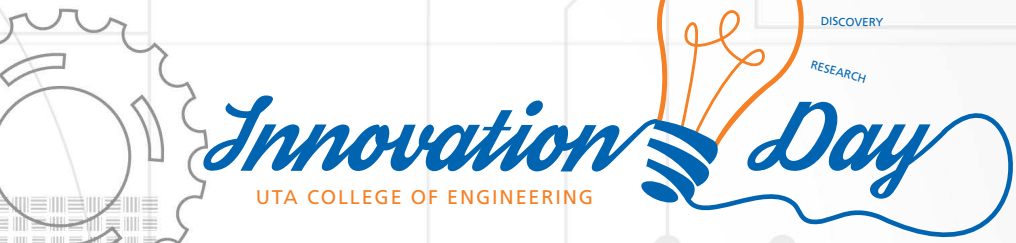

PROJECT ABSTRACTS AND PARTICIPANTS

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1 – Development and Application of TELECOM (Telecommuting Effects on Levels of Emission and COmmunity Mobility) Framework

Aiswarya Acharath Mohanakrishnan
Advisor: Melanie Sattler
Civil Engineering Department

Telecommuting gained significant traction in March 2020, when the COVID pandemic forced millions to work from home. Recent surveys show the employees' interest in continuing remote work. To develop existing transportation infrastructure to serve future needs, Metropolitan Planning Organizations (MPOs) must account for workers' increased preference for telecommuting in transportation planning. Models developed pre-pandemic will likely not apply post-pandemic, as they do not account for workers' positive actual experiences with telecommuting during the pandemic. Overall goal of the study is to develop TELECOM (Telecommuting Effects on Levels of Emissions and COmmunity Mobility), a framework for MPOs to incorporate telecommuting into travel demand modeling (TDM) and emissions modeling and to understand community-level mobility and air quality impacts. Post-pandemic Telecommuting Expectation Models (TeEMs) were developed based on the analysis of survey responses from the national "COVID-19 and the Future Survey." Supervised machine learning algorithms were used to develop the TeEMs models, which use attributes that are available to the MPO's from the census data. The TELECOM framework will be demonstrated using the TDM of the Dallas-Fort Worth Metroplex, to determine changes in the work trips and emissions. The differential impacts of telecommuting on minority and low-income populations will also be examined.

2 – IPVNet: Learning Implicit Point-Voxel Features for Open-Surface 3D Reconstruction

Mohammad Arshad
Advisor: William Beksi
Computer Science and Engineering Department

Reconstruction of 3D open surfaces is an under-explored area of computer vision. Recent learning-based implicit techniques have removed previous barriers by enabling reconstruction in arbitrary resolutions. Yet, such approaches often rely on distinguishing between the "inside" and "outside" of a surface in order to extract a zero level set when reconstructing the target. In case of open surfaces, this distinction often leads to artifacts such as the artificial closing of surface gaps. However, real-world data may contain intricate details defined by salient surface gaps. Implicit functions that regress an unsigned distance field have shown promise in reconstructing such open surfaces. Nonetheless, current unsigned implicit methods rely on a "discretized representation" of the raw data. This not only bounds the learning process to the representation's resolution, but it also introduces outliers in the reconstruction. To enable accurate reconstruction of open surfaces without introducing outliers, we propose a learning-based implicit point-voxel model IPVNet. IPVNet predicts the unsigned distance between a surface and a query point in 3D space by leveraging both raw point cloud data and its discretized voxel counterpart. Experiments on public datasets demonstrate that IPVNet outperforms the state of the art while producing far fewer outliers in the reconstruction.

3 – Dispersion Study of Metal-Organic Frameworks

Joe Alex and Sathvika Gondi
Advisor: Michael Bozlar
Mechanical and Aerospace Engineering Department

Metal-organic framework (MOFs) possess a wide range of potential applications from materials for gas storage and separation to drug delivery systems. In this research, we are hoping to study the dispersion of two types of MOFs synthesized – Cu3HHTP2 and Ni3HHTP2 – in various organic solvents. In the various solvents tested, long term stability of the dispersion was observed in isopropanol, followed by N-Methyl-2-pyrrolidone in both the MOFs considered. There were some unprecedented observations where the Cu-based MOF performed better than its Ni-based counterpart. We explore further into the suspensions using UV-Vis spectroscopy for further analysis in the extent of dispersion in the solvents and in doing so, choose the best solvent for synthesizing a stable MOF-based hydrogel. These hydrogels are then incorporated into different elastomers and polymers altering their physical and mechanical properties without affecting their chemical composition.

4 – Artificial Intelligence Assisted Prognostic Health Monitoring of Polymer Composites

Partha Pratim Das
Advisor: Md Rassel Raihan
Mechanical and Aerospace Engineering Department

With the increased use of composite materials, researchers have developed many approaches for structural and prognostic health monitoring. Broadband Dielectric Spectroscopy (BbDS)/Impedance Spectroscopy (IS) is a state-of-the-art technology that can be used to identify and monitor the minute changes in damage initiation, accumulation, interactions, and the degree of damage in a composite under static and dynamic loading. This work presents a novel artificial neural network (ANN) framework for fiber-reinforced polymer (FRP) composites under fatigue loading, which incorporates dielectric state variables to predict the life (durability) and residual strength (damage tolerance) from real-time acquired dielectric permittivity of the material. The findings of this study indicate that this robust ANN-based prognostic framework can be implemented in FRP composite structures, thereby assisting in preventing unforeseeable failure.

5 – Investigating Effects of Functional Groups on Graphene Oxide and Structural Characterization: A DFT Study

Dogukan Yazici and Emily Williams
Advisors: Michael Bozlar
Mechanical and Aerospace Engineering Department

Graphene oxide material has become frequently used in biomedical, composite, electronic and various other engineering fields. Graphene oxide, which is synthesized based on graphene, shows characteristic properties by becoming much more active thanks to the epoxy, hydroxyl functional groups on it. In order to better understand these activities, we use the Density Functional Theory (DFT) method in this theoretical study. Graphene oxide (GO) material is formed by determining the location of the functional groups positioned on the graphene monolayer by successive optimizations and based on the ratios in the literature. We use Density of States (DOS), vibrational modes and phonon calculations to better understand the effects of these functional groups. At the same time, to investigate the nature of the interaction, we make Charge Density Difference (CDD) analysis, and the bending of the graphene monolayer induced by the functional groups are analyzed by Vibrational Modes (IR) calculations. The obtained stable theoretical graphene oxide structure is intended to be used in our future theoretical studies.

6 – A Situational Assessment on the Development of Combined Cycle Engines

Jose Medina
Advisor: Bernd Chudoba
Mechanical and Aerospace Engineering Department

Combined cycle propulsion systems are a key enabling technology that meets the demanding multi-mode missions of space access vehicles and hypersonic transports alike. Synergistically blending airbreathing and rocket elements leads to an integrated and efficient engine. Therefore, combined cycle propulsion systems represent the next major engine evolution that will emerge in the coming decade. To support their development, a situational assessment is conducted to benefit the next steps in the forecasting process and provide visibility and context to a broad spectrum of past-to-present combined cycle engine and vehicle configurations. First, the major showstoppers to combined cycle engines and a chronological survey representing three major waves in which these engines saw significant research and development are presented. Then, a review of past terms and classification schemes are synthesized to offer an understanding of the types of combined cycle engines and levels of integration. The assessment concludes with emphasizing the need for advanced flight vehicle synthesis tools, which leads to the specifications of a future tool prototype.

7 – Termite Hindgut Bacteria TAV5: Key to Lignocellulose Waste Decomposition

Hussain Ali
Advisor: Melanie Sattler
Civil Engineering Department

Bioenergy from lignocellulose biomass is a promising candidate to help move towards a fossil fuel free future. Unfortunately, lignin is resistant to microbial attack and it often shields lignocellulose components from decomposition as well. Without an effective method of decomposing lignin, at least 10–35% of lignocellulose will likely remain undegraded, lowering the potential for producing methane. Traditional physical/chemical methods for destroying lignin are typically costly due to energy and chemical requirements and can create toxic intermediates. Termites are commonly known for their ability to degrade wood, which contains high levels of lignin; microorganisms present in the hindgut of termites are responsible for decomposition of lignin in wood. TAV5 is the fastest-growing microorganism isolated from the hindgut of Reticulitermes flavipes termite. The overall goal of our research is to use TAV5 to modify lignin and boost methane production from agriculture waste. Lab tests are being conducted in batch-scale reactors with various kinds of waste (rice straw, corn stover, rice husk and wheat straw) to determine the optimal ratios of TAV5 to anaerobic digester microorganisms to decompose waste and produce methane. Based on batch tests, optimal ratios of TAV5 to AD microorganisms will be used to seed wastes in field reactors.

8 – Methane Production With Anaerobic Digestion of Paper Waste and Rice Husk Using Guinea Pig Manure

Hussain Ali
Advisor: Melanie Sattler
Civil Engineering Department

Rural areas in many developing countries lack modern energy services and access to clean cooking technologies. Most of the population in these areas are forced to use traditional cooking resources like firewood and air-dried cattle manure. Use of these traditional technologies causes indoor air pollution and results in deforestation. A solution to this problem can be provided by using low-cost household/community digesters. In recent years, this technology has proved to be very successful in Latin America and Asia. Livestock in most of these regions consists of guinea pigs, cows and llamas. Several studies have been done to study the potential of co-digestion using cow and guinea pig manure. However, few studies have tested anaerobic digestion by guinea pig manure alone. Therefore, our study aimed to evaluate biogas production from anaerobic digestion of organic wastes using guinea pig manure compared to water resource recovery facility sludge as a baseline. Lab tests were conducted in batch-scale reactors containing rice husk and paper waste, inoculated with guinea pig manure or WRRF sludge, incubated at 30°C. Results over a period of 100 days show that guinea pig manure can solely be used to perform anaerobic digestion.

9 – Investigation of Flow Features and Resulting Scour Hole Geometry Around Cylindrical Piers Subject to Wave and Current

Qazi Ashique E. Mowla
Advisor: Habib Ahmari
Civil Engineering Department

Scour is one of the predominant reasons for bridge failure. Scour characteristics under different flow conditions are unique, i.e., scour features in a riverine environment are different from those in coastal and lacustrine environments where waves play a significant role. In the laboratory, 38 experiments were performed to examine the flow pattern around bridge piers and their imprint on the sediment bed under riverine (current-alone), coastal (waves-alone), and lacustrine (waves-current combined) flow conditions. Flow parameters were shuffled to observe their effects on the scour hole geometry. Results indicated that the combination of waves and current led to larger scour depths compared to wave-alone experiments but smaller than those created by current-alone experiments. This study used a comparatively new tool – Particle Image Velocimetry (PIV) to investigate the change in the flow field and vortex characteristics around piers. Observations showed that relative flow velocity, strength of the wake vortices, and wave distances from the channel bottom impacted scour geometry and downstream deposition characteristics. This attempt to relate the size and shape of vortices to the scouring process, when perfected, will allow us to predict scour by observing flow patterns around piers in different flow conditions.

10 – The Effectiveness of TAV5 On Pulp and Paper Lignin Content as a Function of Methane Generation in Anaerobic Digestion

Doreen Ntiamoah-Asare
Advisor: Melanie Sattler
Civil Engineering Department

TAV5 is a bacterium strain of the family Opitutaceae from Termite-Associated Verrucomicrobium isolated from the hindgut of Reticulitermes flavipes, the most common subterranean termite in North America. The genome of TAV5 contains genes coding for enzymes that could structurally modify lignin. According to EPA Toxics Release Inventory Analysis in 2017, pulp and paper mills released about 79,000 tons (5%) of all industrial pollutant releases in 2015: 66% into the air, 10% into water, 24% onto land polluting the environment. Their waste effluents cause severe harm to aquatic life, disturbs the food chain, and also causes various health implications. Pulp and paper primary waste contains high levels of cellulose, hemicelluloses, and lignin which are not easily biodegradable, as lignin tends to shield cellulose and hemicellulose thereby making them recalcitrant to degradation. Hard woods have lignin content of 27.6–30.2% and soft woods have lignin content of 32.4–42.4%. The higher the lignin content, the lower its biodegradability. Hence, the application of TAV5 for lignin destruction can make cellulose and hemicelluloses accessible for biodegradation in anaerobic microbial conversion to biogas.

11 – Utilizing Human-in-the-Loop AI to Re-Evaluate Cellular Uptake Mechanisms of Therapeutic Poloxamer P188

Anne Alsup
Advisor: Michael Cho
Bioengineering Department

Triblock amphiphilic copolymer P188, which was originally approved by FDA to reduce viscosity in blood transfusions, has been shown to demonstrate therapeutic effects for traumatic injuries. Our laboratory has developed a technique to conjugate P188 with the fluorophore Rh110 in order to track transportation of the poloxamer into multiple cell types such as mouse brain endothelial cells (BECs) and human mesenchymal stem cells (hMSCs). The fluorescence tagging of P188 has allowed for studies to investigate P188 transport mechanisms including how BECs are repaired after damage caused by shockwaves to simulate blast-induced traumatic brain injury (bTBI). Currently, the characteristics of transportation in the cell and whether the P188 intracellular accumulation are cell type-dependent remain unknown. Re-evaluating these mechanisms will lead to the identification of drug delivery systems to create a targeted therapy after bTBIs. A human-in-the-loop AI-assisted pipeline was established to automate cell segmentation and improve image analysis, the pipeline significantly reduced the time typically required of laborious hand-drawn identification and analysis of individual cells from hours to < 15 min. The pipeline also provided spatially- and temporally-resolved information of individual cells that were monitored and tracked using fluorescence microscopy.

12 – PET Imaging of Active Medical Device-Associated Infection With D-[5-11C]-Glutamine

Vicki Ea and Cynthia Co
Advisor: Liping Tang
Bioengineering Department

Device-associated infection (DAI) is the major cause of medical implant failure and related lethality, however no clinical diagnosis method exists due to lack of unique surface markers and tracers that can penetrate the bacterial biofilm. D-Glutamine is pivotal in bacterial biofilm formation and virulence but is preferentially utilized by bacteria, not mammalian hosts. Therefore, we previously demonstrated D-[5-11C]-Glutamine as a tracer using positron emission tomography (PET) in mouse infection models. Here, sterile stainless-steel bone screws and screws coated with ~107 CFU Staphylococcus aureus were surgically implanted in the hind-limb proximal tibias of rats 4-5 weeks pre-imaging. In vitro results showed that D-[5-11C]-Glutamine was actively utilized by live bacteria but not by heat-killed bacteria and mammalian cells, whereas L-[5-11C]-Glutamine (control) was utilized by both bacterial and mammalian cells. PET imaging demonstrated substantially enhanced renal clearance of D- versus L-[5-11C]-Glutamine, suggesting host non-utilization of D-[5-11C]-Glutamine. PET quantification of sterile vs. infected screw implant uptake demonstrated significantly higher infection-to-background muscle ratios for D-[5-11C]-Glutamine vs. L-[5-11]-Glutamine (ratio = 3.82 vs. 1.90, respectively; p=0.0005) with no significant uptake in sterile controls. Our results demonstrate

the translational potential of PET imaging with D-[5-11C]-Glutamine for noninvasive detection of medical device-associated infection in humans.

13 – Comparison of Human Glenoid and Acetabular Labrum Regenerative Characteristics

Le Hoang, Bhavya Vaish and Samira Izuagbe
Advisor: Liping Tang
Bioengineering Department

The glenoid and acetabular labrum comprise fibrocartilage and connective tissue and are responsible for distribution of joint reaction forces. Despite their similarities, glenoid labrum repairs tend to have better clinical outcomes than those of the acetabular labrum. To determine if glenoid and acetabular labra have different regenerative potentials owing to histological differences, OCT sections of glenoid and acetabular labral explants were sectioned and stained with collagen II (for quantification of avascular tissue), hematoxylin and eosin (for quantification of vessels), CD90/105 double stain (for quantification of progenitor cells), and Masson's Trichrome (for quantification of extracellular matrix [ECM] density). Overall, the glenoid labrum vascular region is larger in proportion, denser in vessels, and denser in progenitor cells. Furthermore, the glenoid labrum ECM is overall less dense, allowing for increased mobility of progenitor cells and nutrients. Thus, increased supply and mobility of blood and regenerative cells may contribute to the better healing outcomes of glenoid labrum repairs. Improved understanding of labral properties can help doctors make more accurate healing prognoses and develop specialized treatments. A new treatment for enhancing the healing outcome of torn labrum may be achieved by increasing tissue vascularity and resident progenitor cell recruitment at the site of injury.

14 – A 3D In Vitro Model to Assess Intraocular Lens (IOL): Posterior Lens Capsule (PLC) Interactions on Lens Epithelial Cell (LEC) Responses

Samira Izuagbe, Le Hoang, Bhavya Vaish, Cynthia Co, Aaron Ly and Vicki Ea
Advisor: Liping Tang
Bioengineering Department

PCO is caused by the infiltration and proliferation of LECs at the IOL:PLC interface. It is assumed that IOLs with a high affinity to the PLC may inhibit PCO by obstructing the LEC responses (infiltration and proliferation). To test the hypothesis, we created a simulated PLC (sPLC) with human dimensions to study how IOL:PLC physical interactions would affect LEC responses. IOL:sPLC interactions (interface closure rate and adhesion force) were quantified using Optical Coherence Tomography (OCT) and an adhesion force apparatus, respectively. The influence of IOL:PLC interactions on infiltration and proliferation were assessed by seeding LECs on the edge or at the center of the IOL:sPLC interface prior to IOL placement, respectively. Cell density and metabolic activity were assessed. OCT images revealed the IOLs have different affinities to sPLC with an interface closure rate and adhesion force trend of Acrylic>Silicone>PMMA. Cell studies showed that Acrylic IOL's fast interface

closure and strong adhesion force was associated with the lowest LEC infiltration. Similarly, LECs under Acrylic IOLs had no increase, while LECs under PMMA and Silicone IOLs significantly increased. Additionally, metabolic activity was significantly reduced by Acrylic IOLs. The findings support that high IOL:PLC affinity would negatively impact LEC responses.

15 – Validating Stimulatory Responses in A- and B-Cells Using Computer Vision Algorithms

Kelli Fowlds
Advisor: Michael Cho
Bioengineering Department

Diabetes mellitus is a notable global epidemic characterized by dysregulated blood glucose levels. Calcium-dependent insulin release from β-cells is crucial in the regulation of glucose homeostasis. As such, previous studies have attempted to modulate calcium dynamics. These studies can be thoroughly examined through the incorporation of computational analysis. Previous results of using non-invasive electric field stimulation (EFS) and photobiomodulation (PBM) techniques were re-examined utilizing machine learning algorithms and automated statistical analysis. EFS and PBM have both been applied to modulate the calcium channels in β-cells. The automated system has shown to greatly reduce the time required for cellular image analysis, significantly improve the accuracy of the results from the data, and provide extensive information regarding the physiological role calcium plays in insulin secretion. Rather than calculate whole-frame averages, individual spiking patterns were re-analyzed among each individually segmented cell over time. Overall, changes in spiking activity after the application of EFS or PBM among β-cells appears to have been underestimated with earlier hand segmentation methods, facilitating a need for further evaluation into the effectiveness of these non-invasive treatments. These automated techniques will thus be ultimately used to explore the effects of varying treatments on the interaction between α- and β-cells.

16 – Regenerative Potential of Different Regions of Glenoid Labrum

Bhavya Vaish, Le Hoang, Samira Izuagbe and Cynthia Co
Advisor: Liping Tang
Bioengineering Department

The glenoid labrum is a fibrocartilaginous connective tissue that surrounds the shoulder glenoid cavity, providing stability to the humeral head. Glenoid labrum tears can occur at various anatomical locations, including the superior, anterior, posterior, or inferior regions. However, the clinical outcomes associated with tears in each of these regions are not the same. Failure to repair such tears can lead to shoulder instability and the need for repeated surgical intervention. Therefore, it is crucial to understand the anatomical differences among the various regions of the glenoid labrum. Despite this, little is known about the histological differences between these regions. This study investigates the vascularity and cell compositions of the four anatomical positions of the glenoid labrum (superior, anterior, posterior, or inferior) to identify any histological

evidence for differences in their regenerative potential. The results of the study are consistent with the observed differences in clinical outcomes. The inferior glenoid was found to be highly vascularized and contained the highest density of progenitor cells, which corresponds with clinical findings indicating that the inferior region has the lowest reoperation rate. The improved understanding of the composition of distinct glenoid labral positions may help to enhance therapeutic strategies for labral pathology.

17 – Designing a Collaborative Online Transportation Platform for Sustainable Regional Food Distribution

Preetam Kulkarni and Poojan Patel
Advisor: Caroline Krejci
Industrial, Manufacturing and Systems Engineering Department

Regional food systems offer the potential to improve agricultural sustainability and community resilience. However, regional farmers must find ways of expanding their market reach to a larger number of buyers to ensure the survival of their farms. Customers are typically located in urban centers that are geographically distant from farms, and most small-scale farmers do not have the necessary transportation infrastructure to support efficient distribution. This research describes the results of a three-year project aimed at increasing the capacity of Texas regional food systems by improving farmers' access to affordable transportation services. The goal was to develop a cost-effective collaborative online transportation platform that would help regional farmers find suitable transportation providers to make deliveries to urban customers. The project began by investigating transportation challenges faced by Texas farmers and ranchers via interviews and focus groups. The resulting data and ideas gleaned from a study of existing online transportation platforms were used to inform the design and development of a transportation app for farmers. Most of the feedback from farmers was positive and has encouraged ongoing app development, with a goal of small-scale implementation in the spring of 2023. This paper addresses UN Sustainable Development Goals 2 and 8.

18 – Recurrence Network Modeling of 3D Point Clouds and its Application on Additively Manufactured Metamaterials

Yujing Yang
Advisor: Chen Kan
Industrial, Manufacturing and Systems Engineering Department

Additive manufacturing (AM) has been widely adopted for producing metamaterials due to the high flexibility in fabricating complex geometries. However, geometric defects are inevitable in AM, which could significantly alter the properties of fabricated metamaterials. It is of great importance to characterize the complex geometries of fabricated metamaterials for the identification of geometric defects. In this study, a recurrence network based approach is developed for 3D geometry characterization and defect detection. First, key points are sampled from the scanned point cloud, and a local graph centering on each key point is then built to capture the local geometry. Further, a recurrence network was constructed by calculating the similarities and distances among the local graphs. Finally, we integrate a graph neural network with a one-class classification model to identify significant geometric defects. The results of simulations and real-world case studies have demonstrated the effectiveness of the developed approach.

19 – In-Situ Quality Assurance in Additive Manufacturing of Metamaterials Using Incremental Heat Kernel Signature

Zehao Ye
Advisor: Chen Kan
Industrial, Manufacturing and Systems Engineering Department

This research develops an in-situ monitoring framework that effectively encodes layer-wise geometric information of metamaterials produced by additive manufacturing (AM). AM has been applied in producing metamaterials owing to its high flexibility to handle complex geometries. Nevertheless, AM largely contains geometric defects, which could significantly impact the product's quality. In the literature, heat kernel signature (HKS) has been used to represent 3D geometry, but its computational burden makes it difficult to use for point cloud-based in-situ monitoring of AM. To address this issue, an efficient incremental HKS approach is developed. Specifically, for the first few layers, an initial HKS is constructed based on scanned point clouds and the corresponding triangle mesh. After that, when a new layer is printed and scanned, the HKS is not re-calculated. Instead, the mesh and the eigensystem for the calculation of HKS are adaptively updated to directly obtain the new HKS. This, in turn, significantly improves computational efficiency while preserving high accuracy. By comparing the up-to-current geometry of the printed metamaterial with the fabricated one, we can identify out-of-controls that occur due to statistically significant geometric defects. The developed method is evaluated and validated through simulations and real-world case studies of in-situ AM monitoring.

20 – Hardware Evolution: Genome-based Selection of FPGA Netlists for Pulse Identification

William Charles Goorsky
Computer Science and Engineering Department

Traditional Microprocessor Architecture takes design cues from the Von Neumann, Harvard, MIPS, and x86 layouts. Using Field-Programmable-Gate-Arrays (FPGA), advanced layouts which take advantage of unconventional wire meshnets can be used to derive machine-like subcomponents. By using a video training system to refine a bitstream in a natural selection fashion, an evolutionary and mutation genomic method shall produce variants refined to detect pulses inaudible to human ears. By rearranging patterns of the architecture, more effective usage of layouts can be derived to achieve specialized tasks.

21 – Cortex2vector: Anatomical Embedding of Cortical Folding Patterns

Lu Zhang
Advisor: Dajiang Zhu
Computer Science and Engineering Department

Current brain mapping methods highly depend on the regularity, or commonality, of anatomical structure, by forcing the same atlas to be matched to different brains. As a result, individualized structural information can be overlooked. Recently, we conceptualized a new type of cortical folding pattern called the 3-hinge gyrus (3HG), which is defined as the conjunction of gyri coming from three directions. Many studies have confirmed that 3HGs are not only widely existing on different brains, but also possess both common and individual patterns. In this work, we put further effort, based on the identified 3HGs, to establish the correspondences of individual 3HGs. We developed a learning-based embedding framework to encode individual cortical folding patterns into a group of anatomically meaningful embedding vectors (cortex2vector). Each 3HG can be represented as a combination of these embedding vectors via a set of individual specific combining coefficients. In this way, the regularity of folding pattern is encoded into the embedding vectors, while the individual variations are preserved by the multi-hop combination coefficients. Results show that the learned embeddings can simultaneously encode the commonality and individuality of cortical folding patterns, as well as robustly infer the complicated many-to-many anatomical correspondences among different brains.

22 – Air Quality Monitoring System

Rishabh Thakur and Shobika Suresh
Computer Science and Engineering Department

Prior studies have shown that people tend to be less satisfied with indoor air quality, report more acute health symptoms (such as headaches and mucosal irritation), work a little bit slower, and miss more days of work or school when indoor CO2 levels are higher. Evidence for the hypothesis that building characteristics and resultant indoor environmental quality affects health outcomes continues to accumulate. These health outcomes also include Sick Building Syndrome symptoms, allergy and asthma symptoms, and respiratory illnesses. CO2 concentrations in buildings typically range from 350 to 2,500 ppm and become hazardous when they consistently range between 3000 to 5000 ppm. To monitor and control our indoor air caliber we propose a DIY air quality monitoring system using easily available and affordable sensors for input source and a cost-effective cloud implemented monitoring system. The application produces a graphical analysis of the CO2 level and provides daily, weekly and monthly reports for the user to make well-informed decisions.

23 – Frosting Sense: Improvised Cake Decorating Through Interactive Tool

Hoang Vuong
Advisor: Cesar Torres
Computer Science and 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.

24 – Experimental Band Dynamics in Resonant Nanophotonic Lattice

Nasrin Razmjooei
Advisor: Robert Magnusson
Electrical Engineering Department

In this research, we demonstrate band dynamics in one-dimensional optical lattices presenting numerical and experimental results. In subwavelength periodic lattices, depending on the lattice geometry and material composition, leaky-edge state and non-leaky edge state appear. The leaky edge corresponds to high-reflectivity guided-mode resonance, whereas the non-leaky edge represents a bound-state in the continuum (BIC). Here, we design three optical lattices consisting of Si3N4 gratings on glass. Applying refractive-index matching oil on these lattices, we demonstrate band dynamics by calculating zero-order reflectance with respect to wavelength and incident angle. Adding the index-matching oil results in the excitation of higher electromagnetics modes showing the effect of the new interface. The experimental and numerical results pertinent to the proposed device are compared showing perfect agreement.

25 – Fabrication of Ge-Based Resonant 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.

26 – Power Hardware in the Loop (PHIL) Emulation of Electrochemical Energy Storage Systems with Operating Voltages as High as 1 kVDC

Cole Tschritter
Advisor: David Wetz
Electrical Engineering Department

The US Department of Defense has considered employing lithium-ion energy storage as either a prime power source, backup power source, or buffering source in a few of its future mobile electrical power systems. Battery open circuit potentials as high as 1 kVDC have been considered, and while batteries with this high a potential are starting to emerge in industrial solar applications and even in automobiles, their deployment to date is limited. This means that there is a great deal still to understand about how to assemble batteries with this high a voltage and how to ensure they are safely operated and maintained. Devices such as battery management systems are being improved every day and they must be studied and characterized before they are deployed on fully operational batteries. Evaluation of the short- and long-term performance of batteries and their safety equipment is expensive, difficult, and can introduce safety concerns. In the work presented here, a battery emulator has been assembled and validated using a power-hardware-in-the-loop system. Using this method, any type of battery can be emulated so long as a validated MATLAB simulation model at the cell level is available.

27 – Pulsed Dielectric Breakdown of Altered Solid Dielectric Insulation Materials

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

Solid dielectrics are attractive 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 functionally grade the dielectric properties of solid insulators, either by layering them or by dielectrically altering them using nano-particles, is among their most attractive properties. Achieving optimum dielectric properties through spatial grading can significantly reduce electric field enhancements, enabling systems to be designed much more compactly. Since solid dielectrics are not self-healing like liquid dielectrics, it is critical that they be well understood before being designed into deliverable systems. Epoxy dielectrics are especially of high interest because they can fill complex geometries, and because of their ability to be dielectrically altered with nano-particles. In the work presented here, raw and composite epoxy dielectric samples are being studied under pulsed experimental conditions to characterize their dielectric properties.

28 – Study of DC Arc Flash Phenomena

Nicolaus Jennings
Advisor: David Wetz
Electrical Engineering Department

Energy storage systems, at voltages as high as 1000 VDC, are more widely penetrating both civilian and defense electrical power systems. These systems come with inherent risks to the workers who perform installation, operation, and maintenance on them. This has created a need to address personal protective equipment requirements for working in and maintaining these systems. Unlike most AC power systems, DC power and energy storage systems that utilize batteries, photovoltaic modules, and capacitors cannot be switched off or isolated at some points in the electrical system to eliminate a pulsed arc flash hazard. The electrochemical reactions in batteries are difficult, if not impossible, to control during faulted conditions. Thus, these types of power sources present unique electrical safety challenges. The University of Texas at Arlington's Pulsed Power and Energy Laboratory and the Electric Power Research Institute, located in Knoxville, Tennessee, have recently collaborated to study DC arc flash phenomena from valve regulated lead acid and lithium-ion batteries at potentials as high as 930 VDC. The work performed and an analysis of the results obtained will be presented.

150 – Increasing Renewable Energy Potential of Landfill Gas by Electrocatalytic Conversion of Carbon Dioxide to Methane at Low Temperature

Asma Akter Rony
Advisors: Melanie Sattler and James Ma
Civil Engineering Department

The conversion of carbon dioxide into methane at a low temperature has great potential to reduce current international environmental issues like global warming and will create new sources of renewable energy. The overall goal of this research is to increase renewable energy production from landfill gas by an unconventional process called electrocatalytic methanation of carbon dioxide that has not been implemented for landfill gas yet. Landfill gas, hydrogen gas, and helium gas were passed through a catalyst bed in a quartz glass tube in a ratio of 1: 1.09: 1.87, with an electric field imposed by two copper electrodes, connected to a DC power supply. The catalyst used was ruthenium-supported cerium oxide (CeO2) which was prepared by the impregnation method; it showed the highest catalytic activity in previous tests [Yamada, 2020]. After 20 minutes of electrocatalysis, the methane concentration increased by 34.5%. Impacts of other variables such as the electric field's position, time, gas volume, and power will also be analyzed in this research.

151 – FuelFix Fuel Additive Research Program

Asma Akter Rony
Advisor: Melanie Sattler
Civil Engineering Department

FuelFix Fuel Additive Research Program is designed to evaluate the effectiveness of FuelFix Fuel Additive by measuring changes in fuel economy and tailpipe emissions from five vehicles of different make and models before and after use of the additive. The vehicles selected were not previously wrecked, had their engine overhauled, or used any fuel additives within the last 6 months. The vehicles were tested by driving on a 300-mile test route from Arlington to Clyde, TX, once without FuelFix and two or three times with addition of FuelFix. Emissions measured included CO2, CO, VOCs, PM, and NOx, at 1-minute intervals during 10 minutes of hot idling. FuelFix improved fuel economy of vehicles by 5.2 to 12.7%, with an average of 8.6%. Assuming the vehicles are driven the average number of miles per year in Texas (16,172) and using current fuel prices in Texas ($3.078/gallon for gasoline and $4.886/gallon for diesel), fuel cost savings range from $72 to $272/year, with an average of $204. FuelFix reduced tailpipe emissions by 2.3-100%, with variation by pollutant and by vehicle. Largest average emission reductions were for particulate matter. Further testing is required to determine patterns in emission reductions by pollutant and vehicle.

152 – Prioritizing Organic Wastes to Energy-Renewable: Development and Application of the POWER Framework

Doreen Ntiamoah-Asare, Opeyemi Adelegan, Mithila Chakraborty, Arabi Mehrdad, Bahareh Nasirian and Ardeshir Anjomani
Advisor: Melanie Sattler
Civil Engineering Department

Many regions are aiming to divert food waste and other organics from landfills to preserve landfill capacity and increase renewable energy opportunities. The newly developed Prioritizing Organic Waste to Energy-Renewable (POWER) Framework can help cities/regions assess the feasibility of co-digesting organic wastes at existing or new WRRF digesters, on-farm digesters, or stand-alone digesters. The POWER Framework consists of 4 components: 1) GIS Toolbox, 2) Basic POWER Tool, 3) Optimization GUI, and 4) City guidebook. The GIS Toolbox estimates quantities of organic wastes that can be collected for digestion and assist in visualizing the spatial distribution of different waste components at different geographic levels. The POWER Tool is a user-friendly Excel spreadsheet which estimates fuel produced (electricity, or CNG), costs/benefits, emission reductions, renewable energy credits earned, and net energy balance. The Optimization GUI allows the user to determine the overall least-cost system for transporting and digesting waste for conversion to energy. When more than one existing digester is available, the Optimization GUI determines the optimum region(s) of waste to send to each. This presentation will provide an overview of the framework components, and their application to case studies for the State of Vermont and City of Las Vegas, Nevada.

153 – Investigating the Situation of Methane Emission From Landfills in Iran

Sayyed Hossein Khazaei, Mazaher Moeinaddini, Reza Rafiee and Nematollah Khorasan
Advisor: Melanie Sattler
Civil Engineering Department

Rapid economic growth and urbanization have led to an increase in the production of urban waste in Iran in the last few decades, and weakness in the management of solid waste has become one of the fundamental problems of Iran today. The generated urban wastes are taken to landfills and rarely processed and recovered. Carbon dioxide and methane are the main greenhouse gases that are emitted from landfills due to the biological decomposition of organic materials. In the current study, methane emissions from Karaj's landfill in the center of Iran, near Tehran, the capital of Iran, were estimated using the chamber method in summer and winter. Sampling of the landfill surface was done from 3 cells with different ages. At least 25 chambers were set in each cell in one hectare. Ambient temperature and pressure were also recorded during sampling for further analysis. Based on known points, unknown points were estimated through interpolation in the GIS software. The average rate of methane emissions from the landfill surface was 186.63 and 239.3 g m-2 day-1, respectively. The average rate of methane emissions from Karaj's landfill was 283.96 m3yr1. The amount of methane measured in this study was high compared to other studies in the rest of the world.

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

Opeyemi Adelegan
Advisor: Melanie Sattler
Civil Engineering Department

The disposal of food waste is a major issue due to the amount that ends up in landfills (taking up 22% of landfill space) and its potential to generate potent greenhouse gases. A previous study has found that anaerobic digestion (AD) is the most environmentally friendly way to manage commercial food waste as it promotes faster waste degradation (compared to landfills) and maximizes energy production in the form of biogas, while minimizing greenhouse gas emissions. To determine the cost-effectiveness of AD and size biogas storage systems, engineers need a practical model for estimating biogas production, which does not depend on detailed chemical analysis of waste. Therefore, the aim of this study is to develop a model for predicting biogas production based on the food waste category. Batch tests in 125 mL reactors are used to determine the impact of waste category and temperature (thermophilic or mesophilic) on biogas generation. Using data from the batch tests, SAS will be used to develop multiple linear regression models for predicting biogas generation rates. Preliminary results that tested food waste to sludge ratios ranging from 10-100% show that food waste exceeding 70% is less likely to produce a sustainable amount of biogas.

155 – IPVNet: Learning Implicit Point-Voxel Features for Open-Surface 3D Reconstruction

Mohammad Arshad
Advisor: William Beksi
Computer Science and Engineering Department

Reconstruction of 3D open surfaces is an underexplored area of computer vision. Recent learning-based implicit techniques have removed previous barriers by enabling reconstruction in arbitrary resolutions. Yet, such approaches often rely on distinguishing between the "inside" and "outside" of a surface in order to extract a zero level set when reconstructing the target. In case of open surfaces, this distinction often leads to artifacts such as the artificial closing of surface gaps. However, real-world data may contain intricate details defined by salient surface gaps. Implicit functions that regress an unsigned distance field have shown promise in reconstructing such open surfaces. Nonetheless, current unsigned implicit methods rely on a "discretized representation" of the raw data. This not only bounds the learning process to the representation's resolution, but it also introduces outliers in the reconstruction. To enable accurate reconstruction of open surfaces without introducing outliers, we propose a learning-based implicit point-voxel model IPVNet. IPVNet predicts the unsigned distance between a surface and a query point in 3D space by leveraging both raw point cloud data and its discretized voxel counterpart. Experiments on public datasets demonstrate that IPVNet outperforms the state of the art while producing far fewer outliers in the reconstruction.

Other Undergraduate

29 – Data Acquisition System for a Small Scale Demonstration Rail Gun

Benjamin Schmitz, Zaid Meqbel and Andrew Kozelsky
Advisor: David Wetz
Electrical Engineering Department

A digital display for a small demonstration railgun that will provide the operator with diagnostic information about the system will be designed, constructed, and demonstrated. The intended use of the final product is as a demonstration to STEM classes in grades 8–12 and for incoming freshmen to the EE program. This system will record and measure various information about the railgun, including breech voltage, muzzle voltage, breech current, the velocity of the projectile at different points during the launch, and the impact force of the projectile. To measure the velocity of the projectile, various magnetic field sensors will be built and tested. Other sensors will be procured to obtain the other required data. Finally, having an easy-to-read display that shows the audience the velocity, acceleration, and impact force of the projectile will be critical for a more complete demonstration. A microcontroller, Raspberry Pi, and touch screen will be used to accomplish these goals.

30 – UAV Hovering Control

Jyotirmoy Sarker
Advisor: Yijing Xie
Electrical Engineering Department

The student will find the dynamic model of UAV, design a PID controller to keep UAV hovering at a certain altitude and simulate the process using MATLAB.

31 – Powering a Weather Station Using Solar Energy and Measurement of Solar Irradiation and UV Rays

Kayla Garcia, Maxton Manker, Altay Delikanlioglu and Md Safkat Rahman
Advisor: David Wetz
Electrical Engineering Department

For the sophomore design course, we were divided into groups, with each group looking after specific segments. As the solar group, our responsibility was to power a weather station with a battery that can be recharged with a solar panel, along with measuring two specific solar weather phenomena. A solar panel was used to convert solar energy into electrical energy. The power was then regulated through a solar charge controller to charge a battery and power the components in the weather station. The JLM-50 solar panel, GV5-Li-14.2V solar charge controller and K2B12V19EB battery were selected to achieve this. The solar phenomena being measured were the UV index and the solar irradiance. The UV Index provides a daily forecast of the expected risk of overexposure to the sun. It has a scale of 1 to over 11. Solar irradiance is the power per unit area received from the Sun in the form of electromagnetic radiation. It is measured in watts per square meter. The UV index and solar irradiance measurements are sent to the central processing unit for the communications team. The ML8511 UV Sensor and the PGFUN Irradiance Sensor were chosen to measure these phenomena.

32 – Weather Station: Rain Hail

Jose Gonzalez, Ngoc Phan and Brandon De Alba
Advisor: David Wetz
Electrical Engineering Department

A weather station is a device that collects data related to the weather and the environment using a variety of sensors. Our project is to measure rainfall, evaporation and determine hailstone size which will be combined with a control system and other sensors in the sophomore project class to create a fully functioning weather station. This project was developed to help users access precipitation, hailstone size, and evaporation data everywhere in the City of Arlington, Texas. A weather station can be a useful means of measuring atmospheric conditions to provide important information about weather forecasts or disaster warnings.

33 – Weather Station Atmosphere Team

Farley Ruiz, Jyotirmoy Sarker and Joe Garcia
Advisor: David Wetz
Electrical Engineering Department

As the atmosphere team, we were in charge of coding and using sensors to read atmospheric phenomena like temperature, humidity, air pressure, air quality, visibility, and heat index. All of our sensors were analog and required 3.3V to 5V. The output for most of our sensors was linear, where the output signal was linearly proportional to their readings. We mounted all of them on a PCB we designed except for the visibility sensor and air quality sensor which needed their own breakout board.

34 – Weather Station Wind Team

Jaihan Utailawon, Derek Munoz, Joshua Long and Austin Davis
Advisor: David Wetz
Electrical Engineering Department

The sophomore project laboratory class is tasked with designing and building a weather station unit. The wind team is responsible for measuring data on three characteristics of wind: wind speed, wind direction, and wind chill. For this purpose, three sensors were bought and integrated together into a singular wind measuring unit for the weather station. The first sensor is a three-cup anemometer that catches the wind in rotating cups to measure the speed of the wind. The second sensor is a wind vane that determines the direction of the wind relative to the weather station's orientation. The angular position of the wind vane is determined by a magnetic encoder. The third sensor is a magnetometer that works as a compass by measuring the magnitude of the ambient magnetic field in the x, y, and z-direction. The magnetometer is used in tandem with the wind vane to determine the direction of the wind with respect to the cardinal directions. The wind chill is calculated using the measured wind speed and the ambient temperature, whose measurement is provided by a separate part of the weather station.

35 – Communication and Power Distribution for the Weather Station

Christian Morris, Jane Cho and Tan Ho
Advisor: David Wetz
Electrical Engineering Department

The central controller board was built to compile the data received from weather station sensors, including wind, atmosphere, rain, hail, and solar data, which was sent to the display as a string package. There are 12 analog inputs, 1 I2C, 1 GPIO and 1 UART that are needed, hence, the TM4C123GH6PM microcontroller was selected. The HC-05 Bluetooth module is used to transmit data up to 19 meters with 2 layers of interference and has been tested to transmit a maximum of 255 characters. The software is written in C, using Code Composer Studio to debug and write code to the microcontroller. The code is formatted to be modular; functions designed by each group return the group's data. Data is re-formatted as a string containing an identifier (A-N) and numerical data, and the

string will be decoded by the end-terminal display. Test data was successfully received using the Serial Bluetooth Terminal Android app and desktop terminal display. The final power distribution was designed on the printed circuit board, providing other teams with 5V and 3.3V power supply, as well as collecting signals from weather station sensors.

36 – Stepper Motor Control

Esper Johnson, Janet George and Rashad Mainor
Advisor: Kendra Wallis
Electrical Engineering Department

A highly accurate performing system for controlling a stepper motor in micro-stepping mode. It was designed and executed with a custom integrated circuit controlled by an Arduino and code using the Arduino IDE. The integrated circuit is constructed of dual H-bridges to implement pulse width modulation and convert power from DC to AC. The micro-stepping control increases the accuracy of position for the stepper motor's arm and allows for precisely controlled movements. The micro-stepping system used is very important for applications in robotics, printers, and a magnitude of other applications around the world daily. Using a custom integrated circuit allows for the project to be low-cost while performing the best with the chosen stepper motor.

37 – Solar Powered Home Light

Alexander Andonov, Robert Berthelson, Johann Benedict Elano and Appolloh Omolloh
Advisor: Kendra Wallis
Electrical Engineering Department

Build a solar power home light that can store power in a rechargeable battery and change brightness level through pulse width modulation.

38 – Wind Energy Source

Isaiah Boone, Brian Ndara, Richard DiGiovanni and Adam Haddad
Advisor: Kendra Wallis
Electrical Engineering Department

We will show our wind energy source circuit design that can take AC current generated from a permanent magnet generator and convert it into 60Hz AC current that can power a device.

39 – Solar Powered AC Motor Drive

Christian Flores, Alan Flores Pena and Gustavo Castillo
Advisor: Kendra Wallis
Electrical Engineering Department

We are building a solar-powered AC motor drive by using our knowledge of power electronics and fundamental theorems and terms of electrical engineering. We will be using solar panels made up of photovoltaic cells to conduct DC voltage from the sun. Our conducted DC voltage will then be stepped up to a stable

voltage using a DC Boost converter. After, we will convert the DC voltage into an AC voltage using an H-Bridge that will consist of three key parts: an H-Bridge, an LC Filter, and an AC load. The motor will then receive the AC voltage where we will program and produce different sinusoidal waveforms using a microcontroller in order to control the variable speed of the motor.

40 – PV Battery Energy Source

Evan Franklin, Jaime Ramos, David Aboderin and Zacarias Contreras
Advisor: Kendra Wallis
Electrical Engineering Department

This project explores the design and creation of a photovoltaic-powered battery to be used as an energy source. The scope of the project will include the use of converters to match the input voltages with output voltages needed for charging the integrated battery and for powering a given load. To achieve this, the circuit design will consist of buck and boost converters switched by MOSFETs, a bidirectional DC-DC bridge, and the use of a microcontroller to monitor circuit switching states and PV voltage output to reach maximum efficiency.

41 – Wireless Charging

Andrew Richardson, Dwayne Berry, John Chukwu and Christine Steffen
Advisor: Kendra Wallis
Electrical Engineering Department

Wireless power transfer over a small distance requires basic circuit components. Known circuit topology such as the H-Bridge Inverter and a Full Bridge Rectifier can be used to construct a rudimentary wireless charger.

42 – The Effect of Magnesium Acetate on the Formation of Brucite on Magnesium Oxide Surfaces

Jonathan Fuentes
Advisor: Erika La Plante
Materials Science and Engineering Department

Portland cement is the dominant form of cement used worldwide. Portland cement production is a highly energy-efficient process but it does account for about 8% of anthropogenic CO2. Seeking a sustainable alternative cement binder is of great interest to the field of materials science and engineering. MgO-based cements have been broadly studied as a potential alternative to Portland cement due to its low carbon/carbon negative capabilities. The primary challenge in using MgO as a binder is its low hydration rate, which causes a low production of brucite precipitates. The limited amount of brucite forming reduces its carbonation potential and the binder durability. However, the incorporation of specific organic ligands such as acetate may steer the kinetics and reaction pathways of MgO-based binders which would produce more brucite. This study will focus on investigating the effect of magnesium-acetate on the formation of brucite on MgO surfaces.

43 – Extract a Growth Rate from AFM Image Grains by Cross-sections (Gwyddion Analysis Software, Pygwy Scripts, and Python)

LeMaur Kydd
Advisor: Erika La Plante
Materials Science and Engineering Department

Extracting a quantitatively supported value for the growth rate of the samples represented in AFM images of varying granular morphologies (C11/C11OH/C11 (no functional group) carbon chains) of the CaCO3/Bisphosphonate reaction. As of current, there are no existing “accepted” growth rate values for this reaction, so creating a pipeline to define a growth rate for a reaction has many important applications that can be built upon, which will result in unique findings. Defining a growth rate for this specific application, involves using Python to make statistical calculations and analyze relative maxima/minima of cross sections extracted from an AFM scan using Pygwy scripts.

44 – Flow Trigger

Cherryl Maria Bibin
Advisor: Cesar Torres
Computer Science and Engineering Department

Flow Trigger is a project that finds methods and methodologies to induce flow within users that are performing specific tasks.

45 – Using Video Games to Help Children Learn and Retain Educational Material

Kyle Henry
Advisor: Christoph Csallner
Computer Science and Engineering Department

The video games industry has quickly become one of the most popular entertainment industries out there. According to the Entertainment Software Association (ESA), “nearly 227 million Americans play video games” with two-thirds of that group being people over 18. Knowing how popular the industry is, it is surprising how little effort there has been for education to embrace the video game market. Video games could be a very helpful tool that can solve many problems that exist for students today, such as stress and burn out. According to the ESA’s same report, it was shown that 79% of people agreed that games can inspire players and 87% believed games relieved stress. To test the potential for games as an educational tool, we made a couple of educational games and gave them to students to measure their ability to learn from them and tested to see if they favored these games over other common ways to study.

46 – IOT Nursing Display

Abdur Hossain, Meaza Abera, Nicholas Addyman, Craig Holguin and Chonrev Cal
Advisor: Jennifer Roye
Computer Science and Engineering Department

The nursing department presented us with a problem that they had been struggling with for some time. They were in need of a clock that they could easily edit and set to different times and dates to use it in their simulations and training exercises. These simulations are crucial for helping the nursing students prepare for real-life situations that involve time-sensitive tasks and decision making. However, despite their best efforts, they had been unable to find a clock that met their needs. That's where our project comes in. We are determined to create the clock they need, so they can continue to provide effective training to their nursing students. This will not only benefit the students themselves, but also the future patients they care for, by ensuring that they are well-trained and able to handle time-sensitive situations with confidence and competence.

47 – Algorithm Development for Automatic Analysis of Bimodal Optical and Electrical Nanosensing Time-Series Data

Yu Shiuan Huang
Advisor: George Alexandrakis
Bioengineering Department

Nanopore biosensors have played an essential role in bio-analyte characterization, but traditional biosensors are limited by short analyte translocation times. Dr. Alexandrakis has invented the Self-induced Back Action Nanopore Electrophoresis (SANE) to slow analytes down by optically trapping them as they travel through the nanopore. By collecting optical and electrical data, SANE enables comprehensive bio-analyte characterization. However, the manual analysis of bimodal data is work-intensive, highlighting the need for automated data analysis. This project aims to develop a MATLAB algorithm that automatically identifies positive and negative polarity spikes in current changes when a molecule enters and escapes an optical trap. The computer code will also automatically detect positive and negative step changes in the optical signal when a molecule enters and exits the trap, respectively. Additional code will calculate features of the optical and electrical signals, including each event's duration, beginning time, current change, and more. The significance of this work is the creation of an open-source algorithm that researchers can use to speed up protein-ligand interaction analyses in the field of nanopore technologies.

48 – Diagnosis of COVID-19 Impact on Construction Employment: Decline and Recovery

PoAnn Ly
Advisor: Mohsen Shahandashti
Civil Engineering Department

The objective of this project is to study how the COVID-19 pandemic impacted construction employment across the nation by identifying construction workforce decline due to the restriction of all normal activities to battle and slow down the spread of the COVID-19 virus in the beginning phase of the pandemic, and the recovery, to some extent, of the construction workforce, as the restrictions were lifted by state and/or local government to prevent further economic deterioration. It is important to notice that the decline in construction workforce early on was due to some states shutting down all construction sites or sites deemed inessential. Thus, site workers had been forced out of the workforce. As sites began reopening, the construction workforce did not recover fully due to the new COVID-19 protocols in place, which limited the number of workers on site or in specific areas, ordered by state and local government to prevent the spread or contracting of the COVID-19 virus, and eventual spread. The project diagnoses construction workforce decline and recovery in the COVID-19 pandemic era.

49 – Novel Graphene Membranes for CO2 Capture and Sequestration

Alexsanthra Rodriguez, Vitaliano Dattilo and Dogukan Yazici
Advisor: Michael Bozlar
Mechanical and Aerospace Engineering Department

Intense human activities over the last few decades have resulted in growing environmental concerns, including alarming carbon dioxide (CO2) emission levels. It is well known that CO2 is one of the major contributors to climate change. Previous studies have shown that graphene oxide is highly reactive with external molecules. Based on this property, we hypothesize that it can chemically bond with CO2. Thus, our goal is to evaluate the amount of carbon dioxide that can be adsorbed by graphene oxide membranes. In our research, we focused on two different perspectives of CO2 capture: materials science and computational chemistry. To accomplish our goals, we designed an airtight vessel where we located the membranes and performed the experiments. The main goal of the computational methods was to prove what is known from the literature, or better yet, that graphene oxide is more reactive and valuable than stable pristine graphene. We employed Density Functional Theory to compute the adsorption energy of the two structures, which also means evaluating their capacity to capture CO2. The experimental results demonstrate that the membrane can absorb thousands of parts per million of CO2 in just a few hours under stationary diffusion conditions.

149 – Stepper Motor Controller

Griffin Collelo, Anacelia Aguilar and Hannah Kelley
Advisor: Yichen Zhang
Electrical Engineering Department

For our Sophomore Design Project we chose to build a Stepper Motor Controller. It is controlled by an Arduino Uno. We were able to design the board to fit into an Arduino shield format, fitting the drivers and every needed component on a single board. The device can be powered by any 12-volt DC supply. The speed and number of degrees is controlled via a Bluetooth command-line interface which was above and beyond the scope of the project.

Research Experiences for Undergraduates

50 – WIPAR Design Tool Analysis for Use in Developing Hypersonic Waveriders

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

In the interest of designing sufficiently performing hypersonic waveriders, the WIPAR software has been developed by Dr. Kenneth Center at the University of Colorado. This tool will support optimization of the design of waveriders to the specified mission capability. The primary goal for this project is to determine the software's features and its limitations and compare it to similar programs. An in-depth literature search will be conducted to determine how WIPAR has been verified and tested. In addition, similar programs will be reviewed to develop detailed comparisons. This REU project will support the understanding of a valuable tool for conceptually designing vehicles and add to the AVD Laboratory database of capable programs to address waverider design.

51 – 3D Printed Scaled Models for Aeroelastic Wind Tunnel Experiments

Nicholas Caballero
Advisor: Rob Taylor
Mechanical and Aerospace Engineering Department

This work aims to create 3D printed scaled models that will be used for aeroelastic wind tunnel experiments. Two different models of an X-56A-like wing that have been optimized for structural similarity to full-scale models are used. The models will be printed using the single material HP 580 MultiJet Fusion 3D Printer. The CAD models will be modified to increase their manufacturability using the HP 580 MultiJet Fusion 3D Printer and reduce the number of defects that occur during printing. Tooling will be created to ensure model alignment during assembly of the wings. Once assembled, the models will then be surface scanned to find the surface deviation from the CAD models.

52 – On the Resistivity of Dissimilar Laser-Welded NiTi-SS Joints Using an Electromagnetic Field

Adrin Alias, Michael Ray Ramos, Vrunda Mehta, Omar Abdulla Abdulla and Khushi Raju Piparva
Advisor: Amir Ameri
Mechanical and Aerospace Engineering Department

Laser welding as a joining technique has drawn a lot of research attraction for the manufacturing and joining of aerospace materials due to the capability of providing a reliable and lightweight connection. However, obtaining a robust weldment that also preserves the functional properties of the materials remains a key technological challenge in laser welding. This study investigated a new technique for dissimilar laser welding of NiTi/stainless steel wires based on the hypothesis that applying a steady external magnetic field during the welding process, if designed and placed appropriately, would preserve the thermal-dependent shape memory/superelastic (SMA/SE) functional properties of NiTi. Compositional analysis showed a greater contribution of stainless-steel elements in forming the welding pool under influence of the Lorentz force, which resulted in the elimination of brittle Ti-Fe intermetallic phases. A significant reduction in joint embrittlement due to the steady magnetic field was also demonstrated based on hardness measurements. Results from this work may contribute towards improved dissimilar laser welding of NiTi/stainless steel wires.

53 – Investigation of Flammability Properties for Graphene-Reinforced Polymer Nanocomposites

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

This proposal aims to investigate the incorporation of flame-retardant additives, with an initial focus on graphene, into polymer matrix composites for use in additive manufacturing. Thermoplastics will be the focus of the project, as they can quickly create complex objects using versatile 3D printers. Graphene is an ideal reinforcement for these polymer matrices as it inherently provides unique mechanical, electrical, and thermal properties. In this work, we process fiber nanocomposites using a twin-screw extruder, characterize their flammability properties using the UL-94 standard, and finally compare the obtained outcomes with results from the literature. Research in the burgeoning field of high-performance flame-retardant polymers in additive manufacturing offers the potential for real-world impacts on human safety and could aid greatly in the development of lightweight, strong, and safe yet cheap manufacturing materials with versatile uses from electric vehicles to aerospace-grade tools and structures.

54 – Toward Improvement and Homogenizing the Properties of Additively Manufactured Parts Through Inducing Borders During Fabrication

Md Rezaur Rahman and Samia Alif Esha
Advisor: Narges Shayesteh
Mechanical and Aerospace Engineering Department

Laser Powder Bed Fusion (LPBF) of metallic components is associated with microstructure and properties inhomogeneity in the fabricated components. It has been revealed that considering a border surrounding the main part during the LPBF fabrication can address the issue of microstructure inconsistency across the cross section of LPBF-fabricated parts. This study, on the other hand, aims to investigate the effect of such borders on the microstructure homogeneity along the build direction of LPBF-fabricated parts. For this purpose, a cubic sample surrounded by a cubic border will be fabricated to control the rate of heat transfer and then improve the microstructure properties along the building direction. Also, a sample with identical dimensions and the same process parameters will be fabricated without borders as a reference

to be compared. To investigate the variation of the properties along the build direction, microstructure and hardness results will be compared between areas near and away the substrate for both samples. Moreover, the effect of the cubic border on the heat transfer mode during fabrication will be discussed using analysis of melt pools' dimensions, level of surface density, and microhardness measurements.

55 – Consistent Improvement in Targeted Nanoparticle Delivery for PAD Treatment Enabled by a Novel Nanopore Sensor Technology

Bianca Chavez, An Nguyen, Vy Tran, Na Nguyen and Priyanka Iyer
Advisor: George Alexandrakis
Bioengineering Department

Peripheral arterial disease (PAD) is the pathological condition when the blood flow to the lower extremities is limited due to the blockage of the blood vessels, which leads to a high rate of morbidity and mortality. Over 8.5 million Americans have been afflicted with PAD, the majority of whom are elderly. The common approach to treat PAD includes invasive surgical intervention, which can cause discomfort in patients and post-surgical complications, and it is not an effective option for elderly patients. We propose using Intercellular Adhesion Molecule 1 (ICAM-1) antibody as a novel target to help improve delivery of treatment to hypoxic muscle tissue and employ novel nano-sensor technology that can screen large numbers of NPs one at a time.

56 – Biomechanical Characterizations and 3D Light Sheet Imaging Assessment of the Hypertrophic Heart Tissues

Duc Chung
Advisor: Jun Liao
Bioengineering Department

Hypertrophic cardiomyopathy (HCM) is a genetic disease that results in abnormal thickening of ventricular muscle, particularly the septum, causing left ventricular outflow tract (LVOT) obstruction. Hypertrophic cardiomyopathy can be microscopically assessed and diagnosed by large cell size of the hypertrophic cardiomyocytes, disarray of those cells, and a dense abnormal fibrotic microenvironment. The extent of cell hypertrophy and fibrosis can directly impact the mechanical behavior of cardiac septal tissues. Determining the biomechanical and microstructural abnormalities of hypertrophic septal tissues is essential to develop a biomimicking in vitro 3D HCM model. In this REU study, we will perform thorough biomechanical and microstructural characterizations on hypertrophic septal tissues and assess the abnormal 3D fibrotic structure in hypertrophic septal tissues using light sheet imaging technique. The obtained information can be used to guide the development of an in vitro HCM tissue model. An in vitro HCM tissue model that is able to recapitulate the key anatomical characteristics would serve as a cost-effective platform to test and optimize the treatment protocols/regimens.

57 – Designing, Cloning, and Testing Genetically Engineered Metabolic Pathways to Produce Therapeutics in Gut Bacteria

Omar Elkassih, Juan Ramirez, Suzette Martinez, Teresa Le and David Diaz
Advisor: Justyn Jaworski
Bioengineering Department

Equol is a natural isoflavone metabolite derived from daidzein, an isoflavone found in soybean and other soy products. Equol has a chemical structure similar to that of mammalian estrogen and thus can bind with estrogen receptors, allowing it to act as a supplement to estrogen in mammals. Research investigating equol has linked it to a reduced risk of certain cancers, cardiovascular diseases, and hormone-dependent illnesses. While a fraction of the population can naturally convert dietary daidzein to equol utilizing their gut bacteria, a vast disparity exists between populations that can do so; however, allowing a non-equol-producer to produce equol from dietary soy products through a series of engineered enzymatic reactions is achievable and has recently been confirmed. Building from this, we would like to genetically engineer a biocompatible filamentous bacteriophage (a virus that infects only E. coli) to carry these genes necessary for isoflavone metabolization (specifically daidzein to equol conversion), such that these may introduce genes to bacteria of the intestines. By using genetically engineered bacteriophage, specially modified to introduce the necessary enzyme for the series of conversions from daidzein to equol, we can create a probiotic that allows consumers to receive the health benefits of soy-product-derived equol.

58 – Development of Dual Epo Nanoparticles for Treatment of Peripheral Arterial Disease

Ashlen Estrada
Advisor: Kytai Nguyen
Bioengineering Department

Peripheral arterial disease (PAD) is a condition caused by narrowed arteries from atherosclerosis in the lower limb. Due to insufficient blood flow and lack of oxygen and nutrients to target tissue, PAD can lead to serious health problems including critical limb ischemia, stroke, and heart attack. PAD has a high mortality and morbidity rate which affects approximately 6.5 million Americans, especially the elderly. Since the current invasive treatments for PAD have many complications and disadvantages, developing an innovative approach that can limit those drawbacks is in demand and critical. Therefore, we propose a non-invasive and promising nanoparticle as nanocarrier to control pro-angiogenic factor and its gene to ischemic tissue to treat PAD.

59 – Implantable Fluorescence Seed for Breast Cancer Localization

Nicholas Singleton, Halim Nam, Alexis Nguyen and Tasneem Khan
Advisor: Baohong Yuan
Bioengineering Department

Every year, more than two million women in the world develop suspicious breast lesions. Based on current procedures, the wire-guided localization technique involves the implantation of a metal wire that subjects the patient to discomfort and pain when locating and excising the tumor. In addition, any slight movement can displace the wire from the tumor site. Therefore, our design aims to minimize invasive procedures and patients' burdens, while equipping the surgeon with an adequate tumor localization technique to excise tumors using X-ray, ultrasound and ultrasound switchable fluorescence (USF) imaging modalities. These three imaging modalities are compatible with our newly constructed biomaterial, which involves a silicon seed encapsulated with fluorescent indocyanine green nanoparticles. The silicon is a contrast agent that enables imaging under X-ray and ultrasound technologies, while the addition of our fluorescent nanoparticles allows optical imaging under USF. In a clinical setting, medical professionals will insert our biomaterial into the breast tumor via a medical probe. Upon excising the tumor, our seed is also safely removed. Thus, the seed can serve as a less invasive, more secure and cost-effective method for patients during the surgical removal of breast tumors.

60 – Injectable Cellulose-Based Hydrogel Treatment Loaded With Temozolomide for Local Delivery to Glioblastomas: In Vitro Co-Culture and In Vivo Human GBM Xenograft

Cara Anderson, Kayla Meyers, Aaron Ly and Adam Germain
Advisor: Young-tae Kim
Bioengineering Department

Glioblastoma (GBM), the most common form of brain cancer, is profoundly aggressive. Current treatments include radiation therapy, chemotherapy, surgical removal, and new studies in targeted drug delivery. However, these therapies have high cytotoxicity, low survival rates, and high drug degradation. Previous monoculture studies performed in the summer of 2022 in Dr. Kim's research lab were conducted to demonstrate a new in vitro system of drug delivery with the use of an injectable cellulose-based hydrogel acting as the vehicle for the GBM and melanoma chemotherapy drug TMZ. The results of this study revealed that a lower dosage, 25-50μM, of TMZ present a higher death rate (~20%) of the GBM G55 cells and a higher cell viability (~100%) of the healthy astrocytes. To confirm, our team hopes that the co-culture system with G55 and astrocytes inside the same well, undergoing the same treatments as the monocultures, will give a better picture of the effectiveness of the treatment within the therapy window. With these results, local drug delivery can be improved to optimize the window of drug dosage to promote the anti-cancer drug effect with specific killing to reduce off-site targeting and healthy tissue damage.

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

Vivian Nguyen, Yu Shiuan Huang and Natalie Tran
Advisor: Hanli LIu
Bioengineering Department

Patients who suffer from various brain injuries often experience an increase in intracranial pressure (ICP), which can damage brain tissues if left untreated. An external ventricular drain (EVD) is often used to monitor and relieve the pressure by draining cerebrospinal fluid (CSF) from the ventricles in the brain. To accurately measure ICP and drain CSF, the EVD's external pressure transducer must be positioned at the height of the patient's foramen of Monro (an anatomical landmark) inside the brain. Clinicians currently use a laser level device to align the transducer with the tragus of the ear, a common external reference point for the foramen. However, patient head movement can cause misalignment between the foramen and transducer, which can lead to inaccurate ICP measurements and under- or over-drainage of CSF. Our design features an inertial measurement unit (IMU) placed on the forehead to track patient head movements. We have developed an algorithm to obtain displacement data from the sensor's acceleration and angular velocity measurements. The results can then be used to alert the nurse when the height offset exceeds an acceptable threshold and inform them of how to realign the EVD system for proper ICP measurements and CSF drainage.

62 – Prediction of Mechanical Responses for Additively Manufactured Lattice Structures

Cindy Cruz-Rodriguez, Devon Stapleton and Connor Rebodos
Advisor: Chen Kan
Industrial, Manufacturing and Systems Engineering Department

This project aims to develop a machine learning framework for the prediction of mechanical responses of lattice structures fabricated by additive manufacturing (AM). Process-induced geometric imperfections could significantly alter the mechanical responses of fabricated lattice structures. Existing approaches for mechanical property assessment mainly rely on destructive tests and finite element models, which are costly and time-consuming. To achieve fast assessment, this study proposes a machine learning framework to predict the mechanical responses of AM lattice structures based on their fabricated geometries. This research enriches the knowledge about how the fabricated lattice, with process-induced geometric imperfections, will behave under the desired load and sheds light on performance enhancement in AM of mechanical metamaterials.

63 – PA12 Material Aging in Selective Laser Sintering: Machine Learning-Based Prediction

Ginevra Cerreto
Advisor: Emma Yang
Industrial, Manufacturing and Systems Engineering Department

We are studying the behavior of various polymers for 3D printing whenever they are exposed to different temperatures for different time periods.

64 – Exploring Feature Representations for Supercritical Fluid Chromatography via Machine Learning and Surrogate Optimization

Destini Black and Zoe Rodriguez
Advisor: Victoria Chen
Industrial, Manufacturing and Systems Engineering Department

Chemical analysis is crucial to knowledge discovery in society, from detecting disease markers in laboratory blood tests to identifying forensic clues in criminal investigations to measuring concentrations of pollutants in the air we breathe and the water we drink. Supercritical fluid-based analytical techniques are attractive because of the vast areas where they can be applied. A better understanding of optimal experimental parameter settings is needed to address different analytical problems without extensive experimentation, and the optimal settings will vary depending on an experimental study's chosen sample material, analyte compounds, and column chemistry. This REU project will employ machine learning to explore feature representations for different experimental study conditions using published data and new data guided by a surrogate optimization algorithm. The goal of this project is to identify features that are able to characterize experimental study conditions with similar optimal experimental parameter settings. These findings will complement and inform research directions for a project funded by National Science Foundation Award CHEM-2108767. This project is a collaboration between analytical chemists and data scientists in the Center on Stochastic Modeling, Optimization, & Statistics (COSMOS).

65 – A Review on Potential Benefits of Shared Electric Vehicles

Taylor Henson, Natalya Elena Restrepo, Apurva Pamidimuk and Sai Sneha Channamallu
Advisor: Sharareh Kermanshachi
Civil Engineering Department

Urban transportation is the crux of economic growth in both industrialized and emerging nations, but it is also a significant contributor to energy usage, poor air quality, health impacts, and traffic problems. Hence, the decarbonization of the transportation sector by deploying electric vehicles (EV) and shared mobility is currently an environmentally friendly and cost-effective solution. This study sought to review the studies conducted on shared mobility and electric vehicles. A thorough literature search revealed that the EV encompasses the hybrid EV, the plug-in hybrid EV, and the battery EV. EVs also provide various advantages over conventional vehicles, including zero greenhouse gas emissions, ease,

reliability, affordability, convenience, efficiency, and connectivity. In contrast, the most prevalent forms of shared mobility include car-sharing, micro-mobility, ridesharing, ride-sourcing, and micro-transit. The implementation of shared mobility helps reduce the difficulties created by pollution and traffic congestion by lowering the number of vehicles in transit, congestion, and the release of polluting gases in metropolitan areas. Combining shared mobility and EVs may accelerate acceptance of both and minimize energy usage and GHG emissions by relying on smaller, efficient shared EVs. The findings of this research can be utilized in long-range planning for shared electric programs.

66 – Tackling "Forever Chemicals PFAS": Towards a New Treatment Paradigm and Public Awareness

Malaz Bob, Aashutosh Bhatt and Aditi Kale
Advisor: Hyeok Choi
Civil Engineering Department

Due to their unique properties (repelling both water and oil), per- and polyfluoroalkyl substances (PFAS) have been widely used in many industrial, military, and daily consumer products (non-stick coating, stain-resistant fabric, food packaging). They are the recent focus of U.S. federal regulation due to their toxicity. Forever chemicals PFAS are not decomposed naturally due to the extraordinarily strong C–F bonds in PFAS, and more communities are finding their drinking water tainted with PFAS. Removing PFAS is a challenging but significant task. Most destructive treatment technologies inevitably require energy-intensive extreme conditions (e.g., microwave, ultraviolet, plasma, e-beam, and heat). In this REU project, the student team worked with the PI's graduate students to develop more efficient and environmentally friendly chemical treatment methods working under ambient reaction conditions to destroy PFAS (paradigm shift). The team also had chances to attend a series of PI's lectures on experimental techniques and to visit UTA centers (e.g., Shimadzu Centers). To improve public awareness of such toxic chemicals, a fact sheet was created and distributed to the local community. This project provided the team with a unique opportunity to experience hands-on lab skills, modern instrumentation, scientific research initiative, collaborative work, and environmental stewardship.

67 – Laboratory Testing of Engineered Media for Biofiltration Swales to Improve Water Quality

Giang Tran
Advisor: Habib Ahmari
Civil Engineering Department

Expanded shale is an aggregate made from clay or shale heated in a rotary kiln until light and porous, often used as a filtering medium to remove contaminants from storm water. The challenge is that its efficiency, treatment configurations, and life cycle are assumed from vendors or unverified sources. In this project, a "scaled" expanded shale engineered filtration media is installed and tested in a controlled laboratory setting at the UTA Hydraulics Lab. The data from

laboratory experiments is used to demonstrate the effectiveness of expanded shale for the treatment of roadway runoff and to develop design parameters for expanded shale bioswale. In addition, UTA laboratory testing will provide an independent assessment of the performance of expanded shale in water quality improvement. The outcome of this research will significantly help cities, TxDOT, and other departments of transportation to deliver effective, low maintenance, and less expensive solutions for stormwater runoff treatment.

68 – Evaluating Building Thermal Resiliency Under Extreme Weather Events in Texas

Nikhil Yaduvanshi, Daniel Gomez and Ojaswi Thapa
Advisor: June Park
Civil Engineering Department

Climate change has led more extreme weather events (heatwaves, winter storms) which has caused a significant impact on the building sector. Even under such disasters, building systems (heating, cooling, ventilation, and enclosure) should be designed, controlled, and maintained to provide comfortable indoor environments for occupants. However, recent experiences (e.g., Winter Storm Uri, 2022 heat waves) indicated that buildings often failed to satisfy human comfort. For low-income households, extreme weather events even resulted in occupants in danger of heat and cold stresses due to under-performance of the building systems. As we expect more frequent and worse weather-related disasters in near future, it is important to systematically understand what we learned from the previous disasters. The proposed research will have three main stages: 1) a comprehensive review of existing literature of building simulation under extreme weather events, 2) modeling the existing housing stock in (DFW) area, and 3) simulating the building thermal resiliency under extreme weather events in DFW area. Our research will establish the fundamental knowledge of understanding thermal interaction among weather events, building performance, and occupant comfort where it envisions the applicable solutions to mitigate the challenges of climate change in our community.

69 – Advanced Vision Interactive Drone

Talha Nayyar, Akshaj Murhekar, Areeb Khan, Jones Lopez, Yash Wghmare and Nabeel Nayyar
Advisor: Donna French
Computer Science and 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.

70 – Semi-Autonomous TurtleBot with Real-time Object Detection and Depth Estimation

Khang Nguyen
Advisor: William Beksi
Computer Science and Engineering Department

In this project, we introduce a semi-autonomous custom TurtleBot3 with an embedded NDVIA Jetson Nano board and an integrated Intel RealSense D435 depth camera. The custom TurtleBot is able to detect objects in real-time with the MobileNet SSD v2 model deployed and acquire continuous point clouds of the surrounding environment with an integrated RGB-D camera. The demonstration video shows that the TurtleBot performs object detection and estimates the depth of the detected object simultaneously while being controlled from a remote computer.

71 – Recognizing Handposes Using Nearest Neighbors

Rodrigo Pleitez and Preston Mann
Advisor: Vassilis Athitsos
Computer Science and Engineering Department

In the history of computer vision, one particularly big problem is estimating the pose of a hand. The reasons for this problem is the varying shape of the human hand. Perhaps a hand is missing a finger or the finger itself is hard to observe from a certain angle. How do we get computers to recognize this missing information from a single frame or image? We classify the nearest neighbor to the handpose by evaluating how similar the image of the hand is to the image of another hand whose joint positions we currently have from an existing dataset. We evaluate the similarity using distance measurements. The current distance measure we utilize for this project is chamfer distance. Chamfer distance evaluates the minimum distance between a point and a set of points for every point in an system. We can use this with edge detection to isolate the contour of the hand and evaluate the distance between the set of pixel of the hand contour against other hand contour images to evaluate its nearest neighbor.

72 – Database Preprocessing and Database Design for Efficient Analysis of Knowledge Graphs

Ishan Poudel
Advisor: Chengkai Li
Computer Science and Engineering Department

Knowledge graphs (KGs) encode semantic, factual information as triples of the form (subject, predicate, object). They are essential assets to a wide variety of tasks and applications, including recommender systems, web search, question answering, fact-checking, etc. Wikidata is the largest public cross-domain KG. It includes vast information on entities and their relationships. Wikidata represents facts in the form of statements. Statements consist of distinct components, including items, properties, values, qualifiers, and references. With more than 100 million entities in a structured, machine-readable form, Wikidata provides researchers and developers with opportunities for building and evaluating models and algorithms. Most KGs consist of implementation triples, Web Ontology Language triples, and subject matter triples. However, computational tasks and applications, such as Knowledge Graph Completion Methods, need to be applied only on subject matter triples. Wikidata project has made available an online query service. Nevertheless, to efficiently query and analyze the data, it is essential to process and parse it into a database. To this end and to better investigate how the data is represented in Wikidata, we designed data preprocessing scripts. These scripts parse the triples, extract the aforementioned Wikidata objects, and store them in a database.

73 – Design Tow-Steered Composites Plate Structures Using Multiscale Modeling and Transfer Learning

Clay Gifford, Galib Raid and Sami Abbasi
Advisor: Xin Liu
Computer Science and Engineering Department

Tow-steered composites are new lightweight materials that are increasingly used in aerospace structures. However, the design of tow-steered composites with optimal performance for realistic structures is computationally expensive. Advanced deep learning models provide an efficient alternative to physics-based simulations while keeping a reasonable accuracy, but generating high-fidelity training data is also very expensive. To reduce the cost, this project will implement a recently developed mixed-fidelity neural network model to generate mixed-fidelity data for a deep learning model. This deep learning model will be applied to design a composite plate structure under thermal-mechanical loads. The results show that the deep learning model will significantly improve the computational efficiency of multiscale plate analysis of tow-steered composites. The mixed-fidelity model will greatly reduce the training cost while keeping high accuracy.

74 – Practical Efficient Microservice Autoscaling

Md Ahnaf Tajwar Kamal and Md Rajib Hossen
Advisor: Mohammad Islam
Computer Science and Engineering Department

Microservice-based cloud applications are becoming increasingly popular due to their scalability, flexibility in programming languages, and quick and easy deployment compared to traditional monolithic applications. However, resource management in microservices introduces new challenges. In microservice applications, a single service/job request may traverse through many microservices. Hence, the application's performance depends on balanced resource distribution. Meanwhile, existing approaches either allocate microservice resources inefficiently (e.g., rule-based) or require intensive data collection and training (e.g., machine learning-based). In this project, we will be working towards developing a novel, lightweight, and agile resource management system for microservices that will find optimum resource allocation under dynamic operating environments.

75 – MLN Dashboard

Viraj Sabhaya
Advisor: Abhishek Santra
Computer Science and Engineering Department

The project is regarding the visualization of the MLN dashboard and how it can interact with different nodes and edges to represent common clusters/groups. This highlights fields like data science, network visualization and databases.

76 – [MLN-DASH] Web-Based Dashboard for Generation, Analysis and Visualization of Complex Data Sets using Multilayer Networks

Amey Shinde and Pratik Dhakal
Advisor: Sharma Chakravarthy
Computer Science and Engineering Department

Over the last few decades, simple 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 relationship among them with regard to various factors like weather, light, road surface, and geographical region. Indeed, to model such multiple relations, multiple related graphs are useful. This can be done with multilayer networks (MLNs). Currently, algorithms are being developed to create and analyze MLNs. However, there is a lack of an end-to-end-platform that can support the entire lifecycle from generation of MLN from complex data to the final drill-down and visualization. As part of this project, we are developing a multi-user web-based dashboard through which users can create profiles and upload data sets to organize work, configure generation of layers for the data sets, configure expressions to perform

analysis, such as community, centrality, and substructure discovery, and generate interactive visualizations for the layers and analysis results.

77 – Tailoring Post-Curing Methods to Enhance Mechanical Performance of Body Centered Cubic Metamaterials Fabricated Using Stereolithography

Md Humaun Kobir, John Conlin and Samuel Aimufia
Advisor: Emma Yang
Industrial, Manufacturing and Systems Engineering Department

Mechanical metamaterials are present in industries where ultralightweight materials with high energy absorption are desired while maintaining mechanical strength. The global metamaterials market grew from $448 million in 2018 to $1.8 billion by 2023 at a compound annual growth rate (CAGR) of 32.0%. This market is expected to continue its growth at a CAGR of 26.8% from 2023 to 2028 and will reach $5.9 billion by 2028. Metamaterials are artificially engineered structures that are manufactured from periodic geometric patterns. This research is designed with body centered cubic unit cells and subsequent metamaterials as it offers lightweight structures while ensuring mechanical performance. Designing highly complex metamaterial with traditional manufacturing processes is challenging and sometimes, impossible. Thanks to the advancement of additive manufacturing (AM) technologies, we can achieve enhanced manufacturing complexity with increased customization level due to its layer-by-layer manufacturing process. AM technology can achieve complex metamaterial design, but it is suffering to ensure uniform solidification of the printed part, resulting in poor mechanical performance. Post-curing technology is a choice to achieve uniform solidification that not yet explored. In this study, three different post-curing methods will be used which are UV, ultrasound, and oven.

78 – Machine Learning for Site-Specific Management in Precision Agriculture

Joseph Tyer, Javier Garcia, Gregory Myrick, Michael Murphy
Advisor: Yuan Zhou
Industrial, Manufacturing and Systems Engineering Department

Precise agriculture involves the application of technologies and agronomic principles to manage spatial and temporal variations associated with all aspects of agriculture production such that site-specific management decisions can be made to improve crop performance and environmental quality. However, when optimizing management choices, such as seed density and fertilizer application rate, the spatial and temporal heterogeneity of characteristics in a specific field presents challenges. This proposed REU project aims to develop a decision support tool that will enable informed decision-making in site-specific management at the zone level for farmers towards achieving better crop yield outcomes. The research team will work with data collected from diverse sources to build machine-learning models for crop yield prediction. Ensemble methods will be applied to improve prediction accuracy. Potential recommendations

for effectively organizing and operating a farm that will help farmers increase production and profit will be discussed.

80 – Designing Scalable, Affordable and Efficient Microgrids

Cecilia Romero
Advisor: Erick Jones
Industrial, Manufacturing and Systems Engineering Department

Society cannot function without electricity, yet natural disasters, unexpected energy production cuts, or simply a downed power line can sever our connection to this critical resource. Electricity is mostly derived from the burning of limited fossil fuels. In response, society has been pushing toward clean renewable options to increase the sustainability of energy sources, but renewable options like solar and wind are intermittent making ensuring reliability more difficult. A potential solution to the dual problems of sustainability and reliability are microgrids. Microgrids generally use renewable energy resources with battery storage and have controls that manage the electrical sources, energy storage, and connection to the grid. This dramatically increases reliability and, in certain use cases, energy security; if the power grid fails, the microgrid can pick up the slack. Microgrids are now a seasoned technology, but a lot can still be done to improve them. Therefore, our research goal was to evaluate and improve a small-scale microgrid that can generate power via solar (an intermittent but complementary renewable energy source) and store energy via a battery system, and use this information to design a new smart off-microgrid system that is scalable, affordable, and efficient.

81 – De Novo Development of Small CRISPR-CAS Proteins Using Artificial Intelligence Algorithms

Pranav Umakant Pujar, Bharani Nammi
Advisor: Shouyi Wang
Industrial, Manufacturing and Systems 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.

82 – MIMO Micro-Doppler Radar

Khang Pham, Hannah Kelly, Kameron Brazier and Francis Castillo
Advisor: Saibun Tjuatja
Electrical Engineering Department

Novel MIMO imaging radar system designed to detect and localize live human presence obscured by a wall or debris. Provides real-time micro-Doppler

imaging capable of detecting and locating live human presence, as well as providing cardiac readings within a room or through a wall. This project builds on recent research advances in micro-Doppler radar system architecture and applications, such as small drone detection and human gait recognition. The proposed system leverages these advances to solve the critical problem of detecting and localizing live-human presence in search-and-rescue operations after natural disasters and in non-invasive patient monitoring in assisted living facilities. The proposed system consists of three parts. First, the MIMO radar system that will operate in the 2GHz-3GHz frequency range and will have three transmitters and three receivers arranged on a sampling plane. This configuration will enable tomographic processing of the data collected, allowing for imaging capabilities. Second, an antenna beam-sharpening algorithm will be utilized for sidelobe suppression for non-Nyquist MIMO/Synthetic Aperture Radar configuration. The algorithm will enhance the systems ability to detect live-human presence behind wall or debris. Finally, a subspace-based radar imaging and micro-Doppler extraction algorithm will be used for target detection and localization.

83 – Implementation of Game-Based Decision-Making Algorithms for Autonomous Driving

Francis Castillo, Johnathan Dodd, James Wallace, Renever Paz, Aaron Barber and Erin Butler
Advisor: Yijing Xie
Electrical Engineering Department

The field of autonomous vehicles is rapidly advancing, with the goal being Level 5 Driving Automation or full driving automation. However, for autonomous vehicles to reach this level, it is crucial that they can make safe, fast, and efficient decisions. This project aims to address this challenge by implementing advanced game theoretical decision-making algorithms on the LIMO autonomous driving test bed. Game theory is a mathematical framework that can be used to model decision-making in complex, multi-agent systems. By applying game theory to autonomous vehicles, we can optimize their decision-making processes and ensure that they act in a manner that is safe, efficient, and in the best interests of all road users. The LIMO autonomous driving test bed provides an ideal platform for testing these algorithms, as it allows us to evaluate their performance in realistic driving scenarios. The project will involve the development of new algorithms, as well as the implementation and testing of these algorithms on the LIMO test bed. The results of this work will be used to validate the efficacy of these algorithms and to make improvements where necessary.

Senior Design

84 – Through Wall Human Detection

Francis Castillo, Ashley Beltran and Raymond Song
Advisor: David Wetz
Electrical Engineering Department

Detecting a human through walls has long been challenging for law enforcement and search and rescue teams. In recent years, Doppler radar technology has emerged as a promising solution to this problem. Doppler radar detects motion by analyzing changes in the frequency of the radar signal, making it capable of detecting human movements through solid objects like walls. The detection process involves emitting a radar signal that penetrates the wall and bounces off the target object, in this case, a human, before returning to the radar sensor. The changes in the frequency of the reflected signal caused by the target's movement are then analyzed to determine the position and motion of the human behind the wall. This technique has been successfully demonstrated in various scenarios, including detecting a person behind a brick wall, a wooden door, or a concrete wall. However, there are still some limitations and challenges to overcome, such as distinguishing between multiple targets or detecting stationary individuals. Despite these challenges, the ability to detect humans through walls using Doppler radar technology can greatly aid rescue missions and law enforcement operations, providing valuable information and potentially saving lives.

85 – Miniature Coil Gun

Antonio Martinez, Maryem Bijoua, Cody Mitchell and Folajimi Oluwatoni Thomas
Advisor: David Wetz
Electrical Engineering Department

A coil gun, an electromagnetic launcher, is a device that uses a series of electromagnets to accelerate a projectile to high speeds. They have been developed for a wide range of applications, including military, industrial, and scientific research. High-speed bullet trains and particle accelerators are examples of such devices. A typical coil gun consists of a series of coils which are powered by a high-voltage electrical source. When a current is passed through the coils, they generate a magnetic field that interacts with the projectile, accelerating it down the length of the barrel. As the projectile moves through the coils, the magnetic field in each coil is turned off and on in a carefully controlled sequence, causing the projectile to be propelled forward at high speeds.

86 – Solid State Marx Generator

Patrick Chang, Marcus De La Garza, Brayden Moreno, Phillip Gamblin and Ethan Burt
Advisor: David Wetz
Electrical Engineering Department

A Marx generator is a type of circuit that supplies a very high power output

pulse for specified period across a load. The duration and frequency of the pulse can be varied based on the characteristics of the components used. A solid state Marx generator uses a series of stages made up of a combination of a capacitor, a transistor, a couple diodes and a transistor driver. Each capacitor is connected in parallel with the diodes, with a transistor between each capacitor. The input voltage is used to charge up each capacitor in parallel until the transistor driver switches each transistor, creating a lower impedance path for each of the capacitors to discharge their energy into the load. This results in an output pulse voltage that is a multiple N of the input voltage, where N is the number of stages in the generator. A solid state Marx generator was selected in this situation as opposed to a traditional Marx generator as the size of the components used in a solid state Marx allow for a more compact design and the transistors allow for the pulse frequency to be varied by adjusting the transistor driver timing.

87 – Non-Linear Transmission Line

Joel Lopez, Brent Oksanen, Mark Anderson and Emmett Burton
Advisor: David Wetz
Electrical Engineering Department

Nonlinear transmission lines (NLTLs) are commonly used in the electronics industry for generating high-power solid-state sources and radio frequency (RF) signal generators, which are also useful for military and medical applications. NLTLs are used for pulse shaping where a pulse is condensed in time to increase power output. Another mode of operation is to generate high power output oscillations. The input to the NLTL is a high voltage pulse generator operating at 5 kV with a repetition rate of approximately 100 Hz. The output is a high power and frequency oscillation to be coupled directly to an antenna. Due to the project requirements, we will be creating a lumped element NLTL, which is a standard transmission line model with one element becoming nonlinear.

88 – Spectrally Resolved Optical Imaging System

Stephanie Clairmont, Waabee Geshow and Lore Oyedele
Advisor: Weidong Zhou
Electrical Engineering Department

Optical spectrometry is a powerful and widely used characterization tool for scientific research and application in the chemical, biological, and material science areas. Benchtop laboratory spectrometer systems have bulky optical components, moving parts, and long path lengths that deliver unparallel, ultrafine resolution and wide spectral range results. However, due to rapidly growing applications, there is a need for the miniaturization of spectral analysis devices that allow integration into smaller-scale systems that can be moved easily. Scaling down benchtop spectrometer systems becomes a challenge due to the proportionality of size to resolution. The objective of this project is to investigate a high-resolution on-chip/compact spectrometry system which can perform spectral analysis with extreme miniaturization for portable optical sensing systems. The proposed miniaturized system includes a complementary metal oxide semiconductor (CMOS) sensor, an optical metasurface simulated using S4 (Standford Stratified Structure Solver), and a computational

reconstruction algorithm that can reconstruct spectral imaging information ($\Delta\lambda/\lambda$ ~ 0.1nm) covering a broad wavelength range of 400nm to 950nm.

89 – High-Repetition Rate Linear Transformer Driver

Ahmad Alshamali, Johnathan Dodd, Michael Abdelamalak and Danny Celis
Advisor: Greg Turner
Electrical Engineering Department

The study and design of a Linear Transformer Driver. Particularly, solid-state linear transformer drivers, which use semiconductor devices or electric switches to control the charge and discharge of capacitors in order to produce packets or bursts of voltage and current. LTDs are power generators that perform power addition, the process of generating small pulses and combining them to obtain a larger output pulse and deliver to a target load. Modules or capacitor banks are triggered by a waveform generator, each trigger releases a pulse of energy in the form of magnetic fields that is combined by a ferromagnetic core. The magnetic ring represents the transformer core, where the module's copper traces represent the primary winding, and a hollow copper tube represents the secondary winding. Thus, the copper stalk or tube gathers the summed pulses of each module and delivers to a resistive load. In this report, the simulation, testing, and performance of a SSLTD for Senior Design are explored.

90 – Portable Vehicle Speed Radar Measurement System

Ryan Bluestien, Jesus Mendez, Lam Tran, Sam Safaei Mehro and Miriam Guzman
Advisor: Greg Turner
Electrical Engineering Department

Radar speed signs, also known as driver feedback signs, are devices that use a radar to measure the speed of a vehicle and then display that speed to the motorists as they are passing by. These devices are commonly found in school zones, highways, and residential areas to try and deter speeding. Mr. Jesse Lee wants our team to build a portable speed sign that not only measures the speed of vehicles but also stores their speed and pictures if they are going over the speed limit. The main objective of the project is to have a properly working device that consists of a self-sustainable power source and can operate 24 hours per day. The device should be capable of withstanding harsh weather conditions. The data that is collected from the system will be stored in the client domain and will be sent to the City Council as proof of the client's complaint that his street is subject to excessive amounts of speeding.

91 – High Current Generator Module

Jesus Moreno III, Kwame Antwi, Victor Munoz, Duy Nguyen and Juan Carrillo
Advisor: Greg Turner
Electrical Engineering Department

The goal of this project is to create a production-worthy high current generator module that will be capable of generating pulse and ramp waveforms from 0 to

50 amps. This design will integrate with a handler interface board (HIB) and will assist in testing multiple chips such as in wafers, MOSFETS, etc. Ideally, this will be a smart current source that will allow the user to control the current output during testing by means of programming the HIB to the set specifications.

92 – UTA FSAE Torque Vectoring Computer and Digital Dashboard

Javier Manzano Blanco, Nicholas Gonzales, James DeLeon and Chance Kassi
Advisor: Bob Woods
Electrical Engineering Department

UTA FSAE is developing a four-motor electric race car and wants to develop hardware for torque vectoring and a digital display for vehicle information. This project develops the hardware for both devices and establishes software with the intent of torque calculations being easily modifiable and tuned by future FSAE team programmers. The hardware for torque vectoring consists of sensors and a microcontroller that calculate wheel speed, speed over ground (optionally), steering position, yaw rate, acceleration, brake pedal position, and accelerator pedal position, outputting this over CAN. For the digital dash, a crystalfonz LCD is used with an ESP32 to drive the screen using information given to it through CAN bus.

93 – Advanced Control Actuation Drive System

Rey Trevino-Contreras, Loc Nguyen, Abhi Bhakta and Christian Brumback
Advisor: Greg Turner
Electrical Engineering Department

The ACADS is an advance control acquisition device system that can control the speed and position of more than one electric motor. With the use of a four-quadrant controller, the system will be able to control the motors to be within -40 degrees to 40 degrees with an accuracy of less than 1.0 degree. The ACADS will house framework that will be the controlling architecture and electrical circuiting to drive the positioning for motors. This system has a multitude of applications such as electric cars, aerial vehicles, unmanned vehicles, etc.

94 – Flying Roomba

Tam Dau, Miguel Cadena, Minho Shin and Hao Nguyen
Advisor: David Wetz
Electrical Engineering Department

Roomba is an automated vacuum robot used to clean the household floor. The problem with the Roomba is that they only work on a one-story house without user intervention. The idea is to modify a Roomba so that it can detect a staircase by using stereo optical RGB-D Camera and autonomously fly to the top of the stairs where it should resume its activities in 5-minute interval time flight. The RGB-D camera will use canny edge detection to remove noise by Gaussian filter by horizontal line of each stair step, and unapparent line or no line will be considered a landing area. The iRobot Create 2 Roomba will be modified and will communicate with flying system using Raspberry Pi.

95 – Raytheon UAS Showcase

James Wallace, Carlos Mella-Rijo, Stefan Fahlsing, Andrew Riel and Nicholas Partlow
Advisor: David Wetz
Electrical Engineering Department

This project is a competition of various universities sponsored by Raytheon Technologies. Each university will produce two vehicles, an unmanned aerial vehicle (UAV) and an unmanned ground vehicle (UGV). They will perform a series of tasks where their ground drones are targeted by the air drones and fired upon with an infrared laser. The UT Arlington team is composed of groups from three different engineering disciplines: electrical engineering (EE), mechanical and aerospace engineering (MAE), and computer science and engineering (CSE). The MAE team will design the ground and air drone chassis and frames. The CSE team will program the UAV to fly autonomously and use image recognition to detect the UGVs while triggering the IR laser. The EE team will develop and manage the electronics for the UGV to operate autonomously.

96 – The Design and Testing of an Autonomous Aerial and Ground Vehicle

Vishnu Perincheery, Juan Buritica Yate, Bhawika Kandel, Jaelyn Ort, Ethan Quarles and Madelynn Wimmer
Advisor: Bob Woods
Mechanical and Aerospace Engineering Department

This project is a collaboration between the mechanical, electrical, and computer science and engineering disciplines. The mechanical engineering team is tasked with working on the design and testing of the structure and propulsion system of the UAV, and the design of the UGV structure. The propulsion system was chosen in the fall semester based on efficiency, thrust, and flight time requirements. The UAV chassis was developed prioritizing component safety, weight, and easy access of components in case quick replacement is necessary; and the motor mounts and landing gear were designed to withstand rough landing. Simultaneously, a base vehicle was selected for the UGV, after which the motor and gearing were replaced to limit vehicle speed to meet competition requirements. The UGV chassis was developed prioritizing component placement and easy access for quick replacement. The final UAV and UGV will compete in a competition where they will be judged based on four autonomous tasks. These tasks involve the UGV traveling along set paths at set speeds, along with UGVs from other universities, and the UTA UAV must identify and disable only adversary UGVs using a laser targeting system.

97 – Raytheon Technologies Unmanned Aircraft Systems University Innovation Showcase

Jaedyn Brown, Robert Carr, Ja'Lun Morris, Javier Lopez, Peral Iyayi
Advisor: Chris McMurrough
Computer Science and Engineering Department

This project is being undertaken in response to the growing demand for unmanned aircraft systems. As drones' capabilities increase, they are used in

a variety of applications, such as military operations, monitoring, surveillance, and recreation. Under the mentorship of Christopher McMurrough, the student computer science and engineering team will develop a drone that will demonstrate the capability of firing a laser at moving ground targets encountered during autonomous flight. By researching and developing software that allows for the full autonomy of airborne drones, the student CSE team will address the rapidly growing demand for autonomous aircraft systems. Coordination with electrical engineering, mechanical engineering, and aerospace engineering undergraduate students will be a key aspect of the development process. In addition to gaining a comprehensive understanding of drone technology throughout the project, students will be able to apply this research in various areas, such as disaster relief, land surveying, law enforcement, and military applications.

98 – Photogrammetry Drone for Damage Analysis

Jacqueline Hernandez, Humberto Lopez, Aliza Shrestha, Michael Falekulo and Cloe Kouadjo
Advisor: David Wetz
Electrical Engineering Department

In the aftermath of catastrophic events, such as hurricanes, tornados, floods, etc., the common course of action taken by insured home and property owners is to file insurance claims for their assets. Due to the hazardous conditions produced by these incidents, insurance claim services are often delayed or prolonged. However, in recent years, technological innovations have permitted the previously manned survey missions at post-disaster sites to shift focus onto the use of unmanned aerial vehicles, also known as drones. These drones have become an efficient alternative to the traditional damage assessment process carried out by the insurance industry through on-site surveyance conducted by personnel at post-disaster sites. The use of photogrammetry drones makes it possible to expedite insurance claim service while prioritizing the safety of company personnel. This is done by generating three-dimensional landscapes of the damaged assets that can be safely navigated for inspection. For this reason, State Farm has partnered with The University of Texas at Arlington to develop a drone capable of autonomously capturing images while actively avoiding obstacles along its flight path. The images will be compiled to produce the virtual landscapes previously mentioned and will be stored and managed in cloud-based storage.

99 – Disaster Drone – CSE Team

Faith Gutierrez, Asim Regmi, Danielle Pham, Pratik Dhakal, Carlos Sanchez and Mario Villatoro
Advisor: Chris McMurrough
Computer Science and Engineering Department

The goal of this project is to develop a cutting-edge system that utilizes drone, photogrammetry, and virtual reality (VR) technology to allow State Farm agents to remotely assess and process insurance claims for disaster scenarios. The autonomous drone will have object detection capabilities and will be deployed to the disaster area to capture images, which will be uploaded to the cloud for photogrammetry processing. The resulting 3D model will be rendered in a VR

environment, enabling the user to walk around and pinpoint specific locations of damage. This data will then be sent to a website where the agent can add text descriptions to each location. Lastly, the information will be compiled into a comprehensive document for filing an insurance claim. By streamlining the claim process, this technology will enable State Farm agents to quickly and efficiently assist their clients in times of need.

100 – Preventing Necrosis from CPAP Prongs in NICU Patients

Anjani Chavali, Sylvine Ineza, Elizabeth Rhodes and Cara Anderson
Advisor: Liping Tang
Bioengineering Department

The current clinical limitation of a CPAP machine, when used for premature babies and neonates, is skin necrosis and face deformation. The CPAP machine, which is respiratory support, consists of a mask and prongs that are interchangeable for providing airway pressure. However, the long-term use of these leads to the damage of tissues due to the material, a constant point of contact, and friction. Our team has worked to redesign the prongs with a specific angle that ensures better fit and reduces friction on the skin, thereby preventing skin necrosis. In addition, we propose coating it with Hyaluronic Acid-Hydrogel, which is expected to reduce skin irritation. Finally, we recommend silicon molding the prototype as this is a standard material for nasal tubules. The redesigned prongs also come with multiple attachments that vary in size so that the fit can be customized according to the baby. Also, this reduces waste significantly as only the attachment would be discarded in case of improper fit, in contrast to the disposal of the entire set of prongs.

101 – Lightweight, Wearable American Sign Language Translation Device

Cynthia Dominguez, Andy Vu, John Putegnat
Advisor: Oguz Yetkin
Bioengineering Department

Communication gaps between users of American Sign Language (ASL) and non-ASL users result in challenges for ASL users like poor medical experiences due to insufficient patient-doctor communication, higher unemployment, inadequate workplace accommodations, and reduced educational attainment. Our goal is to create a wearable device that translates 24 of 26 letters in the ASL alphabet with a minimum accuracy of 90%. It must be gloveless, portable, not use cameras, and not rely on external laptops for power or operation. To accomplish this, our design utilizes infrared light signals emitted from surface LEDs in a set of rings and wireless fingernail units worn by the signer. Each LED has a unique frequency generated by an oscillator, as well as a different light intensity depending on its position relative to the phototransistor receiving the signal. Phototransistors in the rings detect and transmit the LED signals to a wrist-worn CPU. An Arduino Due microcontroller performs Fast Fourier Transforms on the signals, then sends them to a Raspberry Pi that constructs and analyzes a light intensity matrix using a trained neural network. The neural network predicts the signed letter, then speaks and displays it using a speaker and LCD screen on the CPU unit.

102 – Occupational Health Monitoring and Alert System

Lauren Gomez, Jacie Aaron and Aaron Ly
Advisor: Baohong Yuan
Bioengineering Department

Firefighters are regularly exposed to occupational hazards, including serious health risks due to overheating and overexertion in the line of duty. However, the symptoms of these conditions are difficult to identify, and firefighter culture may discourage self-reporting symptoms. The most prominent causes of injury are overexertion and heat exhaustion. A large amount of heat exhaustion-related injuries occurring on the fire-ground, with others occurring at non-fire emergency incidents. A concerning amount of firefighter fatalities can be attributed to heart attacks caused by overexertion due to the intense strenuous work firefighters face on scene. The goal of this project is to design a system consisting of two devices that will monitor heart rate, oxygen saturation, and estimated core body temperature, equipped with LEDs and haptics for alerting when a firefighter is experiencing symptoms of heat exhaustion or overexertion. A wearable wrist device will provide all-day biometric monitoring with alerting. The second device will be retro-fitted to the helmet with sensor readings taken from the forehead. This design could provide department-wide, standardized biometric monitoring equipment so that all-day, on-duty insight on the health of every firefighter is known, preventing injury and circumventing the ability of firefighters to hide symptoms.

103 – SOMA: Electrolarynx Redefined

Kristen Leiker, Samuel Adedire and Kasra Kolyaei
Advisor: Justyn Jaworski
Bioengineering Department

Laryngectomy is a procedure that removes either part or the entirety of the larynx, typically because of cancer, resulting in an inability to speak. Three alternatives exist that allow the patient to speak again. Out of the three, one is outdated, the second is bulky and robotic, and the third is expensive and invasive. This project focuses on the second alternative called the electrolarynx. This project aims to create an electrolarynx-like device that allows the user to have a more realistic, personalized voice and return autonomy to the patient. The Bioengineering and Computer Science and Engineering Departments are collaborating to create a device and app to achieve this goal. Utilizing artificial intelligence, data will be recorded through the device and computed in the app to output a realistic voice. A realistic voice will allow the patient to more effectively communicate emotion and clarity.

104 – Air Bubble Sensor for ECMO Patients in PICU

Arisahi Rosas, Shreya Vyas and Ifejola Adebo
Advisor: Jun Liao
Bioengineering Department

Extracorporeal membrane oxygenation is known as ECMO. It relieves the strain on the heart and lungs by pumping and oxygenating a patient's blood outside of

the body. There are multiple sensors that are placed in the ECMO machine. One is a flow sensor, which is important because it indicates that blood is flowing in the correct direction. Other sensors include an air bubble sensor. This sensor is critical to detect air bubbles and prevent complications from air embolisms. However, at Cook Children's they do not use air bubble sensors. The goal of this project is to modify an air bubble sensor that is effective for detecting air bubbles in the ECMO machine and to introduce an air bubble sensor that can be used by Cook Children's. We are modifying an existing air bubble sensor to have specific alert systems. The air bubble sensor will have three different ways to alert the nurse that there is air in the circuit. The first alert system is a flickering light. Next, the nurse will receive the warning through email. Lastly, it will have a beeping that is delayed. We will conduct several tests to make sure our sensor's features are functioning properly.

105 – Develop 3D Image Reconstruction and 3D Printing Protocols and Post-Processing Toolkit for Atrial Septal Defect Surgical Planning

Kayla Meyers, Savier Vega Siurano and Khadija Shirwa
Advisor: Jun Liao
Bioengineering Department

Atrial septal defect in the heart requires in-heart surgery that surgeons need to effectively plan for. Currently, they use heart models that are 3D printed whole, but they don't have the proper post-process cleaning tools to remove the support structures from the heart model without drilling a hole at the bottom to reach the small gaps inside, making their surgical planning models not optimal. For our design, we utilized a child atrial septal defect and a normal child heart to 3D-reconstruct the heart models in ScanIP using CT images and 3D-printed the models whole in ninjaflex material. Additionally, we designed and 3D-printed a smaller set of tools that would effectively post-process clean the heart model while keeping it intact. We utilized ABS plastic tips and metal tips with different shapes to effectively clean every part of the model.

106 – VR+EMG

Jane Cho, Michael Hopper, Nicholas Parrill, Luke Howard and Cody Reynolds
Advisor: VP Nguyen
Computer Science and Engineering Department

Render facial expressions using EMG sensors on a VR mask

107 – Medi ID

Christian Blundell, Ivan Chu, Ahamad Natsheh, Mahmoud Natsheh and Alex Stringer
Advisor: Shawn Gieser
Computer Science and Engineering Department

Medi ID is a bracelet with an NFC tag built into the bracelet that stores the user's medical information. This is useful for first responders that give aid to a person who is physically unable to document their medical information. A verified EMT or first responder can scan the bracelet and use the Medi ID progressive

web application to view that person's medical background and insurance information. Access to this information can be crucial and potentially life-saving for a person who is in an emergency situation.

108 – Park Ranger Hologram

Hoang Pham, Felipe Espinoza, Darl Santos, Trevor Therrien and Cameron Chilcoat
Advisor: Shawn Gieser
Computer Science and Engineering Department

The Park Ranger Hologram is a device that projects videos or presentation content regarding the park onto a holographic display. Its goal is to reduce the need for the presence of a park ranger around the exhibit hall. It enables visitors to interact with the presentation and navigate videos by pressing different buttons. The Park Ranger Hologram consists of a projector, an acrylic screen, and a Raspberry Pi to control the projector and buttons. They will be mounted to an enclosure system using some other supported materials. In terms of software, there will be two applications: configuration and hologram. The Park Ranger Hologram has some particular requirements. The most critical one is the performance requirement. It should be able to respond steadily to the pressing button event. The system also needs to ensure the quality of the audio and the video being projected onto the screen. Safety requirements are also an important aspect that we need to consider. We need to make sure the brightness of the projector's light cannot cause any eye damage when visitors look at the screen. Likely, the hologram should be well-built to be stable when functioning.

109 – FishQuest

Kevin Phan, William Sigala, Mohammed Zakiuddin, Brandon Stibich and Othman Kamel
Advisor: Shawn Gieser
Computer Science and Engineering Department

FishQuest is a mobile application for iOS and Android platforms and aims to enhance the traditional fishing experience. FishQuest contains several features to achieve this goal such as a catch logger equipped with machine learning to identify fish species, social media features so that users can share their catches, a map that plots the location of catches, and a missions feature that generates fishing-related missions.

110 – Corps Catch

Ouwaseetofunmi Komolafe, Kevin Le, Bijan Saud, Kouassi Brou and Jianliang Liu
Advisor: Shawn Gieser
Computer Science and Engineering Department

The Corps Catch application would make exploring the outdoor trails in a Corps facility more fun. Its goal, to provide entertainment and education to its users, is achieved by asking increasingly difficult questions based on the current subject of choice during the hiking trail. When enough questions are answered correctly and the player gains sufficient experience points, they are awarded a digital Corps Coin which they can view in their collection. This reward system is based on the actual coins that outstanding personnel receive in the Corps. The aim is to collect as many coins as possible along the hiking trail by answering questions correctly. This application is designed for families and visitors at Corps Trail facilities. Questions would be roughly grouped by age so that the game is not too easy for older players but is still challenging for younger players.

111 – VR Park Tour

Veena Venugopal, Amna Syed, Stephanie Nguyen, Anthony Nguyen and Payton Parrish
Advisor: Shawn Gieser
Computer Science and Engineering Department

VR Park Tour application will provide a platform for virtual interactive tours of the thirteen park locations maintained by the US Army Corps of Engineers (USACE). The app will have two modes of usage available. The first one will be a basic mode (static tour) which would allow the user to experience a 360◦ view of the park location chosen. The second one will be an interactive mode where the system would provide the user with a virtual reality interactive experience by making use of additional gadgets like a VR headset, joy-cons, etc. This app will have its full functionality available in the presence of an active internet connection. Offline uses will be mostly focused on the basic mode. The app can be used at USACE park locations and beyond. The application will also provide functionalities to add future 360 videos to the static viewing experience.

112 – Interactive Living Stream

Louis Rowena Vuppula, Cherryl Maria Bibin, Yuvaram Devarajulu, George Mitchell and Garrett Shimek
Advisor: Shawn Gieser
Computer Science and Engineering Department

The Interactive Living Stream product is a system that utilizes augmented reality to implement a virtual stream at national parks. This product allows users to experience the beauty of the national parks in a more accessible indoor environment. The goal of this service is to allow individuals who are unable to visit national parks an easily approachable experience that can replicate the national parks in a meaningful way. This product promotes educating people on the aquatic wildlife in streams of the national parks by making the sites accessible and provides the opportunity to experience nature. This product also displays the native aquatic wildlife within the experience so that users can see an accurate representation of the local ecosystem in motion. By displaying a realistic environment, this system also promotes education on the local environment, providing accessible opportunities to experience nature and local wildlife.

113 – Smart Planter

Kevin Flores, Samuel Ruiz, Don Bui, Luis Jaen and Samrat Baral
Advisor: Shawn Gieser
Computer Science and Engineering Department

The Smart Planter is a self-watering plant pot that removes the consistent maintenance required in watering a house plant on your own. The Smart Planter is able to monitor the plant's environment by measuring the amount of soil moisture, humidity, temperature, and light exposure. The provided Smart Planter phone application will allow users to observe the data of their plant(s) wherever they are and even be notified when the water tank is low on water. The pot will also have an LCD screen in the front displaying the data of the plant like on the phone for ease of use when near the pot.

114 – Privacy Preserving Expression Recognition for VR

Cody Reynolds, Luke Howard, Nicholas Parrill, Jane Cho and Michael Hopper
Advisor: Shawn Gieser
Computer Science and Engineering Department

Detecting a person's facial expression is important for a number of reasons, but current methods for observing and analyzing facial expressions have limitations both in efficacy and privacy. Cameras are the current leading method of tracking expression, but can be thrown off by objects on the face, especially VR headsets. They also require the user to be constantly looking directly into a camera for them to operate effectively, which can cause concern for users. We wish to use other methods of sensing facial expressions that integrate well with VR headsets. The main focus of this project is furthering technology for detecting expressions and changes in expressions, as it is very difficult to do so, then use the developed technology to render the corresponding emotion to show how the sensor can be applied to software. The sensors we are working with consist primarily of electromyography (EMG) sensors, which detect muscle contractions by the electrical signals muscles emit, as well as Inertial Measurement Units (IMU), which capture acceleration and rotational data.

115 – Sign Translation

Alexander Rios, Mark Thomasson, Stephen Gill and Tommy Ngo
Advisor: Shawn Gieser
Computer Science and Engineering Department

The Sign Translation Project allows U.S. Army Corps of Engineers (USACE) park visitors to translate park signs, particularly the ones showcasing safety, to any language they feel comfortable in reading. To achieve this, we will utilize QR codes on the boards themselves to link to our website that will host all translated versions of the specific sign in the user's chosen language. The goal of this project is to help non-English speaking visitors in the United States to safely navigate USACE parks.

116 – LateLess

Matthew McNatt, Colby Wyrick, Trieu Nguyen, Nghia Lam and Gia Dao Duy Duc
Advisor: Shawn Gieser
Computer Science and Engineering Department

There is a diverse set of cultures, ideologies, and issues surrounding the time of arrival to events of both formal and informal nature. With the development of public roads unable to keep up with the rapid growth of rush hour commuting, and the presence of multiple global standards for what is and is not acceptably late concerning both time and cause, thousands of hours of time are wasted waiting on people that are late to events or setting up analog systems of attendance that often single out the unlucky commuter. By creating a robust UI and adaptable back end of an application for real time updates that links to a road navigation-based API, a solution to all the problems in this set is possible. LateLess is a cross platform mobile application that allows users to create events with attendees from their friended account list, and then track the location of those attendees once the actual time of the event is close. This system should eliminate ambiguity from expected arrival times as well as provide clarity and accountability to actual arrival times.

117 – Mail Thieves

Sakchi Shrestha, Luke Sweeney, Erick Acevedo, Khanh Le and Andrew Dosch
Advisor: Shawn Gieser
Computer Science and Engineering Department

Mailbox Mod Kit allows people to have a secure way to protect their mailbox with a low-cost product. It allows the user to check the contents of their mailbox at the click of a button regardless of the weather conditions. Additionally, the product will take pictures or a short recording of the mailbox's interior, allowing customers to save the records for future proof in the case of filing a claim.

118 – Spanish Language Learning App

Shrishti Nag, Timothy Ninh, Mohammad Elsaad, Prabesh Humagain and Anthony Jackson
Advisor: Chris Conly
Computer Science and Engineering Department

The mobile application is specified for high school students who are trying to learn Spanish. The sponsors of the mobile application want to build an engaging game-featured learning application where students level up within a certain time.

119 – SOMA: Electrolarynx Redesigned

Noor Alyasiri, Prabin Lamicchane, Shivam Patel, Amy Le, Nancy Mathew and Sydney Swayzer
Advisor: Chris McMurrough
Computer Science and Engineering Department

SOMA is an electrolarynx device paired with a mobile application that empowers laryngectomy patients to communicate confidently and improve their

quality of life. These patients often lose their ability to speak due to head and neck cancer or neurodegenerative diseases such as ALS. Existing electrolarynxes emit a robotic-sounding single pitch and amplitude sound, which can be difficult for patients to adjust to and embrace. SOMA, on the other hand, is designed to output speech that closely resembles the patient's original voice by using state-of-the-art machine learning algorithms to preserve the original sound quality. The mobile application offers various features, including BLE connectivity to check the battery life and to turn the device on and off. Users can also authenticate their accounts, access a vocal indicator, adjust volume and pitch, and use a text-to-speech converter independently of the device's connection to the application. This project aims to provide an effective and user-friendly solution to help laryngectomy patients communicate and regain their independence.

120 – Sawyer Robotic Arm Rubik's Cube Solver

Ethan Chase, Jair Lopez, Bridget Gregory, Jonathan Medina and Carolyn Nguyen
Advisor: Chris McMurrough
Computer Science and Engineering Department

A senior design project aiming at creating a demo using the Sawyer Robotic Arm for outreach purposes.

121 – Vision: IR Blaster

Anthony Gamon, Eduardo Martinez, Andrea Marquez, Caleb Hebb and Edwin Martinez
Advisor: Chris McMurrough
Computer Science and Engineering Department

Our product boils down to 2 distinct items: the physical IR Blaster itself, and the software that will manage it and parse user commands. The IR Blaster device will be able to wirelessly receive signals that will tell it what command to send via an IR signal. The IR Blaster will be powered by batteries therefore there will be no external cables running. This device will be placed in a static location in a room that can point to multiple IR compatible devices. The software portion will work as both a database (storing the rooms of the house, what IR blasters are in each room, and what devices each IR blaster can control) and a server (allowing users to send HTTP commands they want to reach a certain device wireless through the IR blaster, as well as providing a User Interface that will allow for greater ease of access).

122 – ARGOOSE - Counter Drone System

James Grumbles, Sanyogita Piya, Augustine Nguyen, Mahin Roddur and Nirdesh Sakh
Advisor: Chris McMurrough
Computer Science and Engineering Department

ARGOOSE is a system that performs drone detection via sensors. Users of ARGOOSE will be able to set up a perimeter detection zone and receive information on detected drones within the area of operation. The ARGOOSE system detects drones and sends back information on detected drones to users. System is designed to perform in an open space with 360° camera detection.

The system is designed to address general drone safety concerns. By providing feedback on drones located in the area, customers can be informed of drone behavior around sensitive locations.

123 – RV Vacation Rest Stop Suggestion System

Prithvidhar Pudu, Rohan Bankala, Akash Balu, Joseph Shadrick, Quynh Nguyen and Kha Do
Advisor: Chris McMurrough
Computer Science and Engineering Department

This application allows end-users to visualize and select suggested rest stop locations after selecting a starting location for their RV trip. The user can then choose one of the five suggested locations. These locations will be visualized to allow users to gauge their exact location relative to their RV trip path. The rest stops will be suggested using a machine-learning model.

124 – Wardriving Drone

Antonio Yep, Gerald Kimeu, Christopher Smith and Gabriel De Sa
Advisor: Chris McMurrough
Computer Science and Engineering Department

Elbit Systems of America has sponsored our team to develop and show that "wardriving", or searching for and logging Wi-Fi wireless networks, can be done with using commercial off-the-shelf hardware and software. Our project will consist of a drone with an on-board companion computer and a flight controller to scout wireless access points in an area. A command center GUI will be used to provide users the drone status, a map fixed on the drone and the wireless access points it found, and a console to input commands.

125 – Intelligent Ground Vehicle

Caleb Rivera, Shreya Bhatta, Ethan Jobe and Brian Quintero
Advisor: Chris McMurrough
Computer Science and Engineering Department

Our team will construct an intelligent ground vehicle that is able to compete in the Intelligent Ground Vehicle Competition. The Maverick Machine purpose is to maneuver through a course while avoiding obstacles all by itself. Therefore, the team has decided to use an electric wheelchair as the base of the Maverick Machine. Then the team will add features to the vehicle which include a camera, LiDAR and other object detection sensors if needed. Additionally, a computer must be added to the vehicle to compute all the inputs from the sensors and to move the motors of the electric wheelchair. Thus, software development is needed to tie everything together and make the Maverick Machine capable of navigating through the course during the competition. As a result, it will allow our team to exhibit our skills and provide an overview of the Computer Science and Engineering Department at The University of Texas at Arlington.

126 – Ecosphere

Tim Tran, Colton Sustaita-Robb, Richard Nguyen, George Vo and Dylan Dinh
Advisor: Chris McMurrough
Computer Science and Engineering Department

A 3D rogue-like adventure game. The player will advance through multiple biomes and enemy types, all the while gaining strength and abilities. The player will periodically gain new random abilities and will use their randomized abilities to create new methods of fighting each playthrough.

127 – Checkers-Playing UR5 Co-Bot

Nimita Uprety, Hoang Ho, Joanna Huynh, Patricia Rojas and Kevin Vu
Advisor: Chris McMurrough
Computer Science and Engineering Department

The UR5 co-bot will be programmed to be able to play the interactive and strategy-based game, checkers, against a human opponent. The robot will have an electro-permanent magnetic attachment that will allow it to pick up and move the individual checkers pieces. The robot is not intended to beat the human opponent every time but rather just has the ability to play a full game of checkers against them. Our project aims to showcase the UR5 co-bot's abilities as a means of promoting the UT Arlington College of Engineering to prospective students through the means of an interactive demonstration.

128 – RV8 Work Cell Safety and Control Integration

Sao Nguyen, Gaurie Sharma, Ana Monter Diaz, Shebin Skaria and David Reichert
Advisor: Chris McMurrough
Computer Science and Engineering Department

This project presents the integration of a robot arm and work cell safety features to ensure the safety of human workers in manufacturing environments. The work cell safety features include light curtains, performance light, and emergency stops that are designed to detect and prevent potential hazards. The work cell is equipped with sensors that detect the presence of humans and stop the robot's movement to stop or slow the robot movement. The integration of these safety features with the robot arm allows for a safe and efficient work environment. The project describes the design and implementation of the safety features, and the results of the testing and evaluation of the integrated system. The results show that the integrated system effectively prevents accidents and improves the overall safety of the work cell. The project concludes with a result of the potential applications of the integrated system in various manufacturing environments.

129 – Social Work VET-SAVR

Javier Gamez, Ayden Fisher, Gabriel Thibodeaux, Kenan Saglik and Evan Guinn
Advisor: Chris Conly
Computer Science and Engineering Department

There is a critical need to train human service professionals undertaking the online graduate military certificate program to provide clinical services to rural veterans at heightened risk of mental health disorders and suicide. Although virtual reality (VR) has the potential to address many limitations of current online training, no commercially available VR training tools designed to deliver field training to future human services professionals exist. Therefore, this research aims to develop a prototypical immersive VR experience of a mental health team's home visit to a rural veteran that will provide graduate students enrolled in the military certificate program with an opportunity to identify environmental indicators of risk factors for veteran suicide during a home visit, similar to one conducted by a rural mental health team. The proposed research is based on the analysis, design, and development phases of the 5-phase ADDIE Model. A focus group with human services professionals who serve rural veterans will inform the design of a VR rural veteran home visit simulation that will be loaded on a headmounted display. The VR prototype will then be tested with five rural veteran experts and five graduate students in the military certificate program for representativeness and usability.

130 – Electric Drivetrain Design

Carlos Carbajal, Angel Valero, Stephanie Munoz, Timmy Nguyen, Alex Santillan and Darshan Bohara
Advisor: Yawen Wang
Mechanical and Aerospace Engineering Department

The project first consisted of modeling and designing a two stage helical gear reduction system for a typical electric vehicle. A CAD model was used to perform static and dynamic analysis in order to determine the models performance. Along with this original design, a CAD model of a physical testing rig was generated in order to do a side by side comparison of the models performances. This will allow for optimization of the original though that is not the focus of the project. The testing rig mentioned is used to simulate defective components such as gears with missing, cracked, or scored teeth as well as defective bearings. The data obtained consists of acoustic and vibrational samples. The data was processed, filtered, and then analyzed. The purpose of these efforts is to identify the types of acoustic and vibrational correlations that exist for specific failure modes.

131 – Soundproofing of Autonomous Vehicles

Ross Everett, Bret Johnson, Grant Roney, Fernando Alejandre, Nicholas McDonald and Amir Yonan
Advisor: Yawen Wang
Mechanical and Aerospace Engineering Department

The computing superstructure necessary for self-driving cars to function presents a unique acoustics problem – the fans produce a significant amount of noise within the cabin that is uncomfortable for passengers. To ensure consumer comfort and promote widespread adoption of the technology, the JERAMY Acoustic Solutions (JAS) Senior Design team will produce a sound dampening solution for May Mobility. The solution cannot compromise the ability of the computer to function, meaning that air flow capabilities must be preserved. In the first semester, JAS created testing procedures to identify the sound profile of May Mobility's Toyota Sienna. After identifying the frequency range and intensity of the fan noise within the cabin, JAS selected three promising sound dampening materials: cork, closed-cell neoprene foam, and open-cell charcoal foam. JAS will test varying configurations of these materials to determine the most effective solution. These materials will be applied to sound dampening structures situated strategically around the computing superstructure to achieve noticeable sound dampening.

132 – Indoor Mapping Robot

Nicholas Vu, Pum Thang, Cesar Ceballos, Issah Pierre and Duy Nguyen
Advisor: Brian Huff
Mechanical and Aerospace Engineering Department

Building Information Models (BIM) are used to manage multidisciplinary data of a building's construction and operation to optimize coordination and production. Current methods of obtaining measurements, dimensions, and photographs of buildings that are used for the creation of BIM are manually done by a person. Starting with a mobile platform, an indoor mapping robot will autonomously maneuver throughout a building and use sensors and cameras to capture point cloud data and location-tagged photos of the environment. The scans will be processed into a 3D model of the building which can be used to streamline the BIM creating process and the photos can be integrated into a website capable of giving a virtual tour of the building.

133 – FIR Measuring Temperature at a Distance

Colton Weber, Gabriel Chavira, Laura Hernandez, Raul Melendez and Matthew Wallace
Advisor: Raul Fernandez
Mechanical and Aerospace Engineering Department

The FIR Measuring Temperature at a Distance Senior Design project was charged with the task to help prevent heatstroke in fire fighters. The goal was to design a device to measure the temperature of an area from a safe distance. This was to ensure that a fire fighter is not exposed to extreme temperatures that could reach the flash point of the suits they wear. The project began with creating list of specifications and then designing a model to suit these specifications. The design chosen to suit this task was a telescoping set of cylinders that, when triggered, would extend five feet and read the temperature. Based on the temperature an alarm will sound notifying the fire fighter if the area is safe to work in. Finite testing was performed, and a prototype was built and tested. Through testing it was found that the trigger mechanism would not work. A new design was created using a better trigger and retention mechanism. After manufacturing, testing was performed on the device. Adjustments were made as needed. The final product was then presented to the UTA Mechanical and Aerospace Engineering Department and the Arlington Fire Department.

134 – Mooring CAM

Muid Khan, Mikaela Leevy, Andrew McConnell, Jonathan Kroll and Mostapha Khazem
Advisor: Raul Fernandez
Mechanical and Aerospace Engineering Department

Mooring for the millions of boats in the Scandinavian Fjords is extremely risky with what is currently available on the market: the objective is to create a mooring tool based on the preexisting rock-climbing cams to allow for mooring to rocky shores and rock faces. The Maritime Group will focus on adapting the cam to meet maritime conditions: adjusting for dynamic loading of a boat on waves with wind speeds up to 10 m/s, a higher durability/lifespan in a saltwater environment, and cutting down on manufacturing costs to competitive levels. The cams should be priced at around $80-$100 and take between $30-$40 to manufacture on a per unit base. Deliverables by the end of this project will include a working prototype, a design package, and a cost analysis of the mooring cam.

135 – Surgical Surface Scanner

Alec Wilhoite, Lazaro Razo, Aman Koirala and Ruben Abraham
Advisor: Raul Fernandez
Mechanical and Aerospace Engineering Department

Our team was contracted by Medtronic to design and deliver a platform that integrates a surface scanner with their 5 degree of freedom robotic arm to scan a bone sample and automatically pilot the robot make cuts across the bone's surface for the sake of stress testing their proprietary surgical drills.

136 – ASHRAE 2023 Design Competition

Donovan Allen, Rejin Adhikari, Jonathon Castiglione, Joseph Conti and Raymond Cui
Advisor: Raul Fernandez
Mechanical and Aerospace Engineering Department

Mav A/C has been tasked with creating a mechanical system to meet the needs of a laboratory building in Cairo, Egypt for the 2023 ASHRAE Design competition. Of the three competition categories, Mav A/C chose to compete in the HVAC Design Calculations category. This category requires a correctly sized heating, ventilation, and air conditioning system to be developed. Using ASHRAE Standards 55, 62.1, and 90.1, Mav A/C will use a variety of rooftop

units (RTUs), dedicated outdoor air systems (DOAS), and split systems to heat, cool, and ventilate the building. Special accommodations were made for the laboratory spaces in terms of air changes per hour (ACH), pressurization, and air recirculation in accordance with ASHRAE's Classification of Laboratory Ventilation Design Levels and Laboratory Design Guide. Throughout the project, occupant comfort and system efficiency were evaluated to ensure that the mechanical system meets all owner requirements while minimizing environmental impact in terms of electrical consumption and carbon emissions.

137 – 4WD FSAE Electric Racecar

Mohammadkian Mahroumi, Dung Ho, Alfonso Sanchez, Thevnin Rumende, Andrew Nguyen and Hung Trinh
Advisor: Bob Woods
Mechanical and Aerospace Engineering Department

Due to the benefits of an electric four-wheel-drive platform over the combustion alternatives, the UTA FSAE Team wishes to integrate this technology into their race cars. Our team performed research, analysis and designed multiple components to compose a package that can reliably replace the current internal combustion powertrain on the FSAE racecar. The powertrain is composed of a frameless electric motor and a planetary gear box to reduce the output speed of the motor to a usable speed at the wheel. This requires a new upright to be designed that houses the gearbox within the hub and mounts the motor. The packaging also includes a water-cooled housing for the frameless motor, a cooling system, hub, bearings, brake setup and various smaller provisions to ensure reliability and serviceability of the system. This package is designed with a space constraint of a 10-inch wheel inner diameter in mind and must clear all the suspension arms. The racecar will be powered by four in-wheel motors to allow for torque vectoring and maximum traction off the line. This package will create a balance of efficiency and performance for the four-wheel-drive electric racecar.

138 – 3D Printed Fixed Wing Aircraft

Christian Do, Javier Hernandez, Ezekiel Flores and Nathan Lin
Advisor: Robert Taylor
Mechanical and Aerospace Engineering Department

The 3D aircraft competition was fabricated for a team to use Aerospace and mechanical engineering knowledge to design, develop, and build a 3D printed aircraft while following a specific set of criteria. The Aviators team is comprised of Mechanical Engineering students that will use their acquired knowledge gathered from the previous semesters to finalize and deliver the completed product. The product will compete for the longest duration of flight as well as for the most innovative design within the competition. An overall successful project will consist of a 3D printed fixed-wing aircraft capable of flying for more than 15 seconds with the allowed option of 8 seconds of power. The Aviators team will use an engineering approach following specific steps to determine the best methods to achieve the objective of a successful flight.

139 – 3D Printed Aircraft Competition

Andrew Tran, Ethan Pham, Kevin Tran and Cedric Zandjio
Advisor: Robert Taylor
Mechanical and Aerospace Engineering Department

Our team is taking part in the UTA 3D Printed Aircraft competition, where we will be tasked with designing, implementing and manufacturing a 3D printed fixed wing aircraft using commercial off-the-shelf propellers and rotors. To meet the competition's requirements, all structural components of the aircraft must be 3D printed using extrusion printing, with the exception of certain mechanical parts. The aircraft will be powered for up to 8 seconds, after which it must glide for as long as possible within the designated flight volume. We will be researching and optimizing various aspects of the aircraft's design, including glide ratio, sink rate, and maneuverability, which will impact the airfoil shape, wingspan, and fuselage size. The focus will also be on optimizing the aircraft's weight to ensure proper lift and flight while maintaining structural integrity. Through analyses and 3D printing techniques, we will create an aircraft with optimal structural and aerodynamic properties, using braces and supports to maintain stiffness during flight.

140 – 3D Printed Aircraft Competition

Adrian Gonzales, Joshua Hatton, Nicholas Caballero, Raymond Fisk and Viet-Long Truong
Advisor: Robert Taylor
Mechanical and Aerospace Engineering Department

The 7th annual 3D Printed Aircraft Competition will be hosted by The University of Texas at Arlington on July 8 at Maverick Stadium. Team Pegasus will be entering this competition with the objective being to design, build, and fly a 3D printed aircraft in the fixed wing category of the competition. The team will be improving upon a previous design based off an AeroVironment RQ-11 Raven UAV. With the competition rules permitting only 8 seconds of propulsion and the restriction of staying within the boundaries of a football field, Pegasus will achieve a minimum controlled glide time of 15 seconds before the aircraft touches the ground. The HP MultiJet Fusion 3D printer and the Markforged composite printer will be utilized to manufacture the airframe structures. Commercial off-the-shelf hardware will be used for propulsion and flight controls of the aircraft. This project is a multi-semester effort. In the fall semester, structural analysis and design modifications were completed. For the spring semester, Pegasus will assemble a prototype to perform flight testing and update the aircraft design accordingly, so that a finalized aircraft can be delivered in May.

141 – DFW International Airport Skylink Demand Prediction

Philip Adams and TJ Nguyen
Advisor: Jamie Rogers
Industrial, Mechanical and Systems Engineering Department

Passengers who fly through Dallas-Fort Worth (DFW) International Airport are prone to experience gate changes while in the airport, arrive on the landside at a

terminal that is not where their flight is, or have a connecting flight in a terminal different from where they arrived when landing. This is due to DFW Airport being the fourth-largest international airport in the United States with high passenger flow that affects the airport's ability to allocate gates to airlines and thus results in frequent gate changes. Passengers are then required to switch to another terminal using either the Terminal Link shuttles on the landside or more commonly the Skylink train system on the airside. However, the Skylink suffers from issues of overheating during the day and overcapacity resulting in longer wait times for passengers. The aforementioned issues at hand are due to the airport not having an accurate demand-tracking system in place or a demand-prediction logic to help optimize Skylink processes for the passengers.

142 – UT Southwestern Streamlining Rehabilitation Intake Process

Sarah Marshall, Emma Leidlein, Devon Stapleton and Cindy Cruz-Rodriguez
Advisor: Jamie Rogers
Industrial, Mechanical and Systems Engineering Department

UT Southwestern Rehabilitation Center must be compliant to the rules set by the Medicare Administrative Contractor (MAC) as a public entity. The challenge is the admission process for patients with private insurance into the Rehabilitation Center. The rehab unit has 32 beds available and 30% of beds are allocated for private insurance patients. Private insurance patients are reviewed based on internal and external referrals and admitted at 8:00 a.m. everyday based on a utilization rate provided by the nursing staff which is updated twice a day. A focus on private insurance patients with external referrals allows an opportunity to streamline, document, and track the availability of beds to ensure treatment is available for patients who meet the criteria.

143 – Improving the Receiving Process at Siemens Energy and Automation Inc.

Edson Ibarra, Lesly Salazar, Aicha Ergaibi and Aaron Delk
Advisor: Jamie Rogers
Industrial, Mechanical and Systems Engineering Department

Siemens' Grand Prairie plant focuses on low/medium voltage power distribution systems, industrial applications, breakers and power panels. We are working with Siemens Energy and Automation Inc. on one of their current projects involving their receiving area. The issue we are trying to resolve is lack of sufficient storage space in the receiving area, which is causing a cluttered workspace, slowing the unloading and receiving processes and creating excess inventory. Our goal for this project is to optimize the space and find a way to make the receiving process more organized to prevent the space from being congested with unnecessary materials. Our group will use the DMAIC methodology to analyze and improve the current layout and implement 5S to allocate more space.

144 – Improve Surface Mounted Technology Manufacturing Line

Diana Garbe, Anh Nguyen, Suleiman Khan and Rujan Upreti
Advisor: Jamie Rogers
Industrial, Mechanical and Systems Engineering Department

The Surface Mounted Technology manufacturing line at the National Circuit Assembly takes great pride in thoroughly inspecting each circuit board manufactured to ensure the highest quality of its products. There are multiple points throughout the manufacturing process where inspections are taking place and we plan to identify redundant or unnecessary inspection steps. Through the introduction of new inspection technology and/or standardization of the existing quality audit, we plan to improve the cycle time by 25%.

145 – Rehrig Pacific "Smart Qualify" Process Retooling

Chris McKelvain, Steven Childs and Alan Rodriguez
Advisor: Jamie Rogers
Industrial, Mechanical and Systems Engineering Department

Rehrig Pacific Company is a leading manufacturer of reusable plastic containers such as stackable pallets, crates and bins. Rehrig Pacific Company has a process called "Smart Qualify", which is a process for providing a solution for customers' Rehrig products based on their specific needs. The current "Smart Qualify" process is tedious. Our objective is to improve the cycle time by 30% for this process.

146 – Production Capacity Improvement at Dollamur Sport Surfaces

Benjamin Roesch, Natalia Alza and Lisette Gutierrez
Advisor: Jamie Rogers
Industrial, Mechanical and Systems Engineering Department

Over the last year, Dollamur Sport Surfaces' annual revenue increased from $25 million to $30 million, and they expect to reach $40 million in the coming year. Their production has been unable to keep up with this growth, resulting in a $10 million backlog of orders. In December 2022, the company moved their production into a new larger facility to provide room to expand and increase their production capacity, but so far this has only provided minimal improvements. The backlog of orders has persisted because the throughput of their facility is restricted by the current production line. This line consists of a production laminator, a saw table, and a waterjet. Nearly all product lines must be processed through this line before moving on to downstream processes. Due to the product variety and lengthy setups associated with that variety, the line does not run very efficiently. Furthermore, the line is currently the bottleneck of the whole facility, limiting the total throughput. The objective of the project is to determine how to integrate a second production line to increase the overall throughput of the system by at least 20%.

147 – Reduction in 3D Printing Queues by Streamlining Data Collection and Retrieval

John Pointer, Pradhyumna Markale, Haoyang Song and Zachery Ruggles
Advisor: Jamie Rogers
Industrial, Mechanical and Systems Engineering Department

The UTA Library system offers a state-of-the-art makerspace to students and faculty alike. The makerspace, named The FabLab, is run by student employees who assist learners with both research and personal projects. The most utilized service offered in the FabLab is 3D printing. The focus of this project is to streamline the 3D printing process by building an innovative tool that will minimize the time spent going though the steps involved in the data collection and retrieval process. Student employees are tasked with an unnecessarily complicated process of collecting learner data, slicing and storing their design files, retrieving said files, starting and storing prints, and finally contacting the learner for pick up and payment. With only twelve operational 3D printers and dozens of different projects being printed during midterms and finals, a large wait queue always occurs. Student employees are also faced with not always having the option to turn down prints they believe may fail then attempting to rectify them if they do, which exacerbates the queue times for learners. Improvements made will lead to improved throughput through the system and a reduction in incoming and outgoing variability in setup and takedown times.

148 – 576W DC-DC LLC Resonant Power Converter

Brenda Rodriguez, David Ray, Prasath Balasundari and Justin Yurillo
Advisor: David Wetz
Electrical Engineering Department

In partnership with Elbit Systems, our team is required to design a resonant power converter to step down 150 VDC to 48 VDC with a current of about 12 A. The project requires the use of TINA and SPICE simulations, prototyping, an Excel sheet that can calculate circuit component values from various input voltages and currents, and a constructed final build of the project. Our project sections out the converter's main functions into an MSP432 microprocessor for the control of switching frequency, a half bridge inverter, an LLC resonant tank with a center-tapped transformer, and a full bridge rectifier. With our use of high frequencies, we want to maintain the highest efficiency possible, so operating at resonant frequency and using zero voltage switching not only minimizes switching losses but also allows us to maintain that high efficiency.

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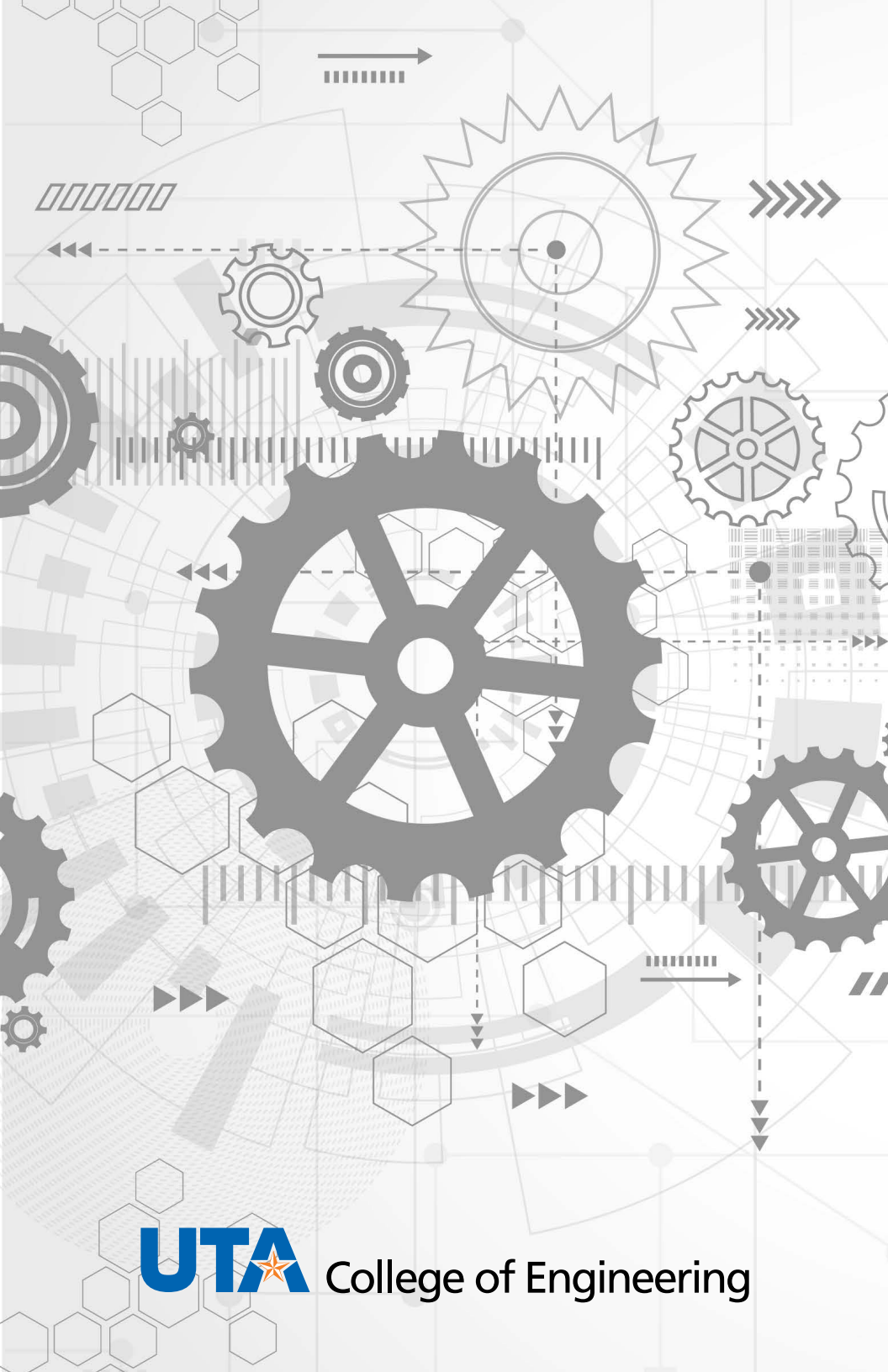
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