FRESNO STATE ENGINEERING 100 1922 - 2022

FRESNO STATE
Lyles College of Engineering

17TH ANNUAL

PROJECTS DAY

RESEARCH
INNOVATION
DESIGN

MAY 1, 2024
2 to 6 p.m.

STUDENT RECREATION CENTER







Free admission and open to the public

engineering.fresnostate.edu

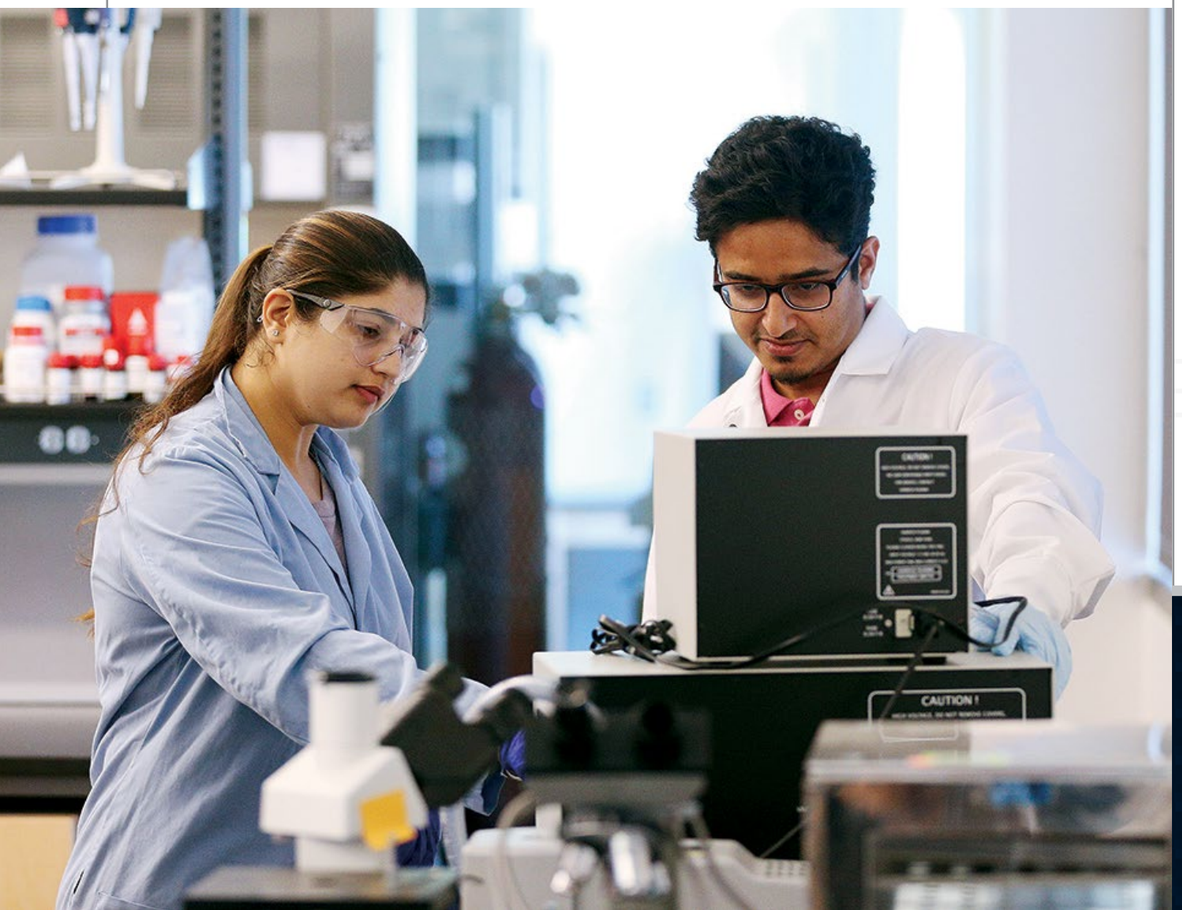
WELCOME ATTENDEES!

Thank you for attending Lyles College of Engineering's 17th Annual Projects Day. It is an honor and privilege for our students to showcase their hard work and innovative designs to the community.

The projects showcased are a culmination of at least one year of research and design activities in the disciplines of civil, computer, electrical, geomatics, and mechanical engineering as well as architectural studies and construction management. Student projects are supported by Lyles College faculty advisors, staff and industry liaisons and are funded by internal and external grants, companies and students. Thank you to the numerous industry professionals for their generous gift of time and mentorship.

Please, enjoy the showcase.

Dr. Ram Nunna
Dean, Lyles College of Engineering
Fresno State



17TH ANNUAL PROJECTS DAY

RESEARCH • INNOVATION • DESIGN

Projects Day Coordinator
Hernan Maldonado
Director of Pathways Student Services

Communications Coordinator
Yesenia Fuentes

CONTENTS:

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ARCHITECTURAL STUDIES AND CONSTRUCTION MANAGEMENT

1 Inspection Technologies for Construction and Maintenance of Highway Infrastructure – Review and Analysis

Student: **Prem Raj Timilsena**
Advisor/Mentor: **Dr. Manideep Tummalapudi**

Project Summary: One of the primary objectives of the Federal Highway Administration (FHWA) and state departments of transportation (DOTs) is to provide high-quality infrastructure that meets or exceeds the desired quality standards. Efficient inspection practices play an important role in achieving this objective as they ensure conformance with plans, specifications, and quality standards. In this digital age, state DOTs are relying on emerging technologies to improve inspection practices. However, there is limited knowledge available regarding various emerging technologies used for highway infrastructure construction and maintenance inspection. The goal of this study is to identify various emerging technologies that are implemented at the state DOTs and their uses/applications for various inspection purposes. The emerging technologies studied in this project include Remote Sensing and Monitoring Technologies - Unmanned Aerial Systems (UASs) and Light Detection and Ranging (LiDAR), Building Information Modelling (BIM), and Augmented Reality and Virtual Reality (AR/VR). Based on a comprehensive literature review and content analysis of journal articles, technical reports, state DOT documents/reports, templates, and guidelines on the identified technologies, the research findings indicate different usage levels among state DOTs and use them for applications such as: structural inspection, verifying quantities, bridge and visual inspection, safety inspection, inspection workforce training, inspection documentation, measurements of pay quantities, among others. This study serves as a valuable resource for state DOTs seeking to maximize the benefits of their investments and embrace innovative inspection technologies.

2 Leveraging Emerging Technologies in Construction: Opportunities and Challenges

Student: **Siddhartha Erelli**
Advisor/Mentor: **Dr. Manideep Tummalapudi**

Project Summary: The research investigates the integration of AI/Robotics, AR/VR, and BIM technologies within the U.S. construction industry, analyzing the influence of company type, size, and geographic location on adoption rates, implementation challenges, and potential solutions. Through an extensive literature review and a survey targeting industry professionals familiar with these technologies, the research evaluates their current usage, benefits, and barriers to widespread acceptance. It explores the specific advantages and challenges of these technologies, identifying key implementation issues and offering strategies to address them. The findings highlight the critical role of effective technology implementation in closing the productivity gaps in the construction sector, indicating how such advancements could shape the industries future and contribute to global economic growth. This research provides a practical guide for adopting emerging technologies in the construction industry, enabling greater integration, innovation, and impact.

3 Project-level Strategies to Plan for BIM and Lean Combined Implementation: Deductions from Literature Review

Students: **Prem Raj Timilsena, Karthik Kondabolu**
Advisor/Mentor: **Dr. Sagata Bhawani**

Project Summary: Building Information Modeling is a process comprising the development, use, and exchange of information with a digital model of a building or an infrastructure to improve the planning, design, construction, and operations of a single project or portfolio of projects. A digital model can serve many BIM uses throughout the project's lifecycle, depending on the project owner's and sponsor's goals and priorities. Because every project is unique and dynamic, we need a project-specific plan for implementing selected BIM uses and maintaining alignment across all phases. On the other hand, Lean represents a culture of respect for people and continuous improvement. While applying Lean is a philosophy-based approach, many methods, such as Big Room Planning, Gemba Walk, Set-based Design, Visual Management, and Work Clusters, serve as a mechanism for instilling the affiliating Lean principles into the project's delivery process. When considering the use of Lean methods on a construction project, alongside significant benefits to partnering with Lean organizations, there is still a need to align the project team with a shared vision and strategy by developing a project-level Lean implementation plan. While many studies corroborate the compounded benefits of BIM and Lean implementations, the review of existing literature revealed that different industry guides

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provide a systematic approach to planning for BIM execution and Lean implementation, but as separate processes and none present a systematic combined approach to leverage the compounded benefits in design and construction at a project level. In the pursuit of addressing this gap, this study focused on identifying, reviewing, and consolidating information from key pieces of literature representing industry and academia, the steps and strategies to plan the combined implementation of BIM and Lean on a project level. This paper presents such steps and strategies along with associated barriers and benefits.

4 Role of Software Vendors in Technology Adoption in AEC Industry: Conducting Validation Interviews

Student: **Karthik Kondabolu**
Advisor/Mentor: **Dr. Sagata Bhawani**

Project Summary: The Architecture, Engineering, and Construction (AEC) industry is currently experiencing a period of significant change, primarily due to the emergence of innovative technologies such as Building Information Management (BIM), Digital Twins, Cloud collaboration, and Artificial Intelligence (AI). However, adopting these technologies is challenging, with many AEC professionals lacking education and support from software vendors. In a previously submitted publication to the i3CE 2024 conference, I explored the literature for This research project focused on exploring software vendors' role in facilitating technology adoption within the AEC industry. For this scope of work, as part of the LCOE stipend, I will conduct validation interviews with selected software vendors to compare my results from the literature review. Specifically, the project will evaluate the effectiveness of software vendor training programs for AEC professionals' software vendors' approaches to supporting the adoption of new technologies.

5 The Role of Stereotypes in the Hiring Process of International Students in California's Construction Industry

Student: **Saiprudhvi Donthula**
Advisors/Mentors: **Dr. Wei Wu, Dr. Vivien Luo**

Project Summary: Amidst globalization, international students emerge as a valuable yet underutilized asset in the US construction industry, contributing distinctive skills and perspectives. However, they face challenges adapting to new social and cultural environments in a competitive workplace. Through surveys and semi-structured interviews with recruiters from construction companies connected to the Department of Construction Management at California State University Fresno, this research aims to understand how descriptive and prescriptive stereotypes influence recruitment practices. By examining the perceptions of employers towards international students compared to local counterparts, the research will uncover the nuanced factors driving hiring decisions. The findings are expected to highlight the impact of stereotypes on the employment prospects of international students and propose collaborative strategies between academia and industry to foster equitable and inclusive hiring practices. Ultimately, this research seeks to enhance the employability of international students and diversify the construction workforce, contributing to a more global and inclusive industry.

6 Sierra National Park Headquarters/Visitor Center

Students: **Emmanuel Verde, Elias Lopez, Paul Quiroz , Luis Castaneda, Max Rheault , Austin Marroquin, PJ Causing, Meredith Baker, Enrique Covarrubias, Money Singh, Luis Cortez, Robyn McMahan**
Advisors/Mentors: **Lloyd Crask, Molly Smith**

Project Summary: Our Senior Capstone Class Project, National Parks Visitor Center and Administration Facilities in the Sierra National Park is the culmination of an immersive senior experience course wherein a team of senior Construction Management (CM) and Architectural Studies (AS) students engage in role-playing and collaborate on a design-build proposal. The proposal encompasses preliminary schematic designs, sustainability initiatives, safety and logistics considerations, team-building strategies, and LEED rating adherence.

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Project Overview: Our team Voyager Inc. is responding to a request for proposal (RFP) for the United States Department of Interior. This is a Design-Build submission for the National Parks Visitor Center and Administration Facilities, Sierra National Monument. This project aims to enhance the visitor experience, provide educational opportunities, and allow easier maintenance and operations for the Sierra National Park.

Project Design: Voyager Inc. integrates sustainability and accessibility with Sierra National Monument's natural beauty. Taking inspiration from Modern Parkitecture, we incorporated various elements such as exposed wood, stone, large windows to maximize natural light and views, and eco-friendly construction techniques. Utilizing local materials, our design minimizes waste while blending seamlessly into the landscape. The Visitor Center features immersive exhibits, while the Administration Headquarters prioritizes efficiency. Our Maintenance and Operations Building ensures responsible stewardship. From infrastructure to pathways, every detail enhances the visitor experience while preserving the park's ecological integrity.

7 Sierra National Park Visitor Center and Park Headquarters Proposal

Students: **Forney, Moises Pedraza, Marina Renteria, Juan Villasenor, August Cameron, Aaron Delgermurun, Alexander Shelly, Ivan Garcia-Lua, Kenny Martinez, Carlos Villalpando**
Advisors/Mentors: **Dr. Yupeng Luo, Professor Loren Aiton**

Project Summary: Our student team, Diamond Blade Construction, comprised of Construction Management (CM) and Architectural Studies (AS) presents our response to the Sierra National Park Visitor Center and Park Headquarters Proposal in response to the Department of the Interior's Request for Proposal. Throughout the Capstone Series, AS students have been working through the schematic, design development, and construction documents phase of the Design-Build Process. Their focus has been on creating innovative solutions to meet the rigorous demands of sustainability, aesthetic, and functionality outlined in the design program. Customary to the Design-Build project delivery method, CM students completed ongoing conceptual estimates and conducted detailed analysis on the design to cost relationship, shaping the final design. The proposal presents these final costs, and expands on the sustainability, safety, team organization, and scheduling that reflect the students' solutions to the remote site, constrained timeframe, and limited budget.

8 Sierra Parks HQ and Visitor Hub: Gateway to Adventure

Students: **Matt Medellin, Carlos Rodriguez, Rogelio Garcia, Leonardo Meza, Javier Ramirez, Ramon Enrique Felix Hernandez, Kyler Collins, Cynthia Santiago-Vizcarra, Alejandro Madrigal, Rey Lopez, Juan Aguirre**
Advisors/Mentors: **Loren Aiton, Dr. Yupeng (Vivien) Luo**

Project Summary: Side channel analysis aims to gather leaked information from the processor. The attacker can then use the leaked information to steal sensitive or private information that the processor contains. The Inertial Hardware Security Module (IHSM) prevents physical access to the processor by rotating a printed circuit board (PCB) mesh at a high speed around the processor. This approach provides a way to build a security defense with relatively affordable parts while increasing the security level. Although this idea is innovative, there are multiple vulnerabilities such as the shaft that penetrates the mesh and an attacker attaching themselves to the system to rotate at the same speed (known as the swivel chair attack). This paper proposes an idea to improve the IHSM by using Visible Light Communication (VLC). The advantage of VLC is the visible light signals are less susceptible to interference and hijacking and ability to cover a larger space simultaneously. The VLC will act as the cage of light where there will be multiple emitters and receivers and the light will rotate giving the illusion of continuous rotation. The idea also proposes multiple enclosures within an enclosure to allow for lower speeds and different rotations directions. The use of VLC along with the rotation of the enclosure ensures sufficient complexity to prevent physical tampering with the microcontroller.

ARCHITECTURAL STUDIES AND CONSTRUCTION MANAGEMENT

9 Use of ChatGPT for Improving Construction Management Students' Professional Communication Skills

Student: **Avantika Dixit**
Advisors/Mentors: **Dr. Wei Wu, Dr. Vivien (Yupeng) Luo**

Project Summary: This research examines how ChatGPT contributes to the development of essential technical writing skills and explores the broader implications of using ChatGPT, including the benefits, challenges, and ethical considerations associated with its integration into technical writing instruction within construction management education. Student participants will first perform a technical writing task independently and then generate a second attempt with the help of ChatGPT. Vignettes of their attempts will be gathered and evaluated by a panel of professional communication subject matter experts consisting of professors and industry professionals. The outcome of this study will help advance the understanding of the possible use of ChatGPT in higher education settings and set stepping stones to more in-depth research endeavors with the aim to develop evidence-based practices and guidelines for more intentional and meaningful educational use of ChatGPT.

10 Analysis of Artificial Neural Network Forecasting Capabilities with Water Demand Data

Student: Luay Al Aghbari
Advisor/Mentor: Dr. Jorge Pesantez

Project Summary: Effective water resources management, including demand forecasting, is crucial for sustainable development. As part of machine learning methods, Artificial Neural Networks have proved to effectively forecast water demand. This project presents a forecasting model using a feed-forward neural network to predict one and multiple time steps of water demand using hourly measurements of the volumetric flow rate measured at the exit of a reservoir. The model includes multiple endogenous and exogenous predictors. We train the model using a data set from a collaborative water utility from Southern California with hourly measurements for the year 2022. Then, we test the model with water demand values in 2023. Results show that our forecasting model can effectively predict the next 24 (one day) and 168 hours (one week) of water demand. Results in terms of the Coefficient of Determination (R2) are around 0.7 to 0.9 depending on the testing period.

11 Assessing the Authenticity of the Virtual Reality Model From a Structural Inspection Perspective

Student: Ziad Ibrahim
Advisor/Mentor: Dr. Xiangxiong Kong
Sponsor: Lyles College of Engineering

Project Summary: Civil structures require constant inspections to maintain their safety and integrity. One of the traditional methods of inspection is to perform an investigation at the site. Recently, advanced techniques such as Virtual Reality (VR) have shown the potential for civil structure inspections by creating a digital replica of the real-world structure. However, the success of VR-based inspections depends on the authenticity of the VR model, as low-fidelity VR models may not depict accurate texture information from real-world structures. The purpose of this project is to "calibrate" the authenticity of the VR model by comparing images from the VR model against the ground truth images taken from the structure. This poster shows the preliminary results from this research project including investigations in 3D photogrammetry-based VR modeling and image processing work via MATLAB Computer Vision Toolbox.

12 Improving Water Distribution Systems Management: A Clustering Approach

Student: Byron Alessandro Toledo Salazar
Advisor/Mentor: Dr. Jorge Pesantez

Project Summary: Building Information Modeling is a process comprising the development, use, and exchange of information with a digital modeCurrent water distribution systems (WDSs) work under complex settings that include several hydraulic devices and infrastructure. Population growth and extensive networks have created the necessity of developing research modeling tools that recreate the characteristics of the WDSs. The modeling of partitioned water distribution systems could assist in a more focalized measurement of hydraulic conditions that can define network changes. This project develops a clustering method that partitions the WDSs into similar subgroups that contain related nodes and strategical areas presenting similar characteristics and direct interconnections. In addition, this study aims to develop a sensitive analysis using an adaptation of K-means and a metaheuristic optimization algorithm to define the changes with different parameters of interest, separate networks, and variations in the number of clusters. The results will be able to model a clustered system with an optimal number of subgroups that present the minimum value of variation from one to another.

13 Rehabilitation of Water Distribution Systems Based on a Clustering Approach

Student: Phoebe Bloomfield
Advisor/Mentor: Dr. Jorge Pesantez
Sponsors: California Institute for Water Resources

Project Summary: Water distribution systems are among the most critical infrastructure in a city's planning. As urban infrastructure ages, systems need repairs and replacements to prevent major disruptions. This project aims to develop an optimal rehabilitation strategy for water distribution systems. The model evaluates the hydraulic effects of replacing pipes while minimizing the number of consumption points that may be affected negatively by the replacement. Also, the model minimizes the strategy cost of implementation by comparing each alternative. Pipe selection uses a clustered-based approach to identify the system's main pipes. The rehabilitation strategy is tested on a synthetic water network. Results show that the systematic rehabilitation plan improves the hydraulic behavior of the water network regarding the number of consumption points reporting low pressure. Also, the extensive search used for the optimal cost converges after evaluating multiple simulation scenarios. Developing tailored strategies for pipe rehabilitation will decrease the likelihood of service disruptions.

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14 Unlocking Water Demand Patterns and Outdoor Consumption Insights for Targeted Conservation Strategies

Student: Angela Maldonado Alfaro
Advisor/Mentor: Dr. Jorge Pesantez
Sponsor: Lyles College of Engineering Startup Package

Project Summary: This research applies a data-driven analysis to explore water demand patterns and identify high outdoor consumers based on monthly water demand measurements. The proposed method relies on a correlation analysis and linear regression model. The average monthly demand is correlated with various household characteristics such as building area, age, and total area. The linear regression model analyzes how monthly demand varies with highly correlated predictor variables. Further analysis is conducted to identify high consumers using a threshold of five times higher than the average demand of all households. Results show building area and age were the most prevalent predictors. Multiple high consumers were identified with the threshold. Finally, demand peaks in the summer months, of which outdoor water consumption can contribute up to 25% of total demand. The proposed method can assist water utilities in implementing focused conservation strategies and efficient system management based on household characteristics in their district.

15 Affordable Prosthetic Arm

Students: Sydney Rivera, Visotheara Var, Jason Yang
Advisors/Mentors: Dr. The Nguyen, Dr. Hovannes Kulhandjian
Sponsors: Research Training Initiative for Scientific Enhancement (RISE)/ Louis Stokes Alliance for Minority Participation (LSAMP)

Project Summary: This research project aims to develop an open-source myoelectric prosthetic arm for trans-radial amputees below the elbow, addressing affordability and mobility challenges. The primary approach involves utilizing Electromyography sensors (EMG), with a focus on both existing commercial sensors and the potential development of a custom EMG sensor designed for prosthetic arm needs. Additionally, the research explores integrating computer vision techniques to enhance the prosthetic arm's functionality. Surface electromyography (sEMG) sensors, measuring voltage differences during muscle activity, form the core of our prosthetic control mechanism. We delve into both the utilization of current market-available sEMG sensors and the development of a bespoke sensor. The sEMG circuit, incorporating operational amplifiers (op amps) for noise filtration and signal interpretation, sends muscle signals to a Raspberry Pi 4B microcontroller using a coded algorithm for precise prosthetic arm control. The research encompasses deciphering muscle signals as input data for the microcontroller and integrating computer vision concepts for enhanced prosthetic functionality. The Raspberry Pi 4B, serving as the central computing unit, interfaces with EMG sensors and executes Python commands to facilitate signal processing, gesture recognition, and potential computer vision applications. EMG patterns are classified through Python scripts, activating motor actuators in real-time and providing feedback for adjusting motor control parameters, ensuring accurate movement execution comparable to a real arm.

16 Autonomous Weed Detection and Elimination System for the Smart Agriculture Robot bullDOG (SARDOG)

Students: Blake Bennett, Devin Rocha
Advisor/Mentor: Hovannes Kulhandjian

Project Summary: We have designed a weed detection and elimination system for the Smart Agriculture Robot bullDOG (SARDOG). SARDOG was designed to provide small farms with a multitude of services. This project includes running images captured by a camera through the YOLOv8 learning model to determine the presence of weeds with adequate confidence in a field setting. Upon weed detection, a raspberry pi will then determine the coordinates of the weeds within the image. The coordinates are then converted to distances to be sent to a CoreXY belt system being driven by two stepper motors. The system uses a gantry to position an attached hose that will spray the target area with a weed-killer chemical.

17 Benchtop Programmable Spin Coater

Students: Yasmeen Hammad, Shannon Woodside
Advisors/Mentors: Dr. Gregory Kriehn, Dr. Zoulikha Mouffak

Project Summary: The objective of the Benchtop Programmable Spin Coater project is to design and develop a cost-effective, compact, and customizable spin coater with decent improved efficiency. We will also add a touch screen to improve user control and a custom-built electronic speed controller that will be programmable to increase rotational speed control. Spin coating is the process of evenly applying a thin coating of polymer onto a flat substrate. A spinning plate, or stage, is used to hold the substrate in place while the coating material is placed in the center. The coating is spread uniformly throughout the surface by applying centripetal movement and acceleration forces.

18 Design and Implementation of a Smart Agricultural Robot bullDOG (SARDOG)

Student: Nicholas Amely
Advisor/Mentor: Dr. Hovannes Kulhandjian
Sponsors: Fresno-Merced Future of Food Innovation (F3)

Project Summary: Agricultural systems face unprecedented challenges, including food supply shortages, diminishing water resources, escalating input costs, and a decreasing agricultural workforce. The recent surge in Agricultural Technology (AgTech) offers a promising solution, enhancing farm productivity and automating monotonous and hazardous tasks. This project is called SARDOG, a smart agricultural robot built upon the Farm-ng Amiga robot framework. Leveraging advanced technologies such

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as artificial intelligence (AI), LiDAR, Internet-of-Things (IoT) sensors, and a robotic arm, SARDOG autonomously performs various intelligent farming tasks. Capabilities include GPS-less navigation using LiDAR, fruit picking with the robotic arm, and soil property testing through a robotic actuator sensor framework. SARDOG can accompany farmers in the field, transporting produce and addressing numerous applications to streamline major farming processes. The primary objectives of SARDOG encompass enhancing efficiency, cost-effectiveness, and humane practices in existing farming processes, while also exploring novel farming applications.

19 Dual Inertial Hardware Safety Module (DIHSM)

Students: Herwin Sihota, Aryan Singh, Omer Al Sumeri
Advisor/Mentor: Dr. Hayssam El-Razouk

Project Summary: Side channel analysis aims to gather leaked information from the processor. The attacker can then use the leaked information to steal sensitive or private information that the processor contains. The Inertial Hardware Security Module (IHSM) prevents physical access to the processor by rotating a printed circuit board (PCB) mesh at a high speed around the processor. This approach provides a way to build a security defense with relatively affordable parts while increasing the security level. Although this idea is innovative, there are multiple vulnerabilities such as the shaft that penetrates the mesh and an attacker attaching themselves to the system to rotate at the same speed (known as the swivel chair attack). This paper proposes an idea to improve the IHSM by using Visible Light Communication (VLC). The advantage of VLC is the visible light signals are less susceptible to interference and hijacking and ability to cover a larger space simultaneously. The VLC will act as the cage of light where there will be multiple emitters and receivers and the light will rotate giving the illusion of continuous rotation. The idea also proposes multiple enclosures within an enclosure to allow for lower speeds and different rotations directions. The use of VLC along with the rotation of the enclosure ensures sufficient complexity to prevent physical tampering with the microcontroller.

20 Electronic Chess Board

Students: Alan Mata, Marco Rojas
Advisor/Mentor: Dr. Nan Wang

Project Summary: Our project is an electronic chess board that will help newer players visualize the possible moves they are able to make. Whenever a piece is lifted up from the board, there will be LEDs that will illuminate the possible positions it is able to go and the pieces it can capture. Each player will also have a LCD display on each side of the board in order to change the settings of the game before it starts. Using the display and its buttons, players will be able to promote pawns into a queen, rook, bishop, or knight. The heart of the project is the Arduino Mega microcontroller which allows us to program the functions of the game and its accessories.

21 Emergency Vehicle Temperature Detector

Students: Nicolas Thao, Rayan Nekkab, Manuel Silva
Advisors/Mentors: Dr. Hayssam El-Razouk , Dr. Woonki Na , Dr. Shuo Wu

Project Summary: With cars becoming more automated there should be a feature to detect children and pets left behind in the car when locked and engine off. Using a thermo-camera for detection, GPS module for idle check, and developed code to send the user a message this can be implemented in a portable kit. Solar panels will be applied to supply the system with power while the sun is out as our system is designed to help detect high temperatures over low temperatures and alert the user of a child or pet left behind. This will require implementations of a series of converters to get the appropriate power output from the solar panel to our system to maintain proper functionality of our components. A Raspberry Pi microcontroller is the core of the system taking in information and sending messages to the owner of the car when necessary.

22 Enhancing Agricultural Productivity through Deep Learning Technologies by Detecting Crop Diseases and Pests

Student: **Saachi Jaiswal**
Advisors/Mentor: **Dr. Alaeddin Bani Milhim**

Project Summary: This research project addresses the global challenge of increasing food demands by adopting an innovative and sustainable approach. This aims to revolutionize agriculture by detecting crop diseases and pests using deep learning technologies to enhance smart farming and precision agriculture. The methodology involves analyzing the latest Machine Learning (ML) technologies in agriculture, comparing current technologies, evaluating efficiency, and exploring innovative approaches. This helps understand their practical applications, advantages, and challenges in farming operations. The approach involves comparing current crop and pest detection technologies, identifying potential ML approaches, collecting data, developing models, and evaluating their effectiveness. These algorithms aim to make farming more precise, efficient, and data-driven, enhancing crop monitoring pest control, and early disease detection, which significantly boosts productivity and sustainability. Full implementation of ML technologies is expected to secure the global food supply environmentally, marking a significant advancement towards innovative and sustainable agricultural solutions.

23 Fault Tolerant Power Supply

Students: **Moses Trujillo, Miguel Ledesma, Ziyuan Li**
Advisors/Mentors: **Dr. Woonki Na, Dr. Hayssam El-Razouk**

Project Summary: This project focuses on designing a switch-mode power supply (SMPS) that improves the efficiency of switching power conversion and the system's reliability. By applying a resonant inductor-inductor-and-capacitor (LLC) converter topology design that allows for soft switching techniques such as zero voltage switching, this project will achieve SMPS with low switching power losses and improved electromagnetic interference (EMI). Another innovation explored in this project is the use of wide-bandgap semiconductors such as Silicon Carbide (SiC) and Gallium nitride (GaN) Metal-Oxide-Semiconductor Field-Effect Transistors, better known as MOSFETs. The emerging technology's low switching losses allowed them to operate at a higher switching frequency. This technology not only leaves a smaller footprint but also reduces power losses. Reducing power losses is not enough today as reliability also becomes increasingly important. A fault-tolerant design will be developed, including a reparability method to increase its reliability.

24 LuLi Smart Cultivation: A Socially-Connected IoT Hydroponics Solution

Students: **Liam Goss, Luigi Santiago-Villa**
Advisors/Mentors: **Dr. Gregory Kriehn, Roger Moore**

Project Summary: This project addresses food deserts by developing an accessible, internet-connected hydroponics system, enabling urban households to grow nutritious food. Leveraging temperature, humidity, light intensity, and water pH sensors, alongside UV lighting and a microcontroller, the system facilitates real-time plant health monitoring. A unique feature is its community-driven web application, allowing users to exchange growing tips and presets, significantly lowering the entry barrier for novices. Designed with a focus on food desert challenges and community engagement, the project aims to make home-grown crops viable for everyone. Over nine months and with a $500 budget, this initiative will produce a functional prototype that demonstrates efficient crop cultivation, highlighting a technology-driven, socially inclusive approach to mitigate food insecurity in urban areas.

25 Self-Balancing Wind Turbine

Students: **Justin Hunziger, Eric Sam, Eric Cruz**
Advisors/Mentors: **Dr. Hayssam El-Razouk, Dr. Shuo Wu, Dr. Woonki Na**

Project Summary: Wind turbines are a very good source of green energy, and their presence in the ocean has been steadily increasing over the years. Our project looks to improve the efficiency of a type of oceanic wind turbine, the floating wind turbine, by reducing the amount of money needed to be spent on connecting the turbine to the sea floor. Additionally, eliminating this

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connection would also reduce impact on wildlife as well as speed up the deployment of future turbines in the ocean. Our project aims to create a system that would allow the turbine to stay upright in the presence of ocean weather conditions like wind and waves, emulating existing water-balancing systems.

26 Semi-Automatic Plant Nursery

Students: **Robert Navarro, Myles Covert**
Advisor/Mentor: **Roger Moore**

Project Summary: This project utilizes principles of electrical and computer engineering to create a semi-automatic planting nursery. The system computer manages several sensors, motors, and lights to keep the environment of the plant in perfect condition for optimal growth. The main goal of this project is to remove user labor as much as possible. After an initial setup, the plant nursery will be able to take care of itself and provide the user with information about its current condition. The system utilizes a large water tank that reuses and recycles water for the plants. The water is monitored using pH, temperature, and nutrient sensors to keep it within an optimal range of the selected plant.

27 Solar-Powered, Smart-Enclosed (SPSE) Garden

Students: **Vicente Evangelista, David Villegas, and Bordin Vang**
Advisors/Mentors: **Dr. Hayssam El-Razouk, Dr. Shuo Wu,. Dr. Woonki Na, Rob Mavis**

Project Summary: The Solar-Powered, Smart-Enclosed (SPSE) Garden is a smart enclosed terrarium that enables crop growth in a controlled environment regardless of seasonal or yard space limitations. It's designed to replicate ideal growing conditions by integrating solar power, ventilation, lighting, irrigation, and monitoring sensors. The terrarium allows users to cultivate their preferred fruits and vegetables indoors. Its purpose is to provide a compact yet efficient way for people without outdoor space to grow healthy crops in a controlled, user-friendly environment. The system's control panel allows users to monitor and adjust conditions for optimal plant growth. The microcontroller has been developed to regulate the environmental conditions with light, temperature/humidity, moisture, CO2, and water-level sensors. The remaining systems are used to make the garden self-sufficient and environmentally friendly. Overall, this innovative design aims to foster healthier plant growth and higher yields compared to traditional indoor gardens, catering to both gardening novices and enthusiasts.

28 SRAM-Based PUF Temperature Sensor

Students: **Eric Rivera, Youssef Ibrahim**
Advisor/Mentor: **Dr. Hayssam El-Razouk**

Project Summary: This research aims to enhance an SRAM-based Physically Unclonable Function (PUF) sensor system for temperature monitoring. Objectives include hardware optimization by replacing components for efficiency, improving temperature reading accuracy, developing a more efficient calibration method, and implementing security measures against physical attacks. Proposed enhancements involve removing the DE2-115 FPGA board, refining calibration techniques, and establishing unique correlations between SRAM modules and the Check Response Pattern (CRP) database for tamper detection. These efforts seek to make the system economically viable for integration into existing systems such as smart cars and other applications requiring reliable temperature monitoring.

29 VR Sensor Glove

Students: **Vincent Lee, David Inthavong, Callista Vongsa**
Advisors/Mentors: **Dr. Hayssam El-Razouk, Dr. Hovannes Kulhandjian, Mr. Roger Moore**

Project Summary: The Virtual Reality (VR) Motion Sensor Glove captures the full range of motion that the hand exhibits through the usage of multi-sensor technology and through imageless methods. The motion of the hand is then transposed into a virtual environment that can be accessed through the Meta Quest 2 headset, where in real-time, the user can visually see and control the full range of hand motion in a virtual environment where hand motion is usually limited by current VR technology. By utilizing wireless technology and allowing users to have full control over all fingers in VR space, this device provides an immersive and enhanced VR experience to users.

30 Affordable Prosthetic Hand

Students: Chaeson Sears II, Nicolas Macias
Advisor/Mentor: Dr. The Nguyen
Sponsors: Fresno State LSAMP, Fresno State RISE

Project Summary: According to the Department of Veteran Affairs in 2010, a prosthetic arm for transradial amputees cost around $20,000 without health insurance. This is a pressing issue as the medical device company, Hanger Clinic: Prosthetics & Orthotics, predicts that by the year 2050, 3.6 million people are expected to have experienced limb loss. This will lead to a significant increase in the demand for prosthetics, which can be very expensive. The objective of this research is to develop an open-source prosthetic arm utilizing 3D printing technology. This approach aims to create a cost-effective prosthetic to assist individuals with limb loss both financially and functionally. Our focus is to achieve maximum functionality in this design by adding multiple degrees of freedom, enhanced by an easy-to-assemble actuation system. To achieve this we are using CAD design software such as SolidWorks in order to model the fingers, palm and wrist functionality before printing a physical copy. Currently, we are experimenting with different hardware such as stepper motors, servo motors and linear actuators, by incorporating them into our CAD designs. This allows us to determine which configuration of hardware will be optimal for our intended requirements. Overall, the ultimate goal of this research is to produce a product that is affordable and simple for users to assemble, ensuring that anyone facing limb loss can regain mobility, regardless of financial constraints.

31 AI-Based Remote Monitoring of Water Treatment

Students: Alberto J. Puga, Jordan Ovando, Jose Rodriguez, Marylu Melendrez
Advisor/Mentor: Dr. Sankha Banerjee

Project Summary: The project is to see the movement of a robotic arm to eventually grab water samples for testing, analysis, and monitoring of a water treatment system. Through the use of Python and cameras the robotic arm will be coded to grab samples. The first contaminant to detect is dyes with the use of an IR thermal sensor. The motivation for the project is to have the robot become a mobile unit for monitoring the performance of a water treatment system with minimal to no human interaction.

32 Benchtop Non-Invasive Glucose Monitoring System Using Si Photodiode

Students: Anthony McDonald, Armando Correa, Spencer Norvell
Advisor/Mentor: Dr. Sankha Banerjee

Project Summary: Systems that puncture the skin are still standard techniques for home monitoring glucose concentrations through electrochemical, colorimetric, or optical disposable strips for finger-prick blood samples [2]. A non-invasive technology can greatly improve quality of life. This technology can also be beneficial for many different agricultural industries. The current standard for glucose measurement in the dairy industry is to use invasive techniques [3]. In recent years, researchers have developed wearable biosensors that enable non-invasive, non-destructive, real-time, in-situ, and in-vivo identification of early stress response in plants [4]. This technology enables timely, economic solutions for commercial farming. Near-infrared spectroscopy has been considered as one of the most effective methods for noninvasive glucose sensing. The aim of this project is to develop a benchtop device that will help determine if the feedback from a Silicon (Si) photodiode creates a reliable correlation suitable for future product development.

33 Biomass Burner

Students: Clark Mueller, Gabriel Carrillo, Miguel Curiel, Antonio Marin
Advisor/Mentor: Dr. Eldeeb, Dr. Nguyen
Sponsor: Walter Mizuno

Project Summary: Our project focuses on making a mobile pyrolysis system, a thermal decomposition process crucial to biochar creation. Pyrolysis is the thermal process involving organic material subjected to elevated temperatures in the absence of oxygen. This project harnesses the potential of this process to produce biochar, a carbon-rich material with an abundant amount of environmental applications. Through this controlled thermal decomposition, the organic material undergoes a

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transformation, resulting in biochar, bio oil, and syngas. We optimized the pyrolysis process in order to obtain a high-quality biochar. Biochar can be used as a carbon sequestration method as well as a soil additive that can help with plant growth and nutrient retainment. Our comprehensive study highlights the applications of biochar, demonstrating the potential as a versatile solution for both carbon management and agricultural sustainability. Through this research we aim to contribute to a more sustainable future by harnessing the power of the pyrolysis and using this in a mobile manner. We also created a SolidWorks model of a pyrolysis system that is intended to be transported via trailer.

34 Electro-active Composite Filament to be Used in 3D Printing

Student: Jelizaveta Chern
Advisor/Mentor: Dr. Sankha Banerjee
Sponsors: NASA - via UC San Diego

Project Summary: 3D printing, specifically the technique of fused deposition modeling, is an accessible and highly versatile method of creating components. It has vast implications for a wide variety of industries due to its versatility and ability to create complex customizable shapes out of many materials. This research project explores the process of creating and characterizing an electro-active composite filament consisting of polylactic acid (PLA), barium titanate (BaTiO3), and MXene, for use in conventional 3D printers. The filamentâ€™s material properties, especially the dispersion of the component materials, are investigated using scanning electron microscopy to evaluate the effectiveness of the filament production method. Finally, a wafer printed using the created filament is characterized to evaluate its electro-active behavior and surface properties.

35 Electron Interaction with Carbon Fiber Composite

Student: Sophie Lewis
Advisor/Mentor: Dr. Sankha Banerjee

Project Summary: This project will be conducted to analyze the effect that electron bombardment has on carbon-fiber composite material. CFC has important applications in the aerospace industry due to its high strength and thermal resistance. In the case of hypersonic, high-temperature flow as is common during atmospheric reentry, the air around the vehicle may begin to ionize. The interaction of free electrons produced by the ionization reaction with the surface of the material is important to note as it can cause ablation (surface stripping), electron penetration far into the surface, and/or a high concentration of electrons trapped inside the material. It is possible for the ablation effects on the composite to be studied using a scanning electron microscope at different electron voltages to observe any material defects, as ablation can increase surface roughness and remove pieces/layers from the material. The interaction volume and energy of electrons entering the material can be simulated to observe what kind of effects that electron bombardment can have within the surface. The simulation of an electron gun hitting a sample of CFC can be conducted using CASINO software at different electron voltage values to visualize the electron interaction.

36 Engineering and Testing of a Novel Composite for the Remediation of Hydrocarbons and Heavy Metals

Student: Jaden Luna
Advisor/Mentor: Dr. Jorge Pesantez

Project Summary: Utilizing a moldable material can help with the remediating of sensitive aquatic environments. The purpose of this project is to develop a versatile, sustainable, low-cost, clay-based sorbent to extract oil and metallic pollution from natural environments. The clay-based sorbent was made from Calcium Bentonite, Metakaolin, Calcium Hydroxide, and Quartz-silica to meet these requirements. “Concretion Spheres” were tested for their conductive-material sorbability when exposed to wastewater that contained traces of conductive metal. Following experimentation, the Spheres showed no sign of statistical effect on the presence of conductive metal. This indicates that modifications to the recipe are necessary for the Spheres to remove metals from wastewater. Then, the Spheres were examined in their oil sorbability. Following the extended period of saturation, Concretion Spheres proved to successfully remove oil from their environment showing an average of 10% remotion. Following a rework of the recipe, these percentages are expected to increase in future experiments.

37 Enhancing UAV Capabilities for Soil Penetration: Investigating Downward Thrust Generation for Efficient Drilling

Student: **Aaron Millwee**
Advisors/Mentors: **Dr. Alaeddin Bani Milhim, Roger Moore**

Project Summary: Unmanned Aerial Vehicles (UAVs) are widely used for agriculture applications. UAVs offer a practical solution for gathering data from field-deployed sensors that require longer deployments. Another application involves utilizing UAVs to deploy sensors and plant seeds in remote or hard-to-access locations, where traditional methods may be difficult or costly. Such tasks often involve additional actuators resulting in greater complexity. An effective drilling requires pressure applied against the surface; however, UAVs are designed to generate thrust upward. The purpose of this research is to determine a method to generate thrust downward; thus, the UAV can be utilized as a drilling source. The project will study the conventional thrust mechanisms and propose potential approaches to inverse the thrust for drilling purposes. This project is the first phase to a multi-phase project aimed at developing a UAV equipped with autonomous capabilities for drilling, sensor deployment, and seed planting.

38 Hydroelectric Energy System

Students: **Drew Cornelison, Skylar McGee, Tanbir Singh**
Advisors/Mentors: **Dr. Sankha Banerjee, Dr. Yuanyuan Xie**
Sponsors: **REP Solar**

Project Summary: The purpose of this product is to integrate a household-scale solar system with a wind turbine to supplement power production for homes and small businesses in the Central Valley. Since solar only produces power during the daytime, adding a wind turbine has the potential to produce power during non-daylight hours. This is a complete system that should be able to power a building at all times. There is a battery storage system that will supply power in the event of a power outage. The components integrated in this system are a wind turbine, solar panel, hybrid wind and solar charge controller and display, battery, and hybrid inverter.

39 The Effectiveness of a MERV and Needlepoint Bipolar Ionizer Filtration System in Filtering Particulate Matters

Students: **Isaiah John Daniel, Patrick Keffer Erwin, Sarai Galindo, Jose Sebastian Herrera-Jacobo, Isaiah Jimenez, Mahnoor Khan, Marylu Melendrez, Skylar Owen McGee, Jordan Fernando Ovando, Cesar Eduardo Patricio, Harut Piloyan, Alberto Javier Puga**
Advisor/Mentor: **Dr. Yuanyuan Xie**

Project Summary: This abstract provides an overview of the comprehensive design proposal for integrating an Archimedes turbine into the Hansen Dam hydroelectric project, aiming to optimize energy conversion efficiency and environmental sustainability. Through meticulous analysis and simulations using SolidWorks and Computational Fluid Dynamics (CFD), the performance of the turbine under operational conditions was evaluated. The project estimates a potential power output exceeding 25 kW per turbine, with the possibility of reaching over 1.2 MW with multiple turbines. Considerations of cost-effectiveness, operational versatility, and ecological compatibility guided the selection of the Archimedes turbine. This study contributes to advancements in hydrodynamic engineering while addressing the urgent need for sustainable energy solutions, aligning with broader goals of renewable energy integration and climate change mitigation.

40 Linear Membrane Welder

Students: **Sarai Galindo, Mahnoor Khan, Darren Ferrer**
Advisor/Mentor: **Dr. The Nguyen**
Sponsors: **Bay City Boiler**

Project Summary: The purpose of this project is to provide Bay City Boiler (BCB) with an upgraded linear membrane welder to develop a more efficient and safer manner to manufacture boiler tubes. An efficient process is necessary in manufacturing

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these tubes at BCB as an average of 1,000 tubes are manufactured yearly. These boiler tubes are created by welding two flat bars to both sides along the length of a tubing of around ten to twenty feet long. The main objective of this project includes providing BCB with an improved clamping mechanism designed to reduce the amount of preliminary actions needed before utilizing the machine to begin the welding process. Another objective includes improving the stability of the weld joint while providing four degrees of freedom to provide the optimal positioning of the weld guns. Refining this product can reduce the labor hours required per tube and provide BCB with the ability to manufacture more boiler tubes a year, resulting in a more profitable future.

41 Machine Learning Applied to Component Failure

Student: **Colton Cunningham**
Advisor/Mentor: **Dr. Aaron Hoskins**
Sponsor: **Research stipend awarded through Dr. Dean Nunna originally funded through N.A.S.A.**

Project Summary: Carbon fiber-based composites are strong, lightweight materials that are used in aircraft and automobiles. When carbon fiber composites fail, they break rapidly and catastrophically. Therefore, if aircraft using composites are not regularly maintenanced, lethal disaster could occur. Currently, there is no way to directly measure the remaining lifetime of a carbon fiber composite, so machine learning predictive algorithms are typically implemented to analyze data and find patterns that can be used to predict the remaining lifetime of a material. This experiment used machine learning to analyze mechanical waves translating through carbon fiber-based composites to predict when the material will break and when maintenance is required to prevent catastrophic disaster.

42 Machine Learning Applied to Graduation Rates of Transfer Students at California State University, Fresno

Student: **Colton Cunningham**
Advisor/Mentor: **Dr. Aaron Hoskins**
Sponsor: **California State University, Fresno**

Project Summary: Bachelor's degrees in engineering are typically intended to take four years to complete. However, the vast majority of students who transfer from a community college either take longer than four years to graduate or do not graduate at all. If factors that contribute to delayed graduation or not graduating at all can be identified, then the University system can intervene when the student transfers to a university and provide tailored resources that will remedy roadblocks students face. This research project focuses on studying key characteristics that prevent engineering transfer students from either graduating or graduating on time from California State University, Fresno. Additionally, this project intends to use an unsupervised learning methodology to analyze what features correspond to community college transfer students graduating later than two years after transfer.

43 Marine Energy System

Students: **Krisztofor Jon-Carlo Arreola, Jelizaveta Chern, Darren Ferrer, Manuel Hernandez, Jose Sandoval, Mahmoud Qaddoura, Ezequiel Trujillo**
Advisor/Mentor: **Dr. YuanYuan Xie**

Project Summary: Marine energy refers to the renewable energy produced by oceanic resources such as waves, tides and currents. In California, our goal is to broaden the state's energy mix, reduce our reliance on fossil fuels and address the challenge of climate change. One innovative approach uses a buoy system alongside an undersea turbine to convert the kinetic motion into electricity. This is done by having the buoy system float on the surface of the ocean, capturing the kinetic motion of the waves as they rock the buoy from one side to another. The movement here generates electricity essentially through the motion of the buoy as it bobs up and down, driving the mechanics of an attached undersea turbine, which further enhances energy generation. The turbine is positioned beneath the buoy and captures the energy as ocean currents push through the system. By Combining both wave and tidal energy capture in a single design, this approach maximizes energy extraction from marine sources, offering a promising solution for sustainable power generation with minimal environmental impact.

44 Mobile Arm Support

Students: **Daniel Butler, Patrick Erwin, Cesar Patricio**
Advisor/Mentor: **Dr. The Nguyen**
Sponsors: **Working with Valley Children's Hospital Sponsored by Fresno State**

Project Summary: This project presents a device for individuals with limited upper body strength who need assistance to perform daily activities when using their upper and lower arms. Fresno State students partnered with a team of rehabilitation specialists from Valley Children's Hospital in order to gain feedback throughout the design process. Focused on improving mobility, the arm support design consists of adjustable spring hinges to oppose gravity for a wide range of arm weights while increasing the range of motion in a total of five degrees of freedom. Design concepts for final implementation were confirmed through rapid prototyping with 3D printing for original parts and modification of existing components. The device is fabricated with high-strength carbon fiber poles and ergonomically constructed to accommodate different mounting surfaces. This innovative mobile arm device holds potential for widespread use as an alternative product when compared to more expensive rehabilitation and healthcare devices.

45 Serpa Sachet Packaging Device

Students: **Isaiah Daniel, Issac Hernandez, Khalal Mosed**
Advisor/Mentor: **Dr. The Nguyen**
Sponsor: **Serpa Packaging Solutions**

Project Summary: This project sponsored by Serpa Packaging Solutions aims to optimize the efficiency of loading sachets through a starwheel mechanism, with the primary objective of eliminating human intervention in the process. Design goals encompass attaining an efficient loading speed of 1000 sachets per minute while ensuring simple design and ease of manufacturability. The system will consist of a belt conveyor, starwheel assembly, various sachet containment and rejection methods, as well as an automatic magazine loading system. Each component will play an elaborate role within our machine with the overarching goal to potentially create a new industry-leading method for automated packaging.

46 Solar Tracking Electric Scooter Charging Station

Students: **Mahmoud Qaddoura, Roger Villagomez, Krisztofor Arreola**
Advisor/Mentor: **Dr. The Nguyen**
Sponsor: **SunDogs**

Project Summary: The purpose of this project is to provide Bay City Boiler (BCB) with an upgraded linear membrane welder to develop a more effThe Solar Tracking Electric Charging Station at Fresno State seamlessly integrates cutting-edge solar

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tracking technology with charging stations, tailored to optimize solar energy capture for electric scooter charging. Utilizing a dual-axis tracking system and incorporating bifacial solar panels, the station dynamically adjusts its orientation, ensuring maximal power output from both direct and reflective sunlight exposure. This innovative system operates for an additional three hours post-sunset, continuing to collect energy throughout the day. Featuring six charging stations equipped with three universal ports, the station accommodates various scooter types prevalent in the market. Beyond its technological advancements, the station serves as an educational tool for students and faculty, highlighting the transformative potential of renewable energy technologies. The project encompasses intricate design considerations, rigorous engineering analyses, and addresses practical challenges associated with implementing such a system on a university campus. Operational three hours post-sunset, the station utilizes stored solar energy for ongoing electric scooter charging. Capable of accommodating up to six scooters simultaneously, it stands as a testament to the seamless integration of innovative technology with sustainable practices. Moreover, the system boasts over-the-air update capabilities, enabling real-time monitoring and dissemination of battery status information, facilitating efficient maintenance and aligning the station with broader objectives of enhancing campus sustainability and fostering environmental consciousness. In summary, the Fresno State Solar Tracking Electric Charging Station represents a sophisticated blend of technology, sustainability, and education, addressing the increasing demand for EV infrastructure on university campuses.

47 Supersonic Flow Over a Flat Plate using Matlab

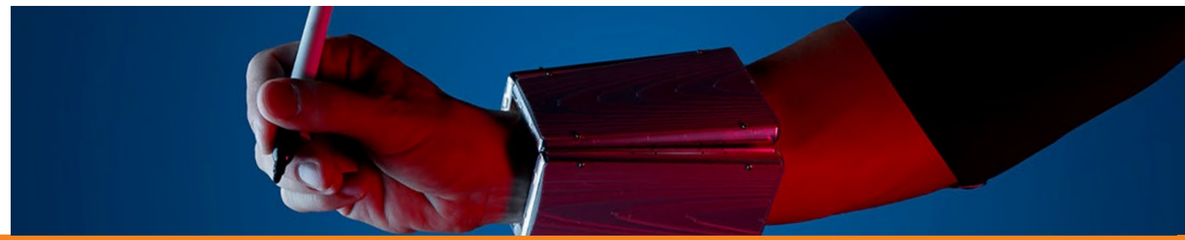
Student: **Diego Alejandro Banos Lemus**
Advisor/Mentor: **Dr. Deify Law**

Project Summary: A flat plate with zero incidence angle over supersonic fluid flow has been studied numerically using the complete Navier-Stokes equations. The problem is formulated as a time marching, two-dimensional spatial coordinate system, the governing flow equations are solved by using finite-difference MacCormack scheme which allows us to achieve a second order steady state solution. Laminar flow is used over the flat plate as a relatively low Reynolds number is set to keep running times short and air is modeled as a perfect gas with a constant Prandtl number, viscosity is being evaluated by Sutherland's Law. Results were obtained by developing a Matlab Code and presents the pressure, temperature, and velocity profiles along the plate. This work contributes to a deeper understanding of supersonic flow behavior over a simple geometry.

48 University Solar Charger for Mobile Transportation Devices

Student: **Jose Hernandez, Jose Herrera-Jacobo, Isaiah Jimenez, Emmanuel Fernandez Robles**
Advisor/Mentor: **Dr. Sankha Banerjee**

Project Summary: Project Summary: Our university project introduces a solar charger tailored for electric scooters, embodying sustainability and innovation. This solar charger provides a practical, eco-friendly solution for people needing a quick charge between classes. It captures the sun's power to charge electric scooters, using a monocrystalline solar panel and a Raspberry Pi microcontroller that regulates the power delivered to each charging port. In addition, the project will also feature a cellular application that will allow the user to connect via Bluetooth to monitor the status of their scooter or charging station. The goal of this project is to create a user-friendly interface and convenient solar charger that will offer students a hassle-free and sustainable charging solution on campus.



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