I-beams introduce a new energy dissipation mechanism that significantly enhances the energy absorption capability of the lattices. At last, we will design different geometries for the I-beams and reinforcements to study the structure-property relations of the proposed lattices.

24 – Distributed Multi-Leader Formation Tracking Within a Weight-Unbalanced Directed Network of Multiple Agents with Matlab and Webots Simulation

Erin Butler
Advisors: Yijing Xie, Cody Lundberg, Nicholas Gans, Frank Lewis and Zongli Lin
Electrical Engineering Department

This project investigates the problem of distributed multi-leader formation tracking of a multi-agent system within a directed network that may be weight-unbalanced. We propose distributed formation tracking algorithms with offline estimators. Under the assumptions that the communication network of the follower agents is strongly connected and each leader agent is accessible by at least one follower agent, all follower agents asymptotically track the center of the leader agents with a time-varying formation offset. A MATLAB simulation is performed to substantiate the theoretical conclusion. A testing platform containing several mobile robots is developed in Webots simulation platform leveraging Robot Operating System 2 (ROS2).

25 – End-to-End Deep Learning-Based Content-Aware Video Compression Network

Aileen Sengupta
Advisor: Venkat Devarajan
Electrical Engineering Department

This network utilizes videos' temporal and spatial redundancy. The temporal correlation in the video is much stronger than the spatial correlation in an image. The algorithms have to compress the temporal domain extremely well to beat the state-of-the-art algorithms for video compression. Traditional video compression algorithms are constrained to predicting temporal patterns strictly in the form of motion and strictly operate from the pixel space. This algorithm works by compressing the video and training a separate neural network with this compressed video I frame, P frame and B frame for better prediction capabilities.

26 – Fabrication of Ge-Based Optical Devices

Fairooz Simlan
Advisor: Robert Magnusson
Electrical Engineering Department

For a host of applications, long wave ($\sim 8 < \lambda < 12\mu m$) infrared components (filters, polarizers, mirrors, lenses, etc) are needed. We have developed efficient fabrication methods to realize this component class. Here, the main experimental aspects are presented.

27 – Analysis of Noise Sources in Avalanche Region of Reverse Biased p-n Junctions

Md Sakiul Islam Sudman
Advisor: Zeynep Çelik
Electrical Engineering Department

There is a need to understand the physical mechanisms for excess noise factor (F) in avalanche diodes for all regions of operation. The current classical theory accounts for F only for low carrier multiplication where single carrier injection starts the avalanche process. Our model fits the white noise exhibited by reverse-biased avalanche diodes in the entire operation region of four orders of current magnitude. In this sense, it is a first. The measured noise data were provided by Texas Instruments. We fitted the measured noise components with the calculated noise components where carrier multiplication takes place. The least squared error method was used to fit the measured and calculated noise components. The noise components were fit in the lower currents considering single carrier injection while mixed carrier injection was considered for higher currents. The validity of the noise model was verified for avalanche diodes of various sizes across many dies.

28 – Characterization of Arc Flash Events from Ultracapacitors and MVDC Capacitors

Nicolaus Jennings
Advisor: David Wetz
Electrical Engineering Department

A significant number of electrical workers are severely injured each year because of electrical arc flash events, and more data is needed to better characterize these events and protect personnel from the danger they present. Significant effort has been invested into understanding arc flash events induced by AC sources resulting in a few widely adopted safety standards. Similar understanding and standards for arc flash events induced by DC sources is lacking and this is a major concern, especially as the Navy begins to introduce energy storage, at voltages potentially as high as 8 kVDC, into ships. Efforts from The University of Texas at Arlington have been performed to begin to fill this knowledge gap. An arc flash measurement setup has been used to perform experiments studying DC arc flash events induced by ultracapacitor devices assembled at voltages as high as 500 VDC, and pulsed power capacitors operating at voltages as high as 8 kVDC. This work will discuss the experimental setup, the experiments performed, and the results obtained to date.

29 – Emulation of a High-Power Electrical and Thermal Load

Brent Oksanen
Advisor: David Wetz
Electrical Engineering Department

Many pulsed power loads are driven by one-of-a-kind electrical sources and they generate high heat load that has to be managed through unique cooling solutions. In the work documented here, an emulator is being designed so that high power sources and cooling solutions can be studied without employing the actual load. Commercial 'instant' hot water heaters are being studied for use in this application. The input is being modified to accept a 1 kVDC source and an M&S tool that will be used to configure the correct number of heaters required, and the right hot-to-cold water mixing ratio is being validated. The rationale, design, and results to date will be presented.

30 – Pulsed Dielectric Breakdown of Solid Composite Epoxy Insulators

Tyler Scoggin, Hayden Atchison and Nicolaus Jennings
Advisor: David Wetz
Electrical Engineering Department

Solid dielectrics are desirable for improving the maintenance requirements, shelf life, power density, energy density, and manufacturing challenges associated with insulating high voltage pulsed power systems. The ability to alter the dielectric properties of solid insulators by using nanoparticle additives is among their most attractive properties. By layering the type and/or fill percentage of nanoparticles, it is possible to spatially grade the dielectric permittivity between two locations. Achieving optimal dielectric properties through functional grading can significantly reduce electric field enhancements, enabling systems to be designed more compactly. Since solid dielectrics are not self-healing like liquid dielectrics, it is critical that they be well understood before being implemented. Epoxy dielectrics are of high interest because of their naturally high dielectric strength and their ability to fill complex geometries. In the work presented here, raw and composite epoxy dielectric samples are being studied under both low voltage and pulsed high voltage experimental conditions to characterize their dielectric properties.

Senior Design

31 – Microgrid

Benjamin Schmitz, Maxton Manker, Kayla Garcia, Richard Ruiz and Joe Garcia
Advisor: David Wetz
Electrical Engineering Department

As the need for cleaner and more efficient energy solutions increases, the integration of renewable energy sources, energy storage systems, and advanced power management technologies has gained traction. The demand for those types of innovative solutions has grown dramatically in response to escalating instability of the power grid. This susceptibility comes from a combination of factors, including aging infrastructure, cybersecurity threats, extreme weather events, drastic fluctuations in electricity demand, and more. The integration of a microgrid with hybrid energy storage modules (HESM) and advanced topologies can be the solution to the previously mentioned problems. We provide comprehensive insights into the concept of microgrids, the functionality and intricate components of HESMs, the chosen topology, and the rigorous MIL-STD-1399 standards that need to be upheld. Furthermore, we will elaborate on the microgrid team's initiatives, including the plans to commission two HESMs and a couple of flywheel sets, as well as their plans for testing and demonstrating the role of those technologies in enhancing power quality.

32 – High Voltage Module Development and Characterization for Automatic Test Equipment

Zaid Meqbel, Andrew Kozelsky, Md Safkat Rahman, Ricardo Perez and Raad Abusaad
Advisor: David Wetz
Electrical Engineering Department

The semiconductor industry is accelerating growth in automotive and industrial markets and that is driving growth in the testing abilities of automated test equipment (ATE). One growth area is high voltage testing in mixed-signal and mixed domain devices under test. High voltage is defined in this presentation as 1,000-4,000V DC. This rising demand for high-voltage testing has prompted the need for innovative ATE solutions. Sponsored by Texas Instruments, our project presents a solution that integrates with existing standard voltage ATE systems and addresses the high-voltage demand. Our objective is to develop a cost-effective and compact high-voltage resource board for ATEs used in

semiconductor testing. The prototype is designed to deliver up to 4 kVDC output while maintaining accuracy, efficiency, and exceptional DC power quality. This resource board must seamlessly integrate with existing ATE setups while adhering to the limitations imposed by the available signals, power resources, and size constraints. In this paper, we discuss the process of design and development of our high voltage ATE resource and we discuss the characterization of the prototype and the DC/DC chosen. The voltage, current, voltage ripple, voltage accuracy, and efficiency are the parameters this project aims to optimize.

33 – Autonomous Tracking Turret Aiming Coilgun Kinetics (A.T.T.A.C.K.)

Layth Ibrahim, Luis Sanchez and Daniel Cruz
Advisor: David Wetz
Electrical Engineering Department

The Autonomous Tracking Turret Aiming Coilgun Kinetics (A.T.T.A.C.K.) system project represents an innovative solution for precision targeting. Through the integration of motorized turret and image recognition, we aim to create an automated system with significant advantages over traditional technologies. A motorized turret system, aiming to mount a pre-existing coilgun. Our project enhances the coilgun's functionality with a motorized turret and an image recognition system for target identification.

34 – Tractor Beam

Jacob Crites, Jyotirmoy Sarker and Ngun Zel
Advisor: Greg Turner, Alexander Johnston and David Wetz
Electrical Engineering Department

The goal of this project is to create a fully embedded autonomous vehicle capable of following a 1:16 scale RC car while it is carrying a full cup of water and not spilling it. The main takeaway is the use of a PID controller to ensure a smooth ride and prevent spilling. There will also be a configuration using just pure proportional control to demonstrate the advantages of using PID. As part of the project requirements, the design is to be fully embedded, meaning all processing must be performed onboard the vehicle and not make use of more powerful laptop processing capabilities. Computer vision is used with an Intel depth camera to recognize the lead vehicle and determine the distance and steering angle differences between the two vehicles. A Jetson Nano single-board computer makes use of its GPU and CPU to perform all processing required, with the GPU being especially useful for real-time image processing for the camera.

35 – Coil Gun

Halil Tulek, Nam Hoang, Thierry Ngimbi and Robert Kim
Advisor: David Wetz
Electrical Engineering Department

The coil gun project requires a projectile to be fired at 50 m/s and is sponsored by Dr. Wetz and DEPS. The coil gun utilizes electromagnetic properties to

accelerate the projectile and will be able to be fired remotely as well.

36 – First Responder Notification

Tuyet Le, Ngoc Phan, Lam Pham and Nayeli Garcia
Advisor: David Wetz
Electrical Engineering Department

In critical situations, like emergencies involving fire trucks, ambulances, and police cars, it's essential to have a system that tells these sirens apart and inform drivers nearby. A smart system will be developed just for this purpose. This system will not only recognize the different sirens, but it will also inform the driver where the emergency vehicle is coming from, and how far away it is. It will be designed to detect and differentiate loud sirens from a distance up to 300 yards, and it will be tested to prevent the system from classifying non-emergency vehicle sirens as emergency vehicle sirens. The primary goal is to create a system that helps keep people safe and that will help emergency responders get to where they are needed quickly and efficiently.

37 – Raytheon Drone

David Davila, Zachary Hargrove, Hannah Kelley and Tuan Vo
Advisor: David Wetz
Electrical Engineering Department

This project is sponsored by Raytheon Technologies, and the team will compete in the 2024 Raytheon Drone Competition with other universities in the South. The UTA team is composed of three different disciplinary groups: electrical engineering (EE), mechanical and aerospace engineering (MAE), and computer science and engineering (CSE). The drone competition will involve two autonomous vehicles: an unmanned aerial vehicle (UAV) and an unmanned ground vehicle (UGV). Each university will design, develop, and implement both vehicles to operate autonomously in the challenges set by Raytheon. A single UAV will perform a series of challenges by attempting to seek, identify, and deliver a water blast to all rival schools' UGV while avoiding delivery of a water blast to their own. The EE team will work on the overall development and oversee the electrical configuration for the UGV to operate autonomously in the competition.

38 – Raytheon Drone Competition

Nick Parker, Jamie Wilson, Alec Babaa, Roberto Azahar and David Qian
Advisor: Chris McMurrough
Computer Science and Engineering Department

The goal of the Raytheon Drone Competition is for an interdisciplinary team consisting of mechanical engineering, electrical engineering, and computer science and engineering students to build one UGV and one UAV that can both autonomously follow pre-determined pathing missions, with the UAV being additionally able to identify ground targets and deploy water on them.

39 – Raytheon Drone Competition

Kristopher Sedghi-Masoud, Ryan Weisblatt, Kevin Martinez and Adan Ortiz
Advisor: Bob Woods
Mechanical and Aerospace Engineering Department

In collaboration with a consortium of universities, the Raytheon Drone Competition fosters the development, integration, and testing of Unmanned Vehicle (UV) hardware to address real-world challenges. This collaborative endeavor provides students with the opportunity to tackle open-ended problems and gain hands-on experience as real-world engineers. A multidisciplinary team of students was entrusted with designing and developing an Unmanned Aerial Vehicle (UAV) and an Unmanned Ground Vehicle (UGV) for an intercollegiate competition. The UAVs are tasked with traversing a specified route at predetermined speeds, delivering a water blast to neutralize enemy UGVs, and performing other objectives. Our team is responsible for designing and constructing the UAV's frame, upper and lower chassis for electrical components, landing gear, and water delivery system as well as the UGV's frame that will house all its respective components.

40 – Frame Assembly Line Balancing

Briana Vargas, Batul Ali, Leslie Munguia and Zoe Rodriguez
Advisor: Jamie Rogers
Industrial, Manufacturing and Systems Engineering Department

National Door Industries, Inc. manufactures plastic and aluminum garage door frames. This project aims to balance the current four-operation line of aluminum Impact Resistant Frames with the recent addition of a new automated washer. There is a lack of information and standardization of the line, fostering an opportunity for improvement in the line. There is a need to understand if the addition of an automated washer machine impacts the production line since the previous method involved manual handwashing of the frames. To understand their current state, we utilized the DMAIC methodology and determined the takt Ttime, required operators/machines, labor/machine utilization, and cycle time. To help aid the calculations, we will take time studies, use standard work charts, combination tables, and load charts. From there we will design a future state proposal and evaluate how adding an automated washing machine impacts the line through various analyses, line balancing, and throughput outcome..

41 – Klein Tools Slot Head Screwdriver Process Improvement

Anna Bria Stone, Andrea Romero Morales, Murielle Mutomb and My Nguyen
Advisor: Jamie Rogers
Industrial, Manufacturing and Systems Engineering Department

Klein Tools, Inc., is an American company founded in 1857 that manufactures a diverse range of hand tools and equipment catering to professionals in fields such as construction, electrical, and line work. Their product line includes, among other tools, pliers, screwdrivers, and wire strippers. The goal of this project is to increase productivity of the bolstering and finning operations of

their slot head screwdriver line at their production plant in Mansfield, Texas. This will be accomplished by employing DMAIC process methodology and other IE tools, such as process maps, time studies, and conducting a root cause analysis.

42 – Gatekeeper Line Balance Analysis

Holland Voight, John Conlin, Damian Patlan and Jonah Covich
Advisor: Jamie Rogers
Industrial, Manufacturing and Systems Engineering Department

If you have ever shopped at a grocery store and have seen employees pushing carts back into the grocery store using an electronic machine, it was almost certainly made by our client, Gatekeeper Systems. They supply dozens of big name grocery stores, including Walmart and Target. Our senior design group visited the Gatekeeper facility, where they assemble their most recent product, Cart Manager Ultra. Due to a steady increase in company growth, Gatekeepers' manufacturing facility located in Arlington, has made some significant changes to their manufacturing operation to keep up with growing demand. Therefore, our team will conduct an updated time study, interpret the results, provide actionable solutions, and suggest implementation methods to rebalance the production line.

43 – Treasures of Magic Packaging Flow

Everitt Miller
Advisor: Jamie Rogers
Industrial, Manufacturing and Systems Engineering Department

Treasures of Magic needs to have a packaging system set up. This project aims to set up the packaging system for the company by implementing storage and inventory tracking in the packaging area that will establish an efficient and effective flow. Types of shelving for the storage will follow engineering standards to account for varying sizes of product. By using the DMAIC process to analyze, design improvements, and implement the packaging system, this will enable increased sales and allow Treasures of Magic to get products out the door in a timely manner.

44 – Increasing Throughput of the Cleaning and Rust Prevention Process at Klein Tools

Josh Edwords, Brian Rogers, Matthew Hayward and Zachary Friend
Advisor: Jamie Rogers
Industrial, Manufacturing and Systems Engineering Department

Our team is working with Klein Tools at their heritage manufacturing facility in Mansfield, TX. This facility primarily manufactures products from Klein's pliers and wire stripper lines. We are focusing on the cleaning and rust prevention production step that is performed before products are packaged for palletizing. This production step is critical to ensure customers receive clean and rust-free

products. Most products manufactured at the facility undergo the cleaning and rust prevention process, so improving the efficiency and throughput of this step will reduce the bottleneck impact of the process. Utilizing the DMAIC methodology, our team will measure and analyze the current process, developing and testing a sustainable, ergonomic, and effective solution.

45 – Increase Efficiency of MSL Racing LLC Paddock Facilities

Massimo Sanchez-Lara, Joceline Villalba, Jordan Watkins and Charles Graham
Advisor: Jamie Rogers
Industrial, Manufacturing and Systems Engineering Department

MSL Racing LLC is a motorsports business based in DFW that focuses on grassroots karting and the improvement of drivers in preparation for a career in motorsports. MSL Racing provides various operations and services. They provide private driver coaches along with tuning and kart service work. Their main service is race day team operations, including attendance at local/club and regional level racing events. They provide hospitality, kart service work, coaching, and data acquisition. Our project will focus on the race day team operations facilities layout and workflow. Currently, MSL Racing does not have a predetermined and optimized layout for varying amounts of space and driver attendance. This leads to inefficiencies in time, space, workflow, and overall team performance The goal of our project is to organize and analyze different facility layout options while adhering to MSL Racing constraints such as equipment, services, and space. We will design setup/tear-down procedures to minimize setup and tear-down times by using the DMAIC methodology, including 5S analysis, time studies, activity work diagrams, spaghetti diagrams, and 3-D modeling software. The final product will allow MSL Racing to save time and money and increase efficiency without sacrificing quality or value to its racing customers.

46 – Ariat International Forklift Station Optimization

Sophia Robertson
Advisor: Jamie Rogers
Industrial, Manufacturing and Systems Engineering Department

Ariat International's offsite storage facility will become an operational distribution center soon. Given the new role, the current forklift stations will need to be redesigned. This project was conducted to improve the current layout and organization of the forklift station to create a more intuitive setup for operators. The DMAIC (Define, Measure, Analyze, Improve and Control) methodology was used to carry out this project from beginning to end. We performed a series of 5S Assessments and observations to measure the current station layout. A variety of analytical techniques were utilized to identify improper procedures and suboptimal configurations. Pilot training and 5S tools were implemented in the forklift station area to achieve the goals defined by the 5S Assessments and observations. To further implement the pilot training and 5S mentality, a Standard Operating Procedures (SOPs) document was developed.

47 – UTA Special Collections: Layout and Process Optimization

Sampson Dewey, Ali Qaroot, Mohammad Odeh, Fernando Flores and Omar El Saad
Advisor: Jamie Rogers and Don Ivey
Industrial, Manufacturing and Systems Engineering Department

This capstone project focuses on optimizing the layout of the back storage area in the UTA Central Library's Special Collections. The goal is to enhance workflow and resource utilization by analyzing the current layout, identifying inefficiencies, and proposing solutions. The design phase involves gathering client requirements, goals, and constraints, emphasizing effective communication with stakeholders. Challenges include a backlog of uncategorized items, hindering efficient retrieval and posing risks of misplacement. The main aim is to design a strategic plan and layout for preservation, categorization, and ease of access. Solutions prioritize storage solutions, item identification, and standardization, aiming to improve shelving configurations and minimize clutter. Key metrics such as space utilization and inventory percentage will be tracked to understand efficiency and identify opportunities for improvement. Stakeholders include archivists, researchers, and visitors, with a better layout benefiting all parties by facilitating faster processing and easier access to materials. The main process that will be used is DMAIC where the phases of define, measure, analyze, improve and control will be further discussed and evaluated.

48 – Hospital Medical Equipment Transport Vehicle

Youssef Muhiar, Akshaj Murhekar, Yash Waghmare, Rohan Tiwari, Krishna Konduri, Diego Vester and Favour Kolade
Advisor: Chris McMurrough and Justyn Jaworski
Computer Science and Engineering Department

Our senior design project, in collaboration with Cook Children's Medical Center, addresses the need for efficient bedside equipment management. Bedside equipment carts require frequent replenishment of essential items, often stored far from patient rooms. Nurses must make multiple trips to the supply room, consuming valuable time and increasing stress during emergencies. Our solution aims to streamline this process, reducing nurse workload and improving patient care. By developing a hospital medical equipment transport vehicle, we seek to enhance efficiency in supply delivery, ensuring essential items are readily available at the point of care. This collaborative project, led by Chris McMurrough and Justyn Jaworski at The University of Texas at Arlington, with guidance from Melodie Davis, leverages innovative technology to optimize healthcare workflows.

49 – Encrypted SMS

Jacob Holz, Landon Moon, Parker Steach, Gilbert Lavin, Nam Huynh
Advisor: Shawn Gieser
Computer Science and Engineering Department

Secure communication is a very useful tool for many people. Internet based communication systems require servers in between users that are controlled by

the service creators, thus granting an opportunity for back door access. SMS is an inherently insecure protocol, but the vast majority of modern phones are able to use it and it requires no intermediate servers to be controlled by our team. The goal of the project is to add a pleasant interface to allow the encryption, transmission, receipt, and decryption of messages over SMS that appears similar to standard messaging apps. We have created a secure program that takes advantage of SMS and avoids its pitfalls.

50 – Furthering Healthcare Education Using the Breathe Easy Sim

Kyle Henry, Ethan Sprinkle, Maicol Zayas, Elisabeth Harris and David Gomez
Advisor: Shawn Gieser and Erica Hinojosa
Computer Science and Engineering Department

The Breathe Easy Sim is designed to provide a solution for the UTA SMART Hospital's need for a medical ventilator simulator that is compatible with the hospital's smart manikin air bladders that allow the manikins to "breathe." Currently, the ventilators being used by the hospital provide too much airflow to the smart manikins, causing the internal air bladders to rupture. Furthermore, while medical simulation devices exist, there is no ventilator simulator technology available on the market. The Breathe Easy Sim will provide reduced and controlled airflow capability so as not to rupture the manikin's air bladder. Additionally, the Breathe Easy Sim will be equipped with simulation software to provide as close an experience as possible to a real medical environment. Other features, such as alarm tones, control dials, buttons, and health diagnostic outputs, will also be simulated to heighten the medical experience.

51 – IGVC Computer Vision System

Abu Talha Nayyar, James Caetano, Brandon Bowles, Sameer Dayani and William Periman
Advisor: Chris McMurrough
Computer Science and Engineering Department

The project aims to develop a modular computer vision system for autonomous vehicles specifically for the IGVC (Intelligent Ground Vehicle Competition) vehicle representing The University of Texas at Arlington in the competition. Utilizing advanced computer vision and LIDAR technologies, this project is a scalable and specific computer vision system tuned to the IGVC competition requirements and test course, allowing navigation through the course by accurately identifying and avoiding obstacles, while staying on track using lane detection. Cameras and LIDAR technology are utilized to map the vehicle's surroundings and accurately locate obstacles in the vehicle's path.

52 – State Farm Social Marketplace Automotive Risk Engine

Ryan Lahlou, Temitayo Aderounmu, Yeabsra Gebremeskel, Athiya Manoj and Waseem Polus
Advisor: Chris McMurrough
Computer Science and Engineering Department

This project introduces a computer science and engineering solution tailored for insurance companies. It automates the scanning and analysis of vehicle listings on social media platforms like Craigslist and Facebook Marketplace. By employing various data analysis models, the system evaluates each post to generate a risk score, primarily targeting indicators of potential fraud. Unlike consumer-oriented applications, the final product caters to insurance companies, providing an interface similar to Splunk. This interface enables efficient data search, aggregation, and report generation tailored to user needs. By leveraging this tool, insurers can expedite risk assessment processes and mitigate potential losses due to fraudulent claims. The system's ability to compile and present comprehensive analyses empowers insurers to make informed decisions regarding policy underwriting and claims investigation. Ultimately, this project contributes to enhancing the efficiency and accuracy of insurance operations in navigating the complexities of online vehicle marketplaces, safeguarding against fraudulent activities, and ensuring the integrity of insurance portfolios.

53 – UTA Skycam

Heath Christman, Youssef Aitbenzanzoun, Somil Ajmera, Alejandro Villarruel
Advisor: Levant Gurdemir
Computer Science and Engineering Department

The UTA SkyCam is a camera system that will continuously view the sky, both day and night, and stream the real-time view onto the network. Built on the Raspberry Pi 5, it will utilize a fish-eye lens to give a view of the sky in all directions, powered by the Rasp Pi HQ Camera. The Computer Module and Camera Components will be housed in a weatherproof enclosure and powered by Power over Ethernet (PoE). The SkyCam will be set up to record in both low and high light conditions.

54 – Patient AI

Abdur Rehman, Hanani Pankaj, Hananeel Pankaj, Phu Nguyen and Sammy Mahmoud
Advisor: Shawn Gieswer
Computer Science and Engineering Department

This project is a nurse-patient simulation, in which the user will take the role of the nurse, and the AI will be the patient. The nurse will interact with the AI patient by talking with it, and the patient will respond accordingly. This project is focusing mainly on improving the communication skills of the nurse. This project has three main components: the speech-to-text, the AI, and the text-to-speech. The user will speak into the microphone, in which the audio will be recorded and converted to text. This text will be given to the AI model, which will output the patient's response. The patient's response will be passed to the text-to-speech component, and the nurse will speak into the microphone to respond to the patient. This loop will continue, simulating a conversation between the nurse and patient.

55 – IGVC Ground Vehicle

Alfredo Reina Corona, Matthew McClure, Tanner Gillis, Ahmed Almudhi, Emmanuel Chinwuba and Joshua Ngo
Advisor: Chris McMurrough
Computer Science and Engineering Department

We are creating an autonomous vehicle with the goal of competing in the Intelligent Ground Vehicle Competition. The vehicle will have the capability to autonomously navigate a course, following GPS waypoints while avoiding physical obstacles and avoiding crossing out of bounds of the course. Our team is one of two teams currently working on this project. Our focus is on developing a pathfinding system, finishing the physical development of the vehicle, and enabling wireless communication between the vehicle and the remote-control station. We will ensure that the vehicle can plan an optimal path around the course while safely avoiding the penalties for hitting obstacles, leaving the course, or driving unsafely. While following these guidelines, it is our goal to navigate the course as quickly as possible to score the most points.

56 – Precision Marking Vertical Robot Arm

Muhammad Anas, Ameen Mahouch, Kundan Singh Mahato, Akshay Paluri, Hyun Ho Kim
Advisor: Chris McMurrough
Computer Science and Engineering Department

The abstract presents the Mitsubishi RV-8CRL vertical robot integrated into an entertaining project involving the creation of art through paintball dispersion. The project's focal point is the Mitsubishi RV-8CRL, renowned for its vertical maneuverability and robust performance capabilities, and by combining engineering precision with creativity. The integration process has seen the incorporation of a linear rail system, enhancing the robot's accessibility with an additional 7th axis. Additionally, Programmable Logic Controller (PLC) programming has been implemented to perform precise paintball dispersion patterns. The study documents research into safety standards and the implementation of notable safety measures, including an industrial signal output tower, rail boundary detection sensors, and proper lockout/tagout procedures. Safety has been a paramount consideration throughout the project's development, with comprehensive safety features seamlessly integrated into the system. These features not only safeguard the equipment but also ensure the well-being of operators and spectators, enabling the project to be enjoyed safely.

57 – IEEE Region 5 Competition

Rolando Rosales, Noor Abdullah, Raquel Reyes, Rodrigo Munoz and Velu Manohar
Advisor: Chris Conly
Computer Science and Engineering Department

The objective of the preliminary rounds is to demonstrate the use of an autonomous robotic system within a confined area to push a button at one end and return to its starting position. Then, in the elimination rounds, the robotic system will perform a series of maneuvers with competitors in the same arena, moving from charging station to charging station until a singular robotic system is left in the trial. The initial game field simulates a known task and environment, while the competitive time trial presents unknown factors with competitors and power optimization challenges.

58 – MavCare - A Smart System for Tracking Surgical Instruments

Joe Marquez, Kunj Patel, Chelsea Takam, Ahnaf Ahmad and Michelle Sanchez
Advisor: Chris McMurrough
Computer Science and Engineering Department

Operating rooms are high-stakes environments that demand precision and efficiency. However, surgical teams often grapple with challenges in managing surgical instruments, leading to potential risks for patient safety and procedural delays. This problem is particularly significant during complex surgeries that require a diverse array of instruments. To address these challenges, this project endeavors to develop a sophisticated system for real-time tracking and management of surgical equipment. Leveraging Ultra High Frequency RFID tags discreetly attached to surgical instruments and a USB reader/writer, the system seamlessly integrates data with a desktop application. This integration provides users with critical information, ensuring the availability and tracking of surgical instruments.

59 – Peer Review

Brendan Sophabmixay, Tahera Fatima, Grant Goodman, John Costa and Sibi Sarveswaran
Advisor: Chris McMurrough
Computer Science and Engineering Department

Peer Review is a full stack web application that allows users who are working in teams to rate their peers by answering a survey of questions. The peers will get a full enhanced analysis with graphs that display what other team members think of them and it also gives them an idea of their progress.

60 – LoRa-Net

Juan Hernandez, Michael Nguyen, Phuong Anh Le, Jason Lazo and Zaynab Shaikh
Advisor: Chris McMurrough
Computer Science and Engineering Department

Natural disasters worldwide cause significant destruction and loss of life annually, leaving survivors and rescuers without vital communication infrastructure. This project aims to address this critical need by offering an accessible, energy-efficient, and cost-effective solution for establishing a communication network across several miles, coupled with an intuitive app design for user-friendly interaction. Utilizing Arduino modules equipped with LoRa technology, the project focuses on transmitting data over long distances while minimizing power consumption. This approach ensures that even in resource-constrained environments, communication networks can be swiftly reestablished. On the software front, leveraging Flutter, a cross-platform development kit from Google, enables the creation of a single codebase for intuitive applications. This eliminates platform exclusivity, ensuring

accessibility to all individuals in disaster-affected regions. By combining hardware innovation with software versatility, the project aims to empower communities to swiftly rebuild communication networks in the wake of natural disasters. This integrated approach not only enhances resilience but also fosters inclusive technology adoption in vulnerable regions.

61 – Development of a Novel 3D Model to Investigate Prong-Induced Nasal Septum Injury in Preterm Infants

Rowa Hamdan, Bianca Chavez and Austen Shelley
Advisor: Liping Tang
Bioengineering Department

Nasal prongs are commonly utilized for administering continuous positive airway pressure (CPAP) therapy in premature infants. Unfortunately, studies indicate that nasal prongs contribute to nasal injury in over 60% of patients. Currently, there is a lack of suitable models for examining the impact of CPAP nasal prongs and masks on the delicate facial structures of infants. To pinpoint the source of this issue, we have devised a 3D model aimed at investigating how prong design may lead to nasal septum injury. Specifically, we constructed a model of a premature neonate's head using MRI scans, ensuring anatomical accuracy of the nasal passageways. The nasal prongs were modeled to match the dimensions of actual products. Utilizing COMSOL analysis, we simulated and evaluated how the placement of nasal prongs and the oxygen flow during CPAP therapy may create pressure points on the nasal septum in clinical settings. By incorporating the appropriate biomechanical properties of premature infant skin to accurately replicate neonatal breathing, we have quantitatively demonstrated the etiology of the condition. The findings of this study are poised to offer crucial insights and modeling approaches that could lead to the development of improved prong designs, thereby addressing a significant concern in neonatal care.

62 – Anthropometric Virtual Assessment

Rohit Sharda, Michael Ikefuna and Duy Vu
Advisor: Jun Liao
Bioengineering Department

This project is in collaboration with Lockheed Martin. It's a process to create a detailed 3D model human figure with the ability to change its measurements, and then place this 3D model human figure in a digitally created cockpit to perform anthropometric tests.

63 – Enhancing Lactate Monitoring Efficiency

Abdur Rahman Rasheed and Kaleb Welch
Advisor: Justyn Jaworski and George Alexandrakis
Bioengineering Department

The aim of this project is to create, develop, and validate a novel diagnostic instrument specifically designed for the quick assessment of blood lactate levels in emergency room settings. Our objective is to develop a device that can measure lactate levels similarly to traditional lateral flow tests by combining current enzymatic techniques with intuitive user interfaces. We predict that this new method will produce exceptionally accurate and dependable lactate readings. It is anticipated that this technology will have a significant positive impact on emergency department staff, especially on nurses who will be able to assess patients more quickly with conditions such as tissue ischemia and sepsis, where lactate monitoring is essential for effective patient management.

64 – Developing and Validating a Portable Troponin Testing Device to Advance Cardiac Care

Fatima Mahjabin Tasnim, Camille Shuey and Prince Osuchukwu
Advisor: Kytai Nguyen
Bioengineering Department

We present a novel portable microfluidic device designed for the rapid and sensitive detection of troponin, a cardiac biomarker crucial for diagnosing myocardial infarction. Our device integrates microfluidic channels functionalized with antibodies specific to troponin, allowing for selective capture of troponin molecules. Leveraging microfluidic technology, our device enables efficient sample processing and analysis within a compact and portable platform. The captured troponin molecules trigger a fluorescence signal, which is detected and analyzed using an integrated optical module and Arduino-based microcontroller. By employing linear regression analysis, our device provides accurate troponin concentration measurements, essential for timely clinical decision-making. The compact and portable nature of our microfluidic device offers potential applications in point-of-care diagnostics, enabling rapid assessment of cardiac health status in diverse healthcare settings.

65 – Improving IV Success Rates for Difficult Vein Access in First Responders to Expedite Lifesaving Fluids

Ramiro Flores, Ugochukwu David Akpati and Thai D Pham
Advisor: Baohong Yuan
Bioengineering Department

In medical scenarios, patients with low blood pressure, high body mass index, or infants face an elevated risk of incorrect IV insertion, leading to potential infections or medication leakage. This challenge is exacerbated in pre-hospital situations where every second counts. Vein finder technology in hospital settings has demonstrated a notable improvement in IV success rates. However, it requires two hands to administer an IV and is very expensive, making it unappealing for medical institutions. Therefore, the development of a portable and hands-free vein finder specifically designed for first responders is crucial. The innovative device would eliminate potential errors during IV attempts in indoor and outdoor scenarios, have an intuitive interface that will maintain vein projection on patients, and be inexpensive in comparison to existing products. It will ensure accurate placement within 2 millimeters of veins that are 10 millimeters deep and 2 millimeters wide. Validation through

testing with a practice arm by a paramedic is essential for prototype accuracy. The implementation of this device not only offers a solution for patients with challenging to see veins but also has the potential to streamline the IV process, leading to decreased Intravenous access times and increased success rates among first responders.

66 – Lot 49 – Mitchell St. Bridge Redesign

Emilia Castillo, Eghe Igiehon and Jose Marquez
Advisor: Tamer Eljifout
Civil Engineering Department

Built in 1980, the Lot 49-Mitchell St. pedestrian bridge at The University of Texas at Arlington serves as a vital connection between Parking Lot 49 and the East Campus for a large student population. However, decades of continuous use and exposure to the elements have led to structural deficiencies that compromise both the safety of the university community and the aesthetic appeal of nearby buildings. This abstract outlines the imperative need for a comprehensive redesign of the bridge, addressing issues of structural integrity, accessibility, aesthetic degradation, and insufficient capacity. Our proposed solution encompasses a thorough examination of existing beams and columns, redesigning the slab deck, introducing a timber overhead structure, enhancing electrical components, and optimizing accessibility features. Our report discusses the research objectives, methodology, and alternative solutions considered in the bridge's restoration. We present a step-by-step account of the design process, encompassing structural analysis, 3-D modeling, and considerations for traffic control and cost estimation. The proposed redesign aims to not only rectify existing challenges but also prepare the bridge for the anticipated growth in university attendance in the coming decades, ensuring a safer and more accessible campus environment.

67 – Carbon Capture Vessel Design

Kevin Matthew, Thao-Vy Ho and Tony Le
Advisor: Raul Fernandez
Mechanical and Aerospace Engineering Department

Because of the rise of CO_2 emissions, there has been a growing desire for CO_2 capturing technology as a solution to mitigate the detrimental effects of climate change and human behavior because of the increased CO_2 levels. MAVESS Co. is designing an airtight vessel capable of performing CO_2 capture experiments. The airtight vessel will be designed to accommodate for multiple sensors (for measuring CO_2 levels, temperature, and relative humidity), battery packs, and CO_2 adsorbents, as well as provide multiple inlets for CO_2 and liquid polymer sorbent injection. Through extensive and thorough research, static and fatigue analyses, and prototype testing the vessel will be designed to be insusceptible to microcrack formation and air leakage while undergoing stresses induced by pressure and temperature increases. As required by the client, the team at MAVESS Co. will also program multiple microcontrollers with Arduino to interface with multiple sensors to gain information about the interior environment of the vessel and confirm CO_2 capture capabilities.

68 – MELD AA2219 Materials Characterization

Edward Nguyen, Rigoberto Gonzalez, Nathaniel Power and Omar Abdulla
Advisor: Robert Taylor and Amir Ameri
Mechanical and Aerospace Engineering Department

This mission targets the microstructural and mechanical property data of MELD Aluminum Alloy 2219 (AA2219) to determine its viability in the demanding aerospace structures of tomorrow. Using these findings, design optimization methods of the MELD process will be developed to reduce turnaround times and internal defects. This comprehensive mechanical testing operation will be carried out to assess the mechanical properties of AA2219 via MELD additive manufacturing. This analysis will encompass room temperature tensile, fatigue, and hardness properties with a focus on both stress-relieved and as-manufactured samples. A set of samples exposed to elevated temperature conditions will also be considered. This investigation explores stress relief's impact on the material's mechanical behavior, possibly revealing slight improvements in properties such as elongation, compressive strength, and bearing strength. At elevated temperatures, the alloy may display a slight reduction in strength and stiffness. These findings on the mechanical behavior of the MELD aluminum are important as this manufacturing process will be used for rotorcraft gearbox applications. A process parameter optimization study will be prefaced with a simplified single layer simulation with variable parameters to model the system and its effects.

69 – The Mooring Cam

Christopher Narro, Blake Ryan and Jeffrey Redinger
Advisor: Raul Fernandez
Mechanical and Aerospace Engineering Department

Boating in countries like Norway is like driving a car in the United States. Boats can be used for both leisure and for business. However, unlike with cars you cannot just stop a boat in the middle of the water. You must secure the boat to something, using either an anchor line or the rock face itself. Project Moorway was tasked with taking a rock-climbing cam, which has been proven to be functional, and modifying it to be used in the saltwater fjords of Norway. Project Moorway focused on the development of a tension block, which would provide a constant force on the cam lobes themselves, along with preventing the cam from being pulled from the rock face. We are currently looking into ways to reduce the number of parts and to make the cam more user-friendly. The end goal is to provide a functional prototype that would be in the $100-200 price range.

70 – High Temperature 3D Printer

Zachariah Kotlarich, Donald Howard, Innocent Ebeh and Chase Robinson
Advisor: Robert Taylor and Ankur Jain
Mechanical and Aerospace Engineering Department

We will design, build, test, and operate a high-temperature 3D printer, modified from open-source parts, with a print volume of 350 mm wide, 350 mm deep, and 609 mm tall that will print with a proprietary heat spreader without the use of a heated chamber and will have in-situ thermal and geometric sensing capabilities.

71 – Shape Morphing Aircraft Wing

Devang Tavkari, Ahmed Abdelaziz, Jason Tran and Abdullah Waleed
Advisor: Paul Davidson
Mechanical and Aerospace Engineering Department

Improving aerodynamic efficiency by optimizing the airfoil geometry has been an important field of research in the aerospace industry. Small alterations in the shape of aircraft wing cross-section can significantly improve the overall performance leading to overall cost reduction. Team Morphics proposes to develop a novel shape morphing airfoil, which can actively enhance its geometry to improve the aircraft's performance while airborne. Shape morphing airfoil will be designed to provide better aerodynamic efficiency while minimizing turbulence and maintaining stability. A special kind of Auxetic structure will be embedded inside the airfoil, which will be compressed and expanded at critical locations along the chord of the airfoil. An electro-mechanical actuation mechanism will be used to control the auxetic structures. The goal of this research is to morph airfoil geometry between different configurations while withstanding the aerodynamic and structural loads. The airfoil will also consist of micro-turbulent drag reduction structures embedded in the airfoil skin, which will help improve the aircraft's drag performance. Our team will focus on employing computational modelling techniques to measure the mechanical performance under multiple loading scenarios to ensure high fatigue life.

72 – NIT: Automatic Tool Elevation and Reloading System – Team MDN Consulting

Michelle Delk, Jeffrey Nelson and Jon Malo
Advisor: Raul Fernandez
Mechanical and Aerospace Engineering Department

The Nitroset concrete fastener system is a manually operated tool used in the construction industry. The task given to MDN Consulting is to automate the use of this tool to increase efficiency and safety, and to remove as much human variability from the use of the tool as possible. This task is split into four primary tasks: an elevation mechanism, reloading mechanism, clearing mechanism, and a cart to safely mount to the robot. The design for the elevation mechanism was executed by utilizing a twelve-inch stroke linear actuator that clamps to two different sections of a telescoping pole. The reloading mechanism consists of a rotating linear actuator that picks up new brackets and inserts them into the firing chamber of the tool. The clearing mechanism uses a crank shaft which enables a linear tool movement that expels the used fastener charge. Lastly, the cart is designed to completely support the tool assembly to protect the robot from debris and allow the tool assembly to be easily detached from the robot in a modular manner. Combined with a microcontroller, these sub tasks accomplish the overall objective of automating the use of the Nitroset concrete fastening tool.

73 – Suction Based End Effector for a Robot

Alyssa Velky, Bao Duong and Lexi Barbee
Advisor: Raul Fernandez
Mechanical and Aerospace Engineering Department

Solstice Solutions, in collaboration with Bell Flight, is engaged in the design of a specialized end effector for the FANUC 2000-iB robot. This end effector is engineered to manipulate its environment through vacuum-powered suction cups, which are mounted on air cylinders, enabling them to extend and retract. Activation of the suction cups occurs upon extension, initiating vacuum flow, whereas retraction ceases the flow. The end effector, measuring 16 x 16 inches, is tasked with elevating wet composite materials for visual inspection by a camera system, aiming to detect any foreign object debris. Successful inspection leads to the application of the wet composite onto a mold by the end effector. To facilitate optimal adhesion to the mold, the suction cups are configured in an array and are capable of independent extension and retraction. Additionally, spring-powered compression components are integrated within this array to ensure uniform compression of the wet materials. Currently, Solstice Solutions is in the testing and assembly phase of the project, with plans to produce a prototype of the end effector, excluding vacuum tubing, by May 2024.

74 – RQ-11 Raven Design Modification

Ahmad Hamzah Yousaf, Alexsanthra Rodriguez, Maryam Shahidzadeh and Joshua Alejos
Advisor: Robert Taylor
Mechanical and Aerospace Engineering Department

AeroPrint Mavs is participating in the 8th annual 3D Printed Aircraft Competition for which the team optimized the design of a fixed wing UAV based on Raven RQ-11. The aim of this project is to optimize the design by reducing the weight of the aircraft to achieve a flight time of at least 18 seconds. To achieve this goal the team performed topology optimization, aerodynamics, and structural analysis to execute detailed design alterations and manufacturing of a new plane. The impact of these changes has been evaluated through the analysis of the first prototype produced using advanced manufacturing techniques. The Markforged Mark 2 and HP MultiJet Fusion 3D printers were utilized due to their capability of printing detailed complex designs. AeroPrint Mavs has successfully integrated the electronic components to the final prototype and achieved a weight reduction of 10% of the overall weight with the first test flight scheduled in March.

75 – Automated Orthopedic Fixator

Michael McQuade, Noah Brown and Ian Padovani
Advisor: Thomas Allsup
Mechanical and Aerospace Engineering Department

Within the world of orthopedic corrections, many medical devices rely heavily on patient responsibility. Specifically for the Hexapod External Fixator, the patient is directly responsible for adjusting six unique struts that connect two platforms attached around a deformed bone. Over the course of the treatment, the patients extend and compress the struts to continuously break and reshape the bone to a desired length and orientation. This responsibility introduces an immense amount of human error, requiring frequent visits to the physician's office for correction. Fixate Group aims to replace the existing manual adjustment struts with a unique design automatically driven by electric motors. These electric motors are controlled by an onboard microcontroller which will inform each motor to rotate a prescribed amount, fully automating the strut adjustments. This transition from manual to automatic adjusting struts will greatly decrease the frequency of required physician visits, while also increasing patient safety outcome.

76 – ASHRAE 2024 HVAC Design Calculations

Thu Hoang, Alejandro Mendoza, Khiem Do and Fernando Rodriguez
Advisor: Raul Fernandez
Mechanical and Aerospace Engineering Department

Our Advanced Vision Interactive Drone (AVID) is an artificially intelligent robot companion designed to utilize the power of computer vision and artificial intelligence to become a human assistive bot that aims to convert visual information into audio input for the visually impaired. AVID is designed to use its sensory equipment with a neural network to translate images of one's surroundings into assistive sound. This translation of image to sound will provide an understanding of the immediate environment that can be used along with active feedback of obstacles to provide directions as needed to allow a visually impaired person to be more cognizant of their surroundings. Active and passive sensors will enable the drone to increase the user's awareness of their environment by translating visual information into spatial audio cues. The drone will follow the user by performing "station keeping" so that it can aid them in navigating complex environments. Changes will be detected as the user moves and those changes will be translated into sound to direct the user via modified headphones. The user will need to learn how to interpret those sounds in order to use them for navigation purposes.

77 – Celebrating 18 Years of AE Senior Design (AE Capstone)

Thomas Ledford and Cody Harris
Advisor: Bernd Chudoba
Mechanical and Aerospace Engineering Department

Aerospace vehicle design has a rich history here at UTA. Over the past 18 years, several student projects have reverse-engineered a variety of vehicles such as the SR-71, X-15, XB-70, X-59, and many more. UTA's AE capstone students have derived unique conceptual design approaches to determine vehicle feasibility and performance. Applying their critical thinking skills to creatively solve problems, students are challenged to complete the general steps to conceptual design. With these steps in mind, gathering data, information, and knowledge allows for the students to learn from the past and design for the future.

Research Experiences for Undergraduates

78 – Transporting Bulk Hydrogen by Airship

Jordan Nalepka, Emma Snelson and Jacob Price
Advisor: Kendra Wallis and Chris Boyer
Electrical Engineering Department

This project explores the theoretical concept of transporting bulk green hydrogen produced by wind farms and solar arrays via airship compared to other methods of transport, such as pipeline, automotive, and overseas freight; and weighs the possible benefits against the possible drawbacks to determine whether this could be a viable alternative to conventional methods of hydrogen delivery. The primary goal of this research is to assess a best-case scenario to determine the overall feasibility of such a concept.

79 – Harness Edge Intelligence for Grid Resilience: Embedded Optimization to Enhance Automatic Restoration in Distribution Systems

Joseph Oh
Advisor: Yichen Zhang
Electrical Engineering Department

Nearly 90% of all power outages have their roots in distribution systems. Distribution system automation, particularly automatic restoration, plays a vital role in grid reliability and resilience and is the cornerstone of modern smart grids. An automatic restoration system consists of multiple protective devices that can communicate with each other and process certain computation tasks. Once an outage is detected, all protective devices will collaboratively determine an optimal post-fault network topology and change their switches' status to reconfigure the network so that the fault is isolated and the power flow is re-routed to supply customers. Compared with traditional manual operation, this automated process can save significant customer minute interruptions. However, current automatic restoration systems use graph search and other heuristic algorithms to determine the post-fault topology, which often results

in suboptimal solutions and even constraint violations. In this project, we will develop an AI-assisted framework for self-healing distribution systems. The outcome of this project will enable automatic restoration systems to handle more complicated scenarios.

80 – Solar Africa

Ayofemi Asaolu, Nathaniel Diggs and Quinn Ariel Xiayuan Meyer
Advisor: Chris Boyer
Electrical Engineering Department

This research project will develop a model for bringing electricity to undeveloped areas of Africa, like South Sudan. It builds on research Dr. Boyer has done in the region for 11 years. Pilot solar projects of all sizes have been attempting to bring electricity to undeveloped regions, from solar lights to village microgrids. While solar projects have succeeded at displacing fossil fuel with clean energy, projects fail to scale because they do not provide a way to create income for the energy. The work proposed for this REU combines a power plant with a manufacturing business. This way, the power plant is large enough to achieve economies of scale. The manufacturing uses the energy and creates revenue that pays for the energy. Excess energy generation can then be distributed and sold as "residential" electricity at an affordable rate. The people can pay for their electricity because they have jobs in manufacturing. Research activities include interviews with potential benefactors (people in Africa that need electricity), a business plan with a financial model, a technical design solution, and a scaled demo of hardware to show at Innovation Day. The results of this research will be used to propose funding for a working project.

81 – Reconfigurable Multi-Objective Solar Inverter and EV Charger System Co-Design

Manas Kulkarni
Advisor: Liwei Zhou
Electrical Engineering Department

This project will develop a multi-functional energy conversion system that can be used for EV charger, solar panel and grid interfaces. The developed equipment is reconfigurable for EV battery charging, solar energy harvesting and grid-connection. Generally, the designed prototype can charge the EV battery from either the grid or solar panel. Also, the power converter can provide grid services with active/reactive power support from the battery or solar panel for a more robust grid operation. The proposed multi-objective energy conversion system is highly reconfigurable for EV, solar and grid interfaces. The corresponding generalized power converter is standardized for various applications. The design cost for hardware components can be largely saved. Also, we are leveraging wide bandgap devices for high frequency switching to reduce the power loss and volume. The energy conversion efficiency and power density will be highly improved. This research project aims at accelerating the energy sustainability by developing more advanced technologies for EV and renewable energy resources.

82 – Soft Pneumatic Actuator-Based Hand and Wrist Exoskeleton for Motion Assistance in Rehabilitation

Suyog Neupane and Samuel Dantan
Advisor: Inderjeet Singh
Electrical Engineering Department

Exoskeletons are being explored for assisting motion therapy for neurological impairment-related rehabilitation. Soft robotic exoskeletons, with their simple actuation mechanisms and flexible nature, are garnering increased attention for upper extremity applications. Coordinating both hand and wrist movements is essential for regaining fine motor hand functions, as many daily tasks necessitate a combination of these motions. However, the development of soft robotic exoskeletons that integrate hand and wrist motion remains an underexplored area. This work introduces a pneumatically actuated soft robotic exoskeleton designed to deliver coordinated assistance to the hand and wrist joints using PD-based feedback control. The findings demonstrate the potential of the exoskeleton to facilitate flexion/extension rehabilitation exercises and task-oriented rehabilitation activities.

83 – Energy Storage on the BESS Train

Prasiddha Pokhrel, Fernando Villa and Michael Moreno
Advisor: Wei-Jen Lee and Chris Boyer
Electrical Engineering Department

This REU studies moving stored energy by batteries on a train. Moving energy has long been performed by train in the form of coal and petroleum. As we decarbonize our energy economy, trains can still play a key role in moving energy stored in batteries in cargo cars. This method may be especially effective in debottlenecking electric wire transmission constraints, providing alternatives for planned transmission maintenance, or providing resiliency during unplanned outages. Research is done to calculate how much energy is feasibly moved, the cost of moving the energy by train, and compare that to possible revenues to create a techno-economical model.

84 – Rheological and Thermal Behavior of Wastewater Sludge: Discrepancy Between Facility Design and Facility Operation in Heat Exchangers

Leslie Gamez, Aditya Ravishankar, Ethan Flaming, Erin Choi, Prachi Saha and Nimad Felegari
Advisor: Hyeok Choi
Civil Engineering Department

This project stems from discrepancy between facility design and facility operation in an engineering practice. Sludge is a byproduct of wastewater treatment. Since sludge digestion can reduce the volume of sludge only by 50%, a hydrothermal process (HTP) has been introduced as pretreatment of sludge before digestion. Through HTP at high temperature, sludge is more liquified and organic compounds become more digestible, which greatly help the subsequent

digestion. Then, sludge is cooled down through cooling heat exchangers (CHEs) to 35-40 °C, an optimum for digestion. Although a medium passing through CHEs is, in fact, sludge containing solids at 7-15%, design of CHEs is simply based on the rheological and thermal properties of clean water, making CHEs less energy-efficient and thus causing subsequent problems. In this REU, the student team worked with the PI's graduate students to experimentally determine the rheological and thermal properties of actual sludge samples and to compare them with the properties of clean water. The team found the rheological and thermal properties of the sludge greatly change during HTP and thus concluded that the properties of actual sludge (not clean water) should be used in the design and operation of CHEs to improve their energy efficiency.

85 – Socio-Environmental Costs Comparison of Trenchless Cured-in-Place Pipe and Open-cut Pipeline Replacement Methods

Elayna Saeed and Allison Pham
Advisor: Vinayuk Kaushal
Civil Engineering Department

The development of underground infrastructure, environmental concerns, and economic trends is influencing society, resulting in the advancement of technology for more efficient, environment-friendly, and cost-effective pipeline installation and renewal. Socio-environmental costs comparison of pipeline renewal and replacement is an essential element when considering sustainable development of underground infrastructure. Project owners, decision makers, design and consulting and contractors commonly take into consideration the construction costs only and overlook the environmental and social cost aspects while making a choice between trenchless and open-cut pipeline installation. Trenchless Cured-in-Place Pipe (CIPP) involves a liquid thermoset resin saturated material that is inserted into the existing pipeline by hydrostatic or air inversion, or by mechanically pulling-in and inflating. The liner material is cured-in-place using hot water, steam or light cured using UV light resulting in the CIPP product. The objective of this study is to compare environmental and social costs of trenchless CIPP renewal method with open-cut pipeline replacement for small diameter sanitary sewers and to identify influencing factors impacting costs using data from case studies and other published research. This methodology can also be applied and will be useful for analyzing larger pipe diameters and at other locations to develop a decision tool.

86 – Removal of Copper Using Aureobasidum Pullulans and Arthrobacter Sp. for the Betterment of Biosolids Quality

Giang Tran
Advisor: Srivinas Prabaiar
Civil Engineering Department

The escalating levels of copper contamination in natural water systems and sewage, primarily attributed to agricultural runoff, industrial discharge, and domestic waste, raise significant environmental and health concerns. The accumulation of copper in biosolids, originating from sewer systems and water treatment sludge, poses a critical challenge as it impacts their suitability for agricultural purposes, typically failing to meet Class A grade standards due to elevated levels of heavy metals such as copper, chromium, and cadmium. Excessive copper levels pose health risks such as anemia, intravascular hemolysis, and acute liver failures while also compromising the quality of biosolids. Addressing this challenge requires the development of cost-effective copper removal methods from wastewater, with biosorption emerging as a promising solution. This project specifically aims to assess copper(II) removal efficiency using mixed cultures of Aureobasidium pullulans and Arthobacter sp. Through batch experiments, the study will investigate the copper binding capacity of these microorganisms under varying pH, temperature, and initial copper(II) concentrations. By comprehensively exploring these parameters, the research seeks to contribute to developing effective strategies for mitigating copper contamination in wastewater and improving the quality of biosolids for safe agricultural utilization.

87 – Performance of Using Expanded Polystyrene Blocks as Building Materials to Reduce the Cost of Energy Consumption

Joseph Reily and Ali Azzawi
Advisor: Raad Azzawi
Civil Engineering Department

The discovery of CRISPR-CAS proteins as a powerful gene-editing tool has revolutionized biomedical research. It has the potential to enable medical breakthroughs of immense magnitude. We used a transformer (self attention) encoder with a feed forward neural network to classify CRISPR-CAS protein by applying feature extraction and feature selection methods on previously identified CAS and non-CAS proteins. We then create a generative model to generate CRISPR-CAS protein sequences, the validity of which can be tested by our transformer-based classifier.

88 – Breaking the Lignin Barrier with Termite TAV5 Treatment Technology (T4): Biopower and Biofuel from Agricultural Waste

Christina Moreno
Advisors: Hussain Ali, Arpita Bhatt, Melanie Sattler and Kimberly Bowles
Civil Engineering Department

Biofuel can be considered one of the best alternatives to fossil fuel. Currently the world produces 3758x106 Mg/year, while the U.S. produces 488x106 Mg/year of agricultural waste. This agricultural waste consists of 90% lignocellulose. However, lignin is resistant towards microbial attack, and current methods to degrade lignin are not viable. TAV5 (Termite Associated Verrucomicrobia) is isolated from the hindgut of Reticulitermes flavipes termites and has been found to break down lignin without any pretreatment. The overall goal of the project is to increase the sustainability of agricultural systems, by improving the production efficiency of biofuel from agricultural wastes (rice straw, wheat straw, rice husk, corn stover). Specifically, the ability of Termite TAV5 Treatment Technology (T4) to decompose lignin and produce biogas from agricultural wastes will be tested. Small scale lab tests have proved an increase in methane

production for all four wastes. The next step is to do a pilot scale study, where we will set up eight (275 gallon) anaerobic digesters with four being control and four with TAV5. The biogas energy produced can be used on-farm for electricity, heat, or vehicle fuel, reducing dependence on fossil fuel and making the agriculture system more environmentally and economically sustainable.

89 – Gamifying Human Building Interaction for Sustainable Indoor Environment

Jacqueline Luong and Ali Aldhalimi
Advisor: June Young Park
Civil Engineering Department

Space heating and cooling characterizes nearly a third of the U.S.'s electricity usage, with the southern U.S. consuming even more. These rates of consumption are greatly affected by the interactions and behaviors that occupants have indoors known as human building interaction. Influencing these behaviors and interactions is focal to reducing both energy consumption and improving indoor health of occupants. One popular form of influencing occupant behavior is gamification, where occupants are persuaded with competition and rewards. However, in the realm of building science, attempts at gamification primarily use monetary rewards to motivate occupants and are not entertaining and captivating to the occupants. A more entertaining approach to gamification should be used to nudge occupants to be more sustainable. This research project aims to improve upon this concept of gamification to create and implement a human-centric digital twin-based gaming device that promotes smart, healthy, and sustainable choices inside of indoor environments.

90 – Soil Borehole Thermal Grout for Enhanced Geothermal Energy Applications

Aashish Pokhrel, Benjamin Mark Williams and Alyssa Phillips
Advisor: Xinbao Yu
Civil Engineering Department

Shallow geothermal energy is increasingly used for applications such as heating and cooling spaces, snow-melting and deicing of bridges and pavements, and soil thermal energy storage, as a green, sustainable, and readily available energy source. In such applications, ground loops filled with heat carrier fluids are installed in the ground to exchange thermal energy with the surrounding soils. During the installation, thermal grout is used to fill the gap between the ground loop pipes and the surrounding soils. The thermal properties of the grout and its response to heating and cooling are critical to ensure the optimum thermal energy exchange between soils and ground loops. This REU research, supplementing an existing TxDOT project, aims to train students to understand geothermal applications and develop an enhanced thermal grout material for high energy efficiency of the current geothermal underground systems. In this research, laboratory tests will be conducted to investigate the thermal properties of thermal grouts in response to varying soil moisture and temperature. New phase-change materials will be mixed with the grout and tested for their performance in heat exchange. The results will lead to a change in the current grouting materials and a much more efficient underground heat exchanger system.

91 – TerraTracker

Nabeel Nayyar, Areeb Khan and Talha Nayyar
Advisor: Donna French and Kelly French
Computer Science and Engineering Department

Introducing TerraTracker: a cutting-edge, self-sustaining search robot dog designed to revolutionize disaster response efforts. Its mission is to navigate through treacherous terrains and aid in survivor extraction through locating endangered persons in the disaster zone. Through the power of reinforcement-based machine learning, TerraTracker will master the art of terrain navigation, ensuring it can adapt seamlessly to even the most challenging environments, such as earthquake-ravaged areas. Equipped with an extensive array of sensors, it not only navigates its environment, but also identifies trapped survivors. Additionally, solar panels will be integrated to extend battery life; therefore, enhancing the self-sustainability. This ensures TerraTracker can efficiently carry out tasks during the crucial initial hours of the operation without the need for frequent recharging interruptions.

92 – Videopedia

Yash Waghmare, Akshaj Murhekar and Tuan Quang Trinh
Advisor: Christoph Csallner
Computer Science and Engineering Department

Videopedia is an innovative, automated video creation platform that transforms textual content into educational and engaging video materials. It employs advanced artificial intelligence, including OpenAI's GPT-4, to analyze input scripts and generate corresponding visual elements. The platform seamlessly combines AI-generated images, sourced GIFs, and custom animations to produce rich multimedia experiences. By leveraging speech-to-text for precise audio segmentation and keyword extraction, Videopedia ensures that visual elements are perfectly synchronized with audio narration, enhancing the learning experience. A cornerstone feature is its dynamic content integration, which adapts the duration and selection of visuals based on audio cues and thematic relevance. This is achieved through a combination of algorithms and audio fingerprinting, which dictates the pacing and transitions of the video. Videopedia's extensive graphic elements library, sourced through various APIs, enriches videos with relevant icons and imagery. This end-to-end automated system aspires to revolutionize educational content delivery, making it more accessible, customizable, and scalable, catering to a wide array of learning styles and preferences. Videopedia stands at the forefront of edtech, offering a potent tool for educators, students, and lifelong learners to explore complex topics through visually captivating narratives.

93 – Machine Learning Unveils the Hidden Link: Public Water Quality, Cancer Incidence, and Energy Waste in Texas

Stepan Zima
Advisors: Vassilis Athitsos and Gabriela Wilson
Computer Science and Engineering Department

Our project aims to explore the potential links between public water quality, cancer incidence rates, and energy waste in Fort Worth, Arlington, and Dallas, Texas. We will use machine learning to analyze the relationship between various water contaminants, which differ by zip code, and cancer incidence. The goal is to identify specific chemicals that may increase cancer risk. The project will also examine the energy consumption of water treatment methods. These processes are typically energy-intensive, and understanding their effectiveness under varying environmental conditions can guide decisions towards more energy-efficient water treatment. The findings from this research could reveal how water quality affects public health and energy usage. This knowledge could then inform healthier and more sustainable practices for public water treatment. The ultimate goal is to contribute to the development of strategies that promote both public health and energy sustainability.

94 – Advancing ClaimBuster: Enhancing Efficiency and Accessibility for Real-time Fact-Checking

Aviral Saxena and Asmin Pothula
Advisor: Chengkai Li
Computer Science and Engineering Department

This project aims to optimize ClaimBuster, a pioneering fact-checking system developed by the IDIR Lab in 2014. ClaimBuster utilizes technologies such as database queries, data mining, machine learning, and natural language processing to aid fact-checking in real-time, across various media platforms. The objective of this REU project is to streamline multiple existing components in the system, develop a user-friendly web-based interface to facilitate the creation, management and monitoring of live fact-checking tasks, and implement additional functions to increase the system's utility, such as remote channel switching and data visualization.

95 – Tortoise: An Assistive Smart Glasses System for People with Memory Loss Conditions

Ahmed Ullah, Abraham Rincon, Steven Culwell and Efaz Hossain
Advisor: Shawn Gieser
Computer Science and Engineering Department

Tortoise is an assistive smart glasses system for individuals with memory loss conditions such as Alzheimer's and dementia. Tortoise addresses three key challenges commonly faced by people with memory loss: recognizing faces, identifying household objects and their locations, and wandering prevention. The proposed system consists of a smart glasses prototype working in tandem with a user-friendly smart-watch application (wearOS/watchOS). The smart glasses use a Raspberry Pi Zero 2W and RPi Camera Module v3 for acquiring an image feed, applying advanced computer vision techniques for facial recognition and object detection. Results, along with GPS data, display on the smart-watch app. Facial recognition involves detecting and classifying faces using MTCNN and the convolutional neural network (CNN) architecture VGGFace, with the watch application maintaining a record of recognized faces. Object recognition employs trained CNN models like EfficientNet and You Only Look Once (YOLO) v8, processing live image data from the smart glasses, while the watch application presents object classifications and GPS coordinates, aiding users in identifying household items. To prevent wandering, a geofencing technique monitors GPS location, alerting caregivers when predefined boundaries are breached, with real-time location data.

96 – Web-Based GUI for Video Content Processing

Amey Shinde
Advisor: Sharma Chakravarthy
Computer Science and Engineering Department

We developed MavStream, a stream data processing system, for processing sensor-based stream data. We are re-examining and extending that to perform video situation analysis on video content. The system lacks a GUI-based dashboard for interaction to input queries and send them to the server for execution. Queries also need to be persisted on the server. This proposal is to accomplishing some of that functionality. The lab director has previously developed dashboards, as he developed one for visualizing Covid data. We have a visualization dashboard for Covid with two panels. One panel shows the spread of Covid at the U.S. county granularity across two periods/intervals that are chosen by the user using a drop-down menu. For instance, comparing 14-day periods before and after a long weekend. The other panel shows animated plots of various features for different countries and regions within. These are available to the public at https://itlab.uta.edu/cowiz. We use data from multiple sources, such as the NY times, CDC, and Johns Hopkins, and use real-time data from WHO and relevant news items on Covid for the period of interest. The focus and goal of this project is to develop a similar interactive dashboard for the MavStream system.

97 – Automated In Situ Segmentation of Sugarcane Roots

Joseph Salas-Leon
Advisor: William Beksi
Computer Science and Engineering Department

Roots provide essential information regarding the health, structure, and growth of a plant. Software tools exist that can help plant scientists extract root information through an image of the roots, however these tools require clean images of only roots in order to provide accurate information. Obtaining proper input images for these tools can be done via manual annotation of the images, but it requires domain knowledge of the plant to accurately annotate the images. In this project, we propose to automate this process by developing a deep learning model that can correctly extract segmented plant roots from

raw images. These preprocessed images can then be used by plant root analysis tools, thus removing the time consuming process of hand-labeling future images. To do this, we will annotate raw in situ root images and then train a model using established image segmentation architectures as a backbone to generate high-quality root segmentations. This project will provide a unique undergraduate research experience and support PI William Beksi's collaboration with Patrick Ellsworth, a research plant physiologist in the U.S. Department of Agriculture Sugarcane Research Unit located in Houma, Louisiana.

98 – mmWatch: A mmWave-Based Surveillance System for Sustainable Future Infrastructure

Yongjun Lee and Aliu Akinwale
Advisor: Dianqi Han
Computer Science and Engineering Department

Surveillance systems are widely deployed in critical infrastructures to detect abnormal human activities. However, existing systems that rely on high-fidelity cameras are both expensive and power-consuming, making them unsuitable for sustainable future infrastructures. In response, this project aims to develop a novel mmWave-based surveillance system, dubbed mmWatch. mmWatch harnesses the latest mmWave sensing technology for area perception. Specifically, the system utilizes Frequency Modulated Continuous Wave (FMCW) radios to sense its surroundings and implements sophisticated signal processing techniques to acquire numerous geographic points on the surface of observed objects. Subsequently, we implemented a velocity-based clustering method to identify the points associated with the human body, and then estimate human body pose and activities. We have prototyped mmWatch using commodity mmWave sensing chips and a computer for data processing, which will be utilized for a comprehensive evaluation in the future.

99 – [MLN-DASH 2.0] Extended Dashboard to Generate, Analyze and Visualize Complex Data Using Multilayer Networks

Viraj Sabhaya and Kevin Farokhrouz
Advisor: Abhishek Santra
Computer Science and Engineering Department

Graphs have been extensively used for studying complex systems of interacting entities from diverse disciplines, such as social networks, transportation and epidemiology. However, when studying data with multiple entities, relationships and features, simple graphs are not always sufficient. For example, to study the pattern among accidents and propose safety precautions, one needs to explore the relationships between various factors like weather, light, road surface, and geographical region. To model such multiple relations, multiple related graphs are useful. This can be done with multilayer networks (MLNs). To support the entire lifecycle from generation of MLN from complex data to the final drill-down and visualization, we have developed a multi-user, web-based dashboard through which users can register, securely log-in, and work in their independent workspaces, work with pre-loaded data sets, generate and analyze

different networks using configuration files, and create interactive visualizations for the networks and analysis results. We plan to enhance this dashboard for robustness, re-usability, and interactivity by adding features like user capability to upload their own data sets, processing of expressions with more analysis algorithms (centrality, substructure discovery) and visualization alternatives, selective sharing of data and results, and improved performance.

100 – Speclearn: Spectrum Learning in Shared Band Under Extreme Noise Conditions

Mohammad Hasibur Rahman
Advisor: Debashri Roy
Computer Science and Engineering Department

The "Speclearn" project introduces a new learning framework to detect radar signals in the shared spectrum settings with the use of machine learning even in the presence of heavy noise. The study aims to be in a position to tell the effect of synthetic noise onto signal detection accuracy in the Citizen Broadband Radio Service band. We first labelled clean spectrograms for training and then used the YOLOv5-based object detection framework. Furthermore, spectrograms are evaluated under a huge set of different noisy scenarios. We noticed that the performance degradation at low noise was unnoticeable, yet the detection of signal in radar systems becomes a complete failure for high noise cases. Thus, with this research, critical insights are gained that enhance the robustness of machine learning models to noisy, shared-spectrum settings in view of potential real-world applications, and will foster further advancements in signal detection technology.

101 – Sourcing and Preprocessing Animal Communication Data for Animal Language Understanding

Hridayesh Lekhak
Advisor: Kenny Zhu
Computer Science and Engineering Department

Whether animals can effectively exchange information through their vocalization has always been a topic of curiosity for people. With the help of natural language processing and deep learning technologies, the mysterious veil of animal language is being gradually lifted by scientists. However, animal communication research faces challenges due to the scarcity of comprehensive datasets. My REU project aims to narrow the gap in animal communication research by using advanced natural language processing and data mining techniques to gather high-quality data from various sources. By employing machine learning models like BERT and vision encoders, trained specifically to focus on desired animal species, we ensure the data is accurate and clean, leading to a robust dataset. Additionally, data preprocessing techniques are employed to enhance the quality and relevance of the acquired data. The main objective of this project is to develop a streamlined pipeline that not only improves data accuracy but also ensures the comprehensive nature of the dataset, which is crucial for future animal language research endeavors.

Understanding animal language is important because it provides insights into social structures, behaviors, and ecological dynamics, thereby enhancing our understanding of the natural world.

102 – Empowering the Future of Wireless Communication: A Comprehensive Exploration of srsRAN for 5G Open RAN Deployment and Beyond

Fuhad Foesal Ahmed and Tin Duc Ngo
Advisor: Debashri Roy
Computer Science and Engineering Department

SrsRAN will set guide posts on how deeply to plunge into this technology to deploy 5G Open RAN, and beyond. The work will be firmly rooted in the promise that Open RAN provides to innovate mobile wireless technology, bring competition, and bring down costs related to deployment. Using the srsRAN software suite, covering both 5G Open RAN Central Unit (CU) and Distributed Unit (DU) implementation, this paper aims to demonstrate its practical deployment with respect to research and development. What sets our focus further from conventional WiFi-based connections is the integration of private 5G networks for better automation and security, particularly in the networked robotics configurations. Based on three major research thrusts, we shall try to demonstrate the performance, adaptability, and scalability of srsRAN. This will encompass the evaluation of network performance in Lightmetrics, developing a near-RealTime RAN Intelligent Controller (near-RT RIC), and porting the srsRAN codebase on ARM-based hardware platforms. Our project will be an advancement towards Open RAN technology and will encourage competition, inclusion, and innovation in the mobile wireless sector and shape a diverse and collaborative future.

103 – Analyzing the Sensor Modality Selection for Competitive and Cooperative Service Robots

Quang Duy Pham
Advisor: Debashri Roy
Computer Science and Engineering Department

In light of the growing interest in leveraging network-enabled robotic and autonomous systems across various sectors, the mobile telecommunication organization 3GPP has taken steps to evolve and expand the performance criteria required to accommodate diverse vertical applications, including vehicle to everything, uncrewed aerial vehicles, and industrial robotics. Furthermore, 3GPP is conducting a stage 1 study on the Network of Service Robots with Ambient Intelligence in Release 19 (3GPP TS 22.916) with a focus on identifying potential gaps and emerging considerations vital for supporting collective operations of multiple service robots (SOBOTs) in unstructured environments. Each SOBOT comes with multiple sensors which capture the complementarity of the environment through multimodal data. Each SOBOT or group of SOBOTs have autonomous decision-making capabilities and operate in complex environments where they need to strike a balance between competition and cooperation to make an optimized decision. The idea is to adaptively choose the most relevant sensory modality based on the spatial arrangement of SOBOTs and the specific nature of their interactions. This will enable SOBOTs to save energy by not employing all sensors simultaneously and enhance their decision-making abilities in dynamic environments.

104 – Enhancing Symbolic Execution With Large Language Models for Efficient Vulnerability Detection in Real-World Software

Muhammad Zaharudin and Muhammad Zuhaimi
Advisor: Faysal Hossain Shezan
Computer Science and Engineering Department

The prevalence of vulnerable code poses a significant threat to software security, allowing attackers to exploit weaknesses and compromise systems. Traditional methods of manual vulnerability detection are expensive, requiring substantial domain expertise. Automated approaches, particularly those based on program analysis techniques like symbolic execution, have shown promise but face challenges in path convergence, scalability, accuracy, and handling complex language features. We propose to introduce a hybrid approach that combines a large language model (LLM), such as GPT-4, with a state-of-the-art symbolic execution tool like KLEE. Our approach aims to enhance symbolic execution by mitigating its inherent challenges. The strategy involves dynamically prioritizing execution paths based on contextual relevance and potential vulnerability disclosure. The LLM will guide symbolic execution towards paths likely to yield significant outcomes, adapting strategies based on evolving context and analysis information. Additionally, we will incorporate semantic information from the LLM to generate more meaningful constraints, reducing the complexity of constraints and directing symbolic execution towards pertinent paths.

105 – Characterization of Recycled Stainless Steel 316L Powder in Additive/Subtractive-Based Hybrid Manufacturing with Directed Energy Deposition

Safwan Zaeem and Ajmaeen Basher
Advisor: Yiran "Emma" Yang
Industrial, Manufacturing and Systems Engineering Department

It is customary to recycle waste powder and use it for further fabrication in additive manufacturing (AM) to save a large proportion of cost. Since the recycled powder in metal powder-based AM directly affects the ultimate quality of the final product, it is really important to study and characterize it before application. Powder features, including particle size, circularity, perimeter, porosity, etc., are proven to influence product quality in literature. The main objective of this proposed research project is to investigate the effect of aging time and temperature on features of Stainless Steel 316L. Students will have full access to facilities at the SIGMA lab for conducting the proposed research.

106 – Agent-Based Modeling of Land Use Decisions for Urban Agriculture

Gavin Wilson
Advisor: Caroline Krejci
Industrial, Manufacturing and Systems Engineering Department

Modern industrial food supply systems are capable of cost-efficient production of large volumes and varieties of food but are also responsible for toxic outputs to the environment, unsustainable energy and water consumption, and economic damage to rural communities. Local food systems, in which consumers source food from nearby farmers, may offer a sustainable alternative. However, scaling up local food production to meet consumer demand will require farmers to allocate more land to this purpose. This research project will use agent-based modeling to study farmers' decisions to engage in and expand urban food production. Farmers will be modeled as autonomous and goal-driven individual agents that are capable of making decisions over time about how and whether to increase their production scale, subject to land-use policy, social influence, market opportunities, and personal values. Survey and focus group data collected from urban farmers in Des Moines, Iowa, will be used to inform agents' decision logic, and stakeholder input will be used to validate agent behaviors. Experimentation with the model will aim to identify which factors have the greatest impact on increasing urban food production, and model outputs will then be integrated with biophysical models to determine effects on the health and well-being of urban residents.

107 – Recommissioning Hybrid Energy Storage Modules

Nathan Miranda, Baseel Khader Atallah, Tara Chandrakasem, Anne Huong Nguyen and Dylan Huang
Advisor: Erick C. Jones Jr.
Industrial, Manufacturing and Systems Engineering Department

This project is focused on broadening our understanding of Hybrid Energy Storage Modules (HESMs), their role in distributed power generation systems, and addressing the unique requirements of the Department of Defense. Building upon the restoration of a previous HESM, the project aims to uncover insights into its operational intricacies. Lessons drawn from these tests inform the construction of a new microgrid incorporating flywheel storage, contributing to a broader knowledge base on scalable HESM systems and controls. The research aims to optimize energy systems, emphasizing applications in sustainable microgrid deployment, cost reduction, enhanced resilience, and increased energy availability for military operations. Anticipated outcomes include a refined understanding of efficient power delivery, real-time monitoring, and a standardized microgrid demonstration.

108 – Autonomous Monitoring of 3D Printing

Mayra Olmos, My Vu Nguyen, Hanumath Ponnaluri, Zehao Ye and Yujing Yang
Advisor: Chen Kan
Industrial, Manufacturing and Systems Engineering Department

Robotic sensing is an emerging technology that integrates sensing, computing and communication with robotic platforms. It offers flexible, cost-effective monitoring and surveillance for large-scale systems, thereby gaining popularity across various industries. However, the lack of strategies to optimize power consumption impedes its broader adoption. To fill the gaps, this study proposes a novel framework that fuses cutting-edge deep learning models to realize energy-aware sensing. The developed toolkits have great potential to be extended to a wide variety of robot-based monitoring and surveillance applications for diverse industries.

109 – Development of Inflamed Endothelium Targeting Nanoparticles to Treat Peripheral Arterial Diseased

Na Nguyen, Sebastian Kim and Lana Abdulhadi
Advisor: Kytai Nguyen
Bioengineering Department

Peripheral arterial disease (PAD) is a condition marked by the narrowing of arteries from a buildup of plaque in the lower extremities brought on by atherosclerosis. About 6.5 million Americans, primarily the elderly, are affected with PAD with a high mortality rate; therefore, the need for discovering innovative and novel approaches is crucial to reduce the complications and disadvantages that come with current invasive treatments for PAD. Most current treatments for therapeutic agents are delivered by intramuscular injection on the gastrocnemius muscle, hence, the drug could not diffuse and distribute evenly around the tissue. In order to improve cellular absorption, bioavailability and enable therapeutic efficacy for locally PAD treatments, we therefore offer a non-invasive and promising drug delivery system by targeting upregulated molecules in PAD's inflamed tissue.

110 – WoundWare: Automating In-Vitro Wound Identification, Localization, and Size with Convolutional Neural Networks

Malak Al-Noubani and Anne Alsup
Advisor: Michael Cho
Bioengineering Department

Tissue regeneration represents a key area of research that will advance patient care associated with traumatic injuries, including wound healing. It aims to increase the rate of wound closure using pharmacologic or physical therapeutics. However, a challenge remains in properly characterizing the wound size and the extent of wound healing. The typical manual approach to analyzing the images of a wound over time is laborious and can lead to inaccurate analysis. In contrast, by training a convolutional neural network, we can automate the segmentation of wound areas and characterize the wound. Therefore, we developed and trained a machine learning model using images of damaged tissue cultures that mimic the skin. Cells were cultured around a physical barrier, and after a selected incubation period, the barrier was removed to create a wound. This simulated the healing process as the cells at the periphery of the barrier proliferated and migrated to fill the wound area. Microscopic images were acquired over time to establish an original dataset of various shapes and timepoints in wound healing. Using this deep learning

algorithm, we propose to generate a high throughput screening tool to quantify wound healing rates under different experimental conditions.

111 – Detection of Landmark Transducer Positioning for Accurate and Safe Cerebrospinal Fluid Drainage

Zachary Armstrong and Binita K C
Advisor: Hanli Liu
Bioengineering Department

An external ventricular drain (EVD) functions as a crucial tool in managing elevated intracranial pressure (ICP) by facilitating the external redirection of excess cerebrospinal fluid (CSF) via a catheter placed in the lateral ventricle of the brain. This passive system depends on gravity for fluid pressure regulation and requires an accurate zero reference position as CSF drainage initiates only when ICP surpasses the pressure established by the height of the EVD's collection system. Our project is dedicated to enhancing the accuracy of ICP measurements and CSF drainage by introducing an accessory device that ensures a stable zero-reference position. This enhancement features an inertial measurement unit (IMU) sensor mounted on the patient's head to track and measure head movements. A Python algorithm analyzes these movements, and upon detection of movements beyond clinically relevant predefined thresholds, 2cm of linear displacement or 15 degrees rotationally, it triggers a visual alarm to alert healthcare professionals to adjust the height of the EVD to the original reference position. Upgrades to the previous model include the ability to discern rotational movements, integration of a live/real-time monitoring and alert system, and the implementation of wireless connectivity.

112 – Design a Heart Perfusion System for Ex Vivo Porcine Heart Research

Brady Killham
Advisor: Jun Liao
Bioengineering Department

Hypothermic machine perfusion (HMP) is an alternative method to static cold storage used to maintain the viability of donor organs until they can be transplanted. HMP has shown advantages over the currently used cold storage method, with lower levels of lactate buildup and less increase of AMP:ATP ratio. Better preservation of donor organs can lower the occurrence of graft dysfunction, providing better outcomes for the recipients of these organs. In this project, we designed a heart perfusion system for ex vivo porcine heart research that can be used to study and optimize the heart transplant protocol. The perfusion system consists of a peristaltic pump, a cooler for cooling fluid to hypothermic temperatures, an oxygenator for providing oxygen to perfusate solution, and a heart housing chamber to hold the heart and act as a perfusate reservoir. Pressure and temperature sensors are mounted at the inlet of the heart housing chamber to make sure the desired perfusion pressure and temperature are achieved. The heart perfusion system will be tested using a porcine heart model verify the functionality of the system.

113 – Data-Driven Anomaly Detection of Electric Powertrain System

Philip Pickard, Steven Tang, Francisco Aguilera, Jocelyn Carrasquillo, Leah Doddy and Sravya Nadella
Advisor: Yawen Wang
Mechanical and Aerospace Engineering Department

The electrification of powertrains is rapidly growing in the transportation and power systems in the recent years, driven by the need for clean energy and high efficiency. Many renewable energy systems have the electric powertrain that requires constant monitoring and scheduled maintenance. Anomaly detection and predictive maintenance of these expensive assets can diminish maintenance costs and improve productivity and quality. However, present vibration surveillance practice underutilizes the information content in vibration signals and only identifies peak amplitudes for simple alert monitoring. Therefore, the objective of this project is to combine data analysis, physical modeling and experimental testing to the application of anomaly detection and predictive maintenance of complex engineering assets.

114 – Nozzle Design for Rotating Detonation Rocket Engines Using Computational Fluid Dynamics and Machine Learning Techniques

Philip Wilson and Khushi Piparava
Advisor: Liwei Zhang and Frank Lu
Mechanical and Aerospace Engineering Department

This study aims to develop a customized aerospike nozzle for rotating detonation rocket engines (RDREs) using computational fluid dynamics (CFD) and machine learning (ML). An extensive CFD dataset comprising nozzle flow fields under various geometric and operational conditions will be generated by solving the compressible Navier-Stokes equations. ML techniques will be employed for data analytics, feature extraction, and the overall design procedure. An optimization algorithm will identify the best-performing nozzle design, which will then be manufactured using 3D printing. The customized aerospike nozzle promises to improve RDRE performance by optimizing thrust in relation to the nozzle's divergence angle and length. The project will elucidate the connections among nozzle geometry, flow physics, and thrust. This study leverages advanced computational methods, coupled with hands-on manufacturing, to design novel propulsion systems.

115 – Evaluation of the Blended Wing Body Configuration for the Next Evolution in High-Performance Racing Sailplanes

Colin Agor and Cody Harris
Advisor: Bernd Chudoba
Mechanical and Aerospace Engineering Department

Throughout the history of aviation, gliding vehicles have made their impact time and time again. Whether in warfare or test flying technology, gliders remain one of the earliest and most useful manned flight vehicles, and they have gone through a multitude of different design iterations. Millions of years

ago thanks to the process of natural selection, nature settled on a flying wing design in the pterodactyl from the dinosaur period, and more modernly, birds. This has led designers to question whether the traditional tail-aft configuration most modern designs use is most efficient. Recent studies into new blended wing body commercial transport aircraft from NASA and others in industry may point aircraft design back towards early aircraft designers' taking lessons from nature for increased performance. Overall, an in-depth literature search and vehicle study will occur, leaving the Aerospace Vehicle Design lab with a detailed understanding of the benefits and drawbacks of such configurations.

116 – Complex Parametric CAD Modeling for 3D Printed Scaled Models for Sustainable Aeroelastic Experiments

Mikaela Leevy, Yen Pham and Suraj Gattu
Advisor: Robert Taylor
Mechanical and Aerospace Engineering Department

Conducting wind tunnel testing for research on an aircraft can exhaust funding rapidly. Operation of a wind tunnel alone can cost several thousands of dollars and the cost to manufacture the model is an additional expense that needs to be considered. To save financial resources and time, additive manufacturing processes can be beneficial in developing aircraft models for testing. For this project, the objective is to parameterize the X-56A wing to allow ease of adjustment in dimensions to create rapid renditions of the model for testing to reduce overall experimental cost and time. In addition to the parametrization of the model, the model is optimized for stiffness as the X-56A model will be used to test for aeroelastic effects. The model is comprised of an internal spar structure and the skin of the wing. The internal spar structure is printed using the Markforge printer with a mix of carbo-fiber and nylon-12 filaments while the surface of the wing is printed using the HP Nylon printer.

Other Undergraduate

117 – An Assessment of Methane Reformation and Methane Pyrolysis Technologies for Hydrogen Production, Greenhouse Gas Reduction, and Decarbonization

Alisa Pjetrovic
Advisor: Frank Lu and Arpita Bhatt
Civil Engineering Department

Methane reformation and methane pyrolysis involves separating, or cracking, the components of methane, leading to the production of hydrogen gas and solid carbon. Because methane is known as a leading cause of climate change, methane reformation and methane pyrolysis technologies are gaining attention as the global community moves to address methane as a greenhouse gas. This undergraduate honors capstone project aims to evaluate, through a systematic literature review, the current state-of-the-art technologies based on seven technology criteria: hydrogen production capability, greenhouse gas absence of reduction, decarbonization capability, reaction stability, operating temperature requirements, energy requirements, and technology readiness level (TRL). This study relies on a thorough literature search that determines state-of-the-art technologies, a comparison of their advantages and disadvantages, and a hypothetical quantitative analysis using a decision-making matrix. Global progress and challenges of methane and biogas utilization are also discussed in this study. This is then tied back to the review in order to provide recommendations on how the studied technologies and their TRLs can be improved to make a lasting impact on global efforts relating to hydrogen production, greenhouse gas reduction, and decarbonization.

118 – Toward Enhanced Fire Safety: Functionalized Graphene as a Key Component in Polymer Composite Flame Retardants

Fernando Parra and Vitaliano Dattilo
Advisor: Michael Bozlar
Mechanical and Aerospace Engineering Department

In the last decade, the use of polymeric material gained a lot of space in different industries such as automotive and aerospace. Furthermore, polymers are very flammable materials. Although a large amount of research is currently being done in the field of flame retardant composites, this still is a crucial issue. In this work, a functionalized graphene-based protective devise is proposed with the aim of making a protective layer against fire. Burning tests, according to the UL-94 standards, assess the resistance of the coating when in contact with fire, which are coupled with XRD and SEM images in order to provide the reasons for the obtained outcomes. It was found that the coating is able to extend the life of the polymer by retarding the ignition of the specimen due to the creation of a fire-inert char layer. The latter was also observed from SEM images and confirmed by the shifting toward lower 2 theta of the picks obtained from XRD analysis. Gas spectroscopy tests were also carried out to ensure that the coating is not toxic, meaning that it is not releasing molecules that can interact with the human body leading to health issues.

119 – Machine Learning based Segmentation of Delamination Patterns from Sparse Ultrasound Data of Barely Visible Impact Damage in Composites

Don Nguyen
Advisor: Paul Davidson
Mechanical and Aerospace Engineering Department

Composite laminates are used in various critical applications due to their high strength, low weight, and flexibility. However, under barely visible impact damage, these composites can be delaminated. While ultrasound transmissions can capture these delaminations, noise in the resulting scans make automation of per ply segmentation difficult. Machine learning, which uses an extensive dataset for training, can solve the issue. But as impact testing data is minimal and hard to create, alternative ways for expanding the dataset are implemented, such as utilizing augmented and synthetic data. This study attempts to find the optimal combination of augmented, synthetic data, and original UT dataset,

providing the best segmentation result. Augmented data was produced through a combination of flipping, rotation, and elastic deformation. Synthetic data was made by simulating statistical variation in real data. The created datasets were trained on a Unet based model to apply per pixel classification. Results show that use of augmented data alone increases accuracy greatly. The addition of synthetic and augmented, increases accuracy only slightly, while improving borders. Overall, the study is promising use of machine learning methods in non destructive inspection use cases.

120 – Re-valorization of Plastic Waste for a Circular Economy Model: A Wind Energy Generator Case Study

Christopher Marquez Rodriguez, Vitaliano Dattilo, Kunal Bachim and Nikhil Alagandula
Advisor: Michael Bozlar
Mechanical and Aerospace Engineering Department

The role of plastic in modern life is gaining a lot of importance due to its versatility, lightweightness, and low cost. At the same time, plastic waste generated a global concern because of its negative effects on the environment. Thus, it is crucial to put more effort into researching innovative methods leading to a circular economy, which involves the reprocessing of the waste stream to re-valorize the plastic waste. This work focuses on mechanical recycling, which is considered the key to sustainable plastic management. However, the latter is still facing challenges such as the reduction in the mechanical performance of the recycling product. In this project, we focus on improving the recyclability of polyethylene terephthalate from waste water bottles by dispersing graphene oxide into the polymer matrix, so that the polymer can be recycled a higher number of times. Strips were prepared, washed, and finally filaments extruded by means of a twin-screw extruder. Multiple recycling procedures were carried out. Finally, the mechanical properties of the virgin and recycled polymers were assessed. The final target is to apply our solution in a vertical-axis wind turbine, that will be used for energy production in a remote location.

121 – Revolutionizing Aerospace and Automotive Industries: The Vital Role of Lignin-Based Fibers

Michael Francis Opperman and Ozge Ece Aydogan
Advisor: Michael Bozlar
Mechanical and Aerospace Engineering Department

In the quest to revolutionize aerospace and automotive industries, lignin-based nanofibers emerge as a promising alternative to carbon fiber. While carbon fiber offers strength and lightweight design, its costly production and environmental impact pose significant challenges. Leveraging lignin, a ubiquitous compound in plants, presents a sustainable solution. Focusing on switchgrass as a source, a resilient plant that grows across Texas and thrives in adverse conditions, underscores our commitment to eco-conscious practices and low-input cultivation. Through innovative pre-treatment and extraction methods, we aim to harness properties of lignin to produce robust bio-based fibers. These lignin-based fibers offer mechanical strength, thermal stability, and UV absorption capabilities. Our endeavor signifies a paradigm shift toward sustainable materials, poised to reshape aerospace and automotive engineering. Positioned at the forefront of the green revolution, we aspire to create a future where strength and sustainability harmonize.

122 – Theoretical Symphony: Harmonizing Graphene and Organic Ligands for Rare Earth Metal Extraction

Audrey Miller and Dogukan Yazici
Advisor: Michael Bozlar
Mechanical and Aerospace Engineering Department

Rare earth metals are essential components in modern technology, contributing to applications ranging from high-performance magnets to catalysts and electronic devices. However, with the majority of global production concentrated in China and the United States accounting for only 15%, concerns about supply chain vulnerabilities have arisen, emphasizing the need for diversified sourcing. Mining challenges for rare earth metals, dispersed in nature, necessitate innovative extraction methodologies. This study explores theoretical aspects of rare earth metal extraction using graphene and organic ligands. Density Functional Theory (DFT) calculations, facilitated by Quantum ESPRESSO and Gaussian software, enable a quantum mechanical approach to understand the electronic structure and properties of rare earth metal complexes. In our laboratory, we synthesize graphene oxide, amine-reduced graphene oxide, and diglycolamide-attached graphene oxide. These materials undergo testing to capture rare earth elements, evaluating the proposed extraction processes' efficiency and selectivity. Gaussian DFT calculations provide a detailed molecular analysis, enhancing our understanding of the chemical transformations involved. This interdisciplinary approach aims to contribute to the development of sustainable and efficient rare earth metal extraction methodologies, addressing critical concerns in global supply chains.

123 – Empowering Prosthetic Freedom through a Machine Learning Integrated Model

Dakota Houdeshell, Edwin Philip, Kevin Hoang, Luke Kim and Anna-Trang Nguyen
Advisor: Young-Tae Kim
Bioengineering Department

The realm of prosthesis development has greatly expanded in recent years. Many amputated individuals now have access to neural prosthetics that allow for certain freedoms of movement. The current market employs the use of myoelectric signals to read and process movement. This method has a certain degree of inaccuracy and is limited by the number of possible movements. Our team aims to develop a prosthetic model that uses machine learning to increase the accuracy of readings as well as the number of freedoms on a commercial prosthetic. The central idea of this project is to have a camera that will record the hand motions on the non-amputated limb and mirror the motion onto the prosthesis. The prosthesis will be run on a pre-trained machine-learning model that will make inferences based on the hand motion shown through a live camera feed.

124 – AI Video Editor

Isaac Valdez
Advisor: Chris Conly
Computer Science and Engineering Department

With the development of AI models for image, audio, and video editing and generation, artists have many AI tools available to use for generating content, but to the author's knowledge there is no central tool that integrates these models together in one AI video editor. This project hopes to develop a multimedia editing/generation system (primarily for image and video) with integrated AI tools.

125 – SuperGo

Sheena Buwemi
Computer Science and Engineering Department

The mobile app "SuperGo" revolutionizes the shopping experience by providing a simple solution to a common problem: finding items in stores. With just a few taps, users can search for any item on their shopping list and instantly receive a map or directions to its exact location in the store. Say goodbye to wandering aisles aimlessly; our app saves time and frustration, making shopping efficient and enjoyable.

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