



FRESNO STATE

Lyles College of Engineering

19TH ANNUAL PROJECTS DAY

RESEARCH
INNOVATION
DESIGN

APRIL 29, 2026
2 to 6 p.m.

RESNICK STUDENT UNION



Free admission and open to the public
engineering.fresnostate.edu



WELCOME ATTENDEES!

Welcome to the Lyles College of Engineering's 19th Annual Projects Day! Today is a celebration of our students and the innovation, creativity and perseverance they demonstrate through their work.

The projects featured here represent at least a year of research, design, testing and collaboration across civil, computer, electrical, geomatics, and mechanical engineering, as well as architectural studies and construction management. Each project reflects the commitment our students have made to tackling complex challenges and developing practical, forward-thinking solutions.

Their accomplishments are the result of long hours in the classrooms, laboratories and fieldwork, guided by faculty mentors and supported by staff and industry partners. Through these experiences, our students have strengthened not only their technical expertise, but also their leadership, teamwork and problem-solving skills.

We are proud of their achievements and grateful for the community that supports their growth. Thank you for being here to recognize and celebrate their outstanding work.

Dr. Ram Nunna

*Dean, Lyles College of Engineering
Fresno State*

19TH ANNUAL PROJECTS DAY

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FRESNO STATE

Lyles College of Engineering

CONSTRUCTION MANAGEMENT AND ARCHITECTURAL STUDIES



1 Agricultural Technology Education and Laboratory Building

Students: Estefani Zermeno Romo, Evan Angel Candelaria, Cesar Alfonso Castaneda, Christopher Kevin Espinoza Gonzalez, Elliott Stephan-Taylor Mills, Ennis Hasan Mohammad, Fatima Plascencia Gutierrez, Julian Rosas
Mentors/Advisors: Loren Aiton, Dr. Yupeng Vivien Luo

Project Summary: The senior capstone project involving a mixture of Architectural Studies and Construction Management students highlights real-world partnerships and collaboration. As a team focused on design build methodologies, our team is dedicated to delivering the capstone project with the intention of serving and supporting agricultural innovation. With a project budget of \$122 million dollars and a required building square footage of 81,000, our team seeks to deliver spaces that inspire advancement in agriculture through hands-on learning and collaboration within the industry. Along with taking measures to consider the surrounding agriculture through attentive safety and sustainability efforts. This project aims to increase California State University, Fresno's students and industry partners' preparation and innovation in the evolving world of agriculture.

2 Agriculture Technology Building Abstract - Orvis Tierra

Students: Anthony Melella, Cesar Rocha, Esmeralda Ramirez, Vicente Maldonado, Daniel Ramirez, Jesus Aquino-Aguilar, Nolan Martinez
Mentor/Advisor: Dr. Yupeng Vivien Luo

Project Summary: In this culminating capstone project, students from Architectural Studies and Construction Management formed Orvis Tierra, an integrated design-build team responding to a formal Request for Proposals (RFP) for a hypothetical Agriculture Technology building at Fresno State. The team developed a comprehensive proposal, including design documents, cost estimates, and construction schedules that reflect real-world practice. Working within a \$122 million budget and targeting LEED Gold certification, the team prioritized sustainable strategies and ergonomic spatial planning to support collaboration among students, faculty, and industry partners. By applying individually conducted research on different building systems, each team member influenced the final design by integrating early suggestions during the design phase. The members also worked collaboratively by assuming roles typical of real-world design-build applications. By assuming professional roles, the team influenced the building's design and completion of associated deliverables, setting accurate expectations for its members and the industry.

3 Application of Generative AI for Waste Reduction in Construction - A Systematic Review

Student: Sukumar Bachu
Mentor/Advisor: Dr. Tolulope Sanni

Project Summary: The construction industry generates large amounts of material waste and greenhouse gas emissions, making sustainable solutions increasingly important. This research explores how Generative Artificial Intelligence (GenAI) can help reduce construction waste and improve efficiency across the Architecture, Engineering, and Construction (AEC) sector. A systematic literature review was conducted following PRISMA 2020 guidelines, analyzing 29 peer reviewed studies published between 2020 and 2025. The study examines current applications of GenAI in waste reduction, identifies key benefits and challenges, and highlights future research opportunities. Findings show that GenAI supports waste prevention through optimized design, robotic sorting of demolition materials, and improved lean construction workflows. While benefits include better decision-making and material efficiency, challenges such as data limitations, high costs, and reliability concerns remain. This study provides a foundation for advancing AI-driven sustainability in construction.

4 Cultivating for the Future: Agricultural Technology Education and Laboratory Building

Students: Alondra Guerrero, Audriey Alpuerto, Breana Quintero, Zwe Htet Aung, Carlos Vargas, Fernando Rodarte, Jovanny Rodriguez
Mentor/Advisor: Dr. Yupeng Vivien Luo

Project Summary: This interdisciplinary senior capstone project, developed collaboratively by Construction Management (CM) and Architectural Studies (AS) students, proposes a new Agricultural Technology Education and Laboratory Building at California State University, Fresno. Using a design-build approach, the project simulates integrated project delivery and cross-disciplinary collaboration. Envisioned as a bridge connecting Lyles College of Engineering and Jordan College of Agricultural Sciences and Technology, this building includes robotics, automation, drone testing, and student support spaces to foster collaboration between faculty and students. The project was developed to meet a specified \$122 million budget and an 81,312 sqft program. AS students led design development, site analysis, programming, and sustainability strategies, while CM students focused on cost estimating, scheduling, site logistics, and constructability review. The poster highlights design intent through floor plans, renderings, sustainability features, cost summary, and scheduling. It demonstrates how the design-build approach aligns architectural vision with construction execution.

5 Foundation 7: Fresno State Agricultural Technology Building

Students: Rogelio Lopez Magana, Ramiro Moreno, Cristian Sosa, Nicole Figueroa, Fabian Sepulveda, Jacqueline Lopez, Isabelle Estes
Mentor/Advisor: Molly Smith

Project Summary: Foundation 7 is a multidisciplinary, student-led design-build team formed to simulate the structure and demands of a professional construction project conducted over two academic semesters. The team consists of seven students from the Architecture and Construction Management programs, organized to reflect an integrated design-build delivery model. The project centers on the Fresno State Agricultural Technology Building, focusing on unique features like equipment-heavy research spaces, flexible lab areas, and green spaces being incorporated into the building. Foundation 7 is developing a proposal that integrates detailed quantity takeoffs, a milestone based construction schedule and a sustainability focus analysis to constructability and performance. Our team is addressing unique project challenges like coordinating MEP systems, balancing innovation and sustainability with budget limits and coordinating long lead items during the preconstruction phase. Project's Day attendees will see renderings, 3D models, scheduling visuals and cost summaries that will highlight the project's unique features. Through this process, the team identified tradeoffs between cost, sustainability goals, and constructability, leading to a deeper understanding of how complex project decisions are made in a professional setting.

6 Hydrogen Fuel Cell Electric Vehicle Workforce Development in Public Transit

Student: Jaskaran Preet Singh
Mentor/Advisor: Dr. Manideep Tummalapudi

Project Summary: Public transit agencies are increasingly adopting hydrogen fuel cell electric vehicles (FCEVs) as a pathway toward zero-emission mobility systems. However, this technological transition presents critical workforce development challenges requiring specialized competencies beyond existing transit technologies. This systematic review publications from 2010-2024 across academic databases and transit agency sources to identify essential FCEV workforce competencies and compare them with predecessor technologies. The analysis examined knowledge, skills, and abilities across vehicle operators, maintenance technicians, and facility personnel. Findings reveal that FCEVs demand integration of mechanical, electrical, and chemical safety competencies. Comparative analysis demonstrates asymmetric transferability patterns: CNG backgrounds provide strong foundations for operators, while BEB technicians contribute high-voltage electrical competencies. However, PEM fuel cell maintenance, hydrogen material compatibility, and integrated safety protocols represent entirely new competency domains. The study identifies strategic recruitment pathways and modular training approaches that leverage transferable competencies, emphasizing that workforce development must receive priority to technology deployment.

CONSTRUCTION MANAGEMENT AND ARCHITECTURAL STUDIES



7 New Agricultural Technology Education and Laboratory Building

Students: David Valdovinos-Valencia, Alexa Gamez, Bryan Gutierrez-Ruiz, Wilner Vargas, Carlos Briceno, Kevyn Luna, Salvador Anaya, Braulio Moreno

Mentors/Advisors: Loren Aiton, Dr. Yupeng Vivien Luo

Project Summary: The New Agricultural Technology Education and Laboratory Building is a facility that goes beyond the boundaries of traditional agricultural practices. Our senior capstone course for Architectural Studies and Construction Management majors entails collaborating to develop this facility. Functioning as a Design-Build firm, our team works together to produce architectural design solutions, estimates, schedules, and LEED sustainability solutions. With the adjustment and rise of AI technology, through intensive, considerate design, Pacific Legacy Builders has prioritized delivering the New Agricultural Technology Education and Laboratory Building in the best manner through efficient construction practices, while also creating a new modular experience on the Fresno State Campus. Pacific Legacy Builder's design philosophy is grounded in modern iterations of traditions that bridge construction and design integrity.

8 New Agricultural Technology Education and Laboratory Building California State University, Fresno

Students: Analiese Figueroa, Maya Abou Taha, Alejandro Barajas, Manuel Figueroa, Odalis Mata-Figueroa, Arturo Hernandez, Yatziry Martinez, Flavio Ventura

Mentor/Advisor: Molly Smith

Project Summary: Our year-long senior capstone project focused on developing a new 81,312-square-foot Agricultural Technology Education Building at Fresno State, a collaborative hub where agriculture and engineering converge to highlight the integration of science, technology, and practice. Led by the Jordan College of Agricultural Sciences and Technology in partnership with the Lyles College of Engineering, the project addresses California's agricultural challenges, including labor shortages, climate pressures, water scarcity, rising costs, and new emerging technologies. The facility supports applied research in robotics, drone systems, artificial intelligence, and controlled-environment agriculture, with an emphasis on laboratory-based, hands-on instruction. Key challenges included integrating specialized labs within a flexible framework, reducing the program from 97,600 to 81,312 square feet, achieving LEED Gold certification, and aligning scope with budget and schedule under a design-build model. The project demonstrates strategic planning and interdisciplinary coordination, applying skills developed in Fresno State's Construction Management and Architectural Studies program.

9 Potential Agricultural Technology Education and Laboratory Building

Students: Morgan Parent, Kayla Contreras, Sunem Serrano-Mendoza, Blazej Skochinski-Chavez, Isaiah Soto, Alan Viruete-Millan, Daniel Zavala-Candelario, Cooper Lilles

Mentor/Advisor: Molly Smith

Project Summary: Starting in August 2025, the senior capstone students in both Architectural Studies and Construction Management have been brought together to test their abilities in a project that will simulate what type of work environment is expected after Fresno State. The senior capstone class tests our abilities as students to conduct research towards our hypothetical building as if we were working on its construction from day one. Various research viewpoints were implemented, such as site analysis, city-centric code analysis, scheduling, and estimating. As a team, the Construction Management and Architectural Studies students work together to bring two sides of the industry together for a project that will test everyone's abilities. The project, a new Agricultural Technology Center, will be displayed to showcase the work that each student has accumulated during their time at Fresno State to prove their readiness for the field.





10 A Comparative Study of Unreal Engine and Unity for 3D Gaussian Splat-Based VR

Student: **Daniel Ornelas**
Mentor/Advisor: **Dr. Xiangxiong Kong**

Project Summary: Civil infrastructure inspection often depends on manual visual assessment, which is costly, time-intensive, and vulnerable to human error. This study explores the use of 3D Gaussian Splats (3DGS) - a mesh-free, photorealistic representation generated from multi view imagery - to create Virtual Reality (VR) environments that support more efficient digital inspections. A 3DGS model was integrated into Unreal Engine 5 (UE5) and Unity to evaluate their suitability for deployment on the Meta Quest 3. UE5 provided built-in VR templates, but required significant adjustments during export. Unity offered a smoother export pipeline, but demanded more custom coding to implement interaction and annotation tools. The comparison highlights trade-offs in workflow complexity, rendering performance, and development flexibility. We also report the challenges we faced during the VR modeling workflow in this poster presentation.

11 A Comprehensive Water Demand Analysis of California using County-level Demand and External Determinants

Students: **Aaron Fregoso, Makayla Cawley**
Mentor/Advisor: **Dr. Jorge Pesantez**

Project Summary: California has faced extreme weather events that led to desperate management decisions about the usage of available clean water. These climate change conditions, exacerbated by an increasing population, require more sustainable management to prevent disasters occurring over one of the most vital requirements for life. This project presents a comprehensive analysis of the change in demand over time and the influence of weather and socioeconomic conditions at multiple locations across California. We have included monthly water demand reported by multiple counties from 2013 to 2021 to analyze the consumption trends and variance in water demand and the effects of those important exogenous determinants. The data for water demand for these assumptions comes from the CaRDS dataset [Gross et. al]. These values were then compared with the respective weather information, including: max, min, average temperature, precipitation, dew, humidity, wind gust, and wind speed; as well as county-level socioeconomic information consisting of education levels, unemployment rate, and mean and median incomes. Our modeling was implemented in the MATLAB programming language and includes multiple visuals and trends throughout our datasheet of over 4000 data points. Results showed strong proportionality between water demand and population density, seasonal peaks aligned with climatic cycles, and associations with socioeconomic patterns. These findings put together the demographic, environmental, and economic drivers of water use. Future work should focus on utilizing predictive modeling to integrate policy interventions and exploring strategies for equitable water management.

12 A Framework for Evaluating Photogrammetry Workflows Using Image Similarity Metrics

Student: **Felipe Ramirez**
Mentor/Advisor: **Dr. Xiangxiong Kong**

Project Summary: Photogrammetry is the science of extracting geometric and color information from a series of images. The objective of this project was to develop a framework for evaluating structural differences and visual distortions introduced by contemporary photogrammetry workflows. To achieve this, RealityScan was used to generate a textured 3D model from an image dataset. The resulting model was aligned with the original source images and rendered in Blender. MATLAB was then employed to compute the Structural Similarity Index Measure (SSIM), Multi-Scale Structural Similarity Index Measure (MS-SSIM), and Peak Signal-to-Noise Ratio (PSNR), which quantify the structural fidelity and visual quality of the reconstructed model relative to the original images. A case study of a building structure was reported in this poster to test out the performance of the proposed framework.

13 Assessment of Existing Leak Localization Efforts in Water Distribution Systems

Student: **Carly Boyer**
Mentor/Advisor: **Dr. Jorge Pesantez**

Project Summary: Water distribution systems (WDS) are essential infrastructure that are vulnerable to leaks occurring at multiple locations within the network. Leak detection using pressure sensors has been extensively studied in the literature. However, pressure measurements for leak localization offer significant opportunities to narrow down the search area. Leak localization is a complex task that depends on network topology and hydraulic properties. Factors such as sensor placement, spacing, and measurement temporal resolution can be used to evaluate a supervised learning algorithm for leak localization. This research presents a systematic approach to assessing existing leak localization methods. The approach uses multiple networks and hydraulic and topological characteristics from the literature to summarize the effects on localizing leaks of different components, such as network size, range of nodal elevation, fluid velocity, and the presence of tanks and controls. The results will provide researchers and practitioners with an objective comparative analysis that can be adapted to specific network conditions. Furthermore, this project supports the WDS community in locating leaks and reducing their negative impacts, such as property damage, service interruptions, water loss, intrusion contamination, and revenue loss for utility providers.

14 Evaluating Single-Stair Residential Design with Enhanced Fire Protection Systems

Student: **Artur Martirosyan**
Mentor/Advisor: **Dr. Julio Roa**

Project Summary: Can a single exit stair, when paired with enhanced fire safety systems, provide a level of life safety comparable to that of a traditional two-stair building? In order to improve safety and make evacuation easier, California building codes require residential buildings taller than three stories to have two exit stairways. However, especially in small- to mid-rise buildings, this requirement lowers usable space and raises construction costs. With the goal of achieving safety levels equal to or surpassing conventional two-stair buildings, this project investigates the feasibility of single-stair configurations with cutting-edge fire safety features. The study evaluates the effectiveness of both conventional and enhanced fire safety measures. Additionally, it weighs the financial advantages of removing a second staircase against the additional costs of installing improved safety features. Practical limitations regarding building height and occupancy are also being addressed. In order to illustrate the suggested single-stair approach, the results are also applied through the design of a case-study building that includes CAD drawings and a scaled physical model.

15 Examining the Correlation Between Resilient Modulus (M-E) and California Bearing Ratio (CBR) for Central Valley Soils

Student: **Soushilya Maggidi**
Mentor/Advisor: **Dr. Lalita Oka**

Project Summary: Subgrade soil properties are fundamental to pavement durability, as inadequate characterization often leads to premature failure. While the California Bearing Ratio (CBR) has traditionally been used to evaluate subgrade strength due to its cost-effectiveness, it fails to capture the soil's elastic response to the repeated dynamic loading typical of traffic. Consequently, modern Mechanistic-Empirical (M-E) design has shifted toward using the Resilient Modulus (Mr). However, because direct Mr testing is expensive and requires specialized equipment, engineers often rely on empirical correlations to estimate it from CBR values. A critical gap exists as current national correlations often fail to account for the unique characteristics of California's Central Valley soils, such as high fines content and extreme moisture sensitivity. This study addresses this discrepancy by developing region-specific CBR-Mr correlations through laboratory testing of representative soil samples from the Fresno and Clovis areas, including sandy loams and silty clays. By establishing localized mathematical relationships and comparing them against national models, this research provides more reliable design inputs that reflect local conditions, ultimately improving the performance and longevity of regional pavement infrastructure.



16 Investigating the Impact of Recycled Asphalt Pavement (RAP) on Cracking Trends in Asphalt Sections: A Data-Driven Study Using LTPP

Student: **Rahul Akula**
Mentor/Advisor: **Dr. Xiaojun Li**

Project Summary: The use of Recycled Asphalt Pavement (RAP) has increased in recent years because it helps reduce construction costs and supports environmental sustainability. By reusing old asphalt materials, agencies can save natural resources and lower project expenses. However, there are still questions about how RAP affects long-term pavement performance, especially when it comes to cracking. Since cracking is one of the most common types of pavement damage, it is important to understand whether adding RAP makes pavements perform better, worse, or about the same over time. This study examines the effect of RAP on cracking trends in asphalt pavement sections using data from the Long-Term Pavement Performance (LTPP) database. The research compares pavement sections that contain RAP with those that do not. Cracking behavior is evaluated by looking at cracking type and overall cracking levels across several years of field surveys. The study also considers traffic levels and climate conditions, since both factors can strongly influence pavement performance. A data-based analysis is carried out using simple statistical measures, such as average cracking values, to compare performance between RAP and non-RAP sections. The results help identify performance patterns and possible regional differences.

17 Investigating The Relationship Between Subsidence And Drawdown In Piezometric Levels In The Central Valley

Student: **Veronica Molina Rodriguez**
Mentor/Advisor: **Dr. Lalita Oka**

Project Summary: Land subsidence associated with groundwater extraction represents a cumulative and often irreversible process that threatens infrastructure integrity and long-term aquifer sustainability. In California's Central Valley, subsidence is closely linked to piezometric drawdown in compressible alluvial systems, where declining pore pressure increases effective stress and induces large consolidation settlement (subsidence). This study evaluates the relationship between subsidence and groundwater level decline across selected counties in the Central Valley (Contra Costa, Sacramento, San Joaquin, Solano, Stanislaus, and Yolo) through an integrated framework combining observational data, GIS-based spatial analysis, and transient numerical modeling. Publicly available USGS data were compiled to construct a reproducible regional database, incorporating subsidence records since 2011 and piezometric data for 2020 - 2025. Spatial interpolation identified priority areas characterized by cumulative subsidence of up to 0.51 ft and marked groundwater depletion. A 12-month MODFLOW (PMWIN) simulation for 2024, including seasonal recharge and pumping, reported a minimal water budget discrepancy (0.01%) and a sustained annual storage deficit, with declines reaching 68% in some areas. The results thus reinforce the physical linkage between drawdown and subsidence along with quantifying the shortage that caused the overdraft. Thus, this modeling approach offers a strategic water management metric to support preventive, evidence-based groundwater management in drought-prone regions.

18 Mining Claim Accessibility Through GIS

Student: **Katlin Rowley**
Mentor/Advisor: **Dr. Mike Berber**

Project Summary: The information contained in mining claim documents is highly valuable to the mining surveying industry. Although the information contained within these documents is crucial, that information is rarely easily accessible. In general, in order to acquire recorded mining claim documents, an individual in California would have to work with their County or the Bureau of Land Management to acquire those documents. This can be an expensive and time consuming process. The enclosed project aims to solve this issue and increase the accessibility of mining claim documents. This project completed this objective by prototyping an interactive GIS map for Trinity County that allows you to select the mining claim of interest and directly access the recorded mining claim. The project was then expanded to include research into the current open source mining claim GIS data from government agencies. These layers are then compared to the GIS prototype created within this project. Overall, demonstrating the ability of GIS to increase transparency and accessibility within the mining surveying industry.

19 Mining Surveying: Methods and Standards

Student: **Katlin Rowley**
Mentor/Advisor: **Dr. Mike Berber**

Project Summary: Geomatics engineering is a complex and diverse field with many subspecialties; two such subspecialties being adjustment computations and mining surveying. The overlap of these subspecialties will be the focus of this research proposal. Within mining surveying, a licensed land surveyor or engineer is not typically required and a set of accuracy standards is not widely adopted within the United States. With this in mind, this research aims to answer the question of whether current mining surveying techniques and adjustment computation procedures (accuracy standards) when marking mining claims effectively protects ownership rights.

Ownership rights are at the center of a multitude of geomatics engineering work, and many organizations have established standards to help ensure that data accuracy is sufficient to protect these rights. Some examples of this being the American Land Title Association (ALTA) standards and the American Society for Photogrammetry and Remote Sensing (ASPRS) standards. Standards such as those from ALTA and ASPRS address the importance of accuracy within their subspecialties of geomatics engineering. Determinations made based upon these standards can and do effect rights, and this is one of the many reasons why a standard for the subspecialties were created. A set of standards to follow helps to ensure that the work being done throughout the subspecialty is to the same level of accuracy and quality, and therefore the same level of protection of rights.

The absence of an adopted method to establish ownership rights, within Mining Surveying, may create a risk for the public/owners. Individuals creating mining claims may not be using surveying techniques and adjustment computation procedures to a sufficient standard to protect the rights that a mining claim would grant individuals if produced to a set of adopted standards. Widely adopted mining procedures and standards may need to be put into place to properly protect the ownership rights a mining claim creates. The proposed research will work to identify whether current mining surveying techniques and accuracies are sufficient to protect ownership rights, or if a mining surveying method(s) and standards publication is necessary.

Researching and compiling historical records of the evolution of mining surveying, current mining surveying procedures/ techniques, mining regulations and mining laws at both the federal and state of California level will be fundamental to making this determination. It is expected that this research will indicate that a mining surveying methods and standards publication is necessary. The goal of such publication being to protect ownership rights. If such determination is made, this research will encompass recommendations as to what the adopted methods and standards for mining surveying should be. This will be accomplished by analyzing current land surveying techniques and technologies along with widely adopted accuracy standards in adjacent geomatics engineering subspecialties. This analysis will be applied to the findings of why a mining surveying methods and standards publication is necessary. Methods and standards will be recommended based upon how current surveying technology, techniques, and accuracy standards can effectively address the identified deficiencies in current mining surveying procedures.





20 Modeling Pressure and Flow Deviations for Leak Detection in Water Distribution Networks

Student: **Angela Maldonado**
Mentor/Advisor: **Dr. Jorge Pesantez**

Project Summary: Detecting and localizing leaks in water distribution systems presents a persistent challenge for water utilities due to aging infrastructure. Undetected leaks can lead to significant potable water losses, reduced pressures, and contamination into the distribution system. Pressure sensors are commonly used to locate leaks and reduce water losses. However, limited physical and economic feasibility may prevent utilities from utilizing sensors for leak detection. This research proposes an adaptable water distribution network model to simulate network behavior and detect leaks using pressure and flow deviations. The hydraulics-based model will identify whether a pipe deviates from its expected pressure and flow. By analyzing the deviations from expected conditions, the model will estimate probable leak locations. The methodology intends to cross-validate the results of the distribution network model with an operational system containing pressure sensors. The proposed model offers utilities a scalable, cost-effective tool to optimize system performance and improve water distribution management.

21 Pedestrian Network Performance Analysis of Reduced Vertical Egress Redundancy in Multi-Story Buildings

Student: **Artur Martirosyan**
Mentor/Advisor: **Dr. Julio Roa**

Project Summary: What impact does reducing vertical egress redundancy have on multi-level building evacuation performance? In order to increase life safety through redundancy, traditional building codes mandate that residential buildings taller than three stories have two exit stairways. However, the transportation performance implications of removing one of these vertical routes remain under-explored. In this project, a multi-story building is treated as a network of pedestrian transportation, with occupants serving as dynamic flow units and stairways acting as vertical links. The study compares two-stair and single-stair configurations to assess congestion, bottleneck formation, flow rates, and overall evacuation time using evacuation modelling principles and transportation flow theory. System resilience and efficiency under varied occupant loads are being measured using capacity analysis. Furthermore, to evaluate trade-offs between infrastructure efficiency and redundant egress capacity, a cost-performance comparison is also carried out in this project. Ultimately the results are used to demonstrate the effects on network performance in a real-world setting using a case-study building model.

22 System-Level Transfer Learning from Public Water Demand Datasets

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

Project Summary: The limited access to demand datasets has constrained the analysis of water distribution systems (WDSs). Water agencies may face challenges at implementing uniform metering systems and at sharing the entire dataset due to confidentiality for their customers. For that reason, only public or synthetic datasets have been used to develop data-based models that predict hydraulic parameters along open source networks. All these models rely on high-quality, complete source data to train and generate predictions. However, these predictive models also have the capability to transfer knowledge from observed patterns. This characteristic, known as transfer learning, may support the use of publicly available datasets to predict demand related to networks with low-quality or scarce data. This study is focused on using a transfer learning approach to train predictive models from public data for system-level demand. The data processing and training involve a network similarity analysis and classification based on consumption levels and intraday patterns. The results aim to demonstrate that pretraining neural networks improves the prediction for similar water networks, which have limited data. The development of this approach intends to provide water agencies with the ability of understanding their networks from existing models and accessible datasets. Likewise, it is supposed to simplify the analysis of networks that have undergone changes over time.

23 Triaxial Testing of Soil-Rubber Mixtures for Sustainable Seismic Geotechnical Design

Students: **Inam Ullah, Soushilya Maggidi**
Mentor/Advisor: **Dr. Arezoo Sadrinezhad**

Project Summary: The use of recycled materials in geotechnical engineering has gained increasing attention due to sustainability concerns and the need for resilient infrastructure in seismic regions. Tire-derived aggregates and soil-rubber mixtures offer potential advantages such as reduced unit weight, enhanced energy dissipation, and improved deformation characteristics, making them attractive for applications including retaining wall backfill, embankments, and foundation systems. This study employs monotonic and cyclic triaxial testing to investigate the mechanical and seismic behavior of sand-rubber mixtures under loading conditions relevant to earthquake demands. Specimens containing varying TDA contents are tested under controlled confining pressures to examine stress-strain behavior, stiffness degradation, deformation response, and energy dissipation under repeated loading. The findings of this research will establish experimentally based trends that clarify the role of rubber content in governing seismic response and will provide critical data to support the safe and effective use of recycled tire materials in sustainable geotechnical design.





24 10s3p Battery Pack with Passive Balancing BMS

Students: **Javier Jimenez, Roberto Carlos Barajas, Jesus A. Barajas Luque**
Mentor/Advisor: **Dr. Woonki Na**

Project Summary: This project develops a modular Battery Management System (BMS) for a 10s3p lithium-ion battery pack intended for light electric vehicle applications. Lithium-ion batteries offer high energy density but require careful monitoring to prevent safety hazards such as overcharging, deep discharge, and overheating. Our system continuously monitors the voltage and temperature of each cell group and uses passive balancing to equalize charge differences by safely dissipating excess energy as heat. A distributed architecture is implemented, where individual ATtiny841-based cell modules manage local sensing and balancing, while a central ESP32 controller aggregates data and hosts a WiFi-enabled web dashboard for real-time monitoring. The design emphasizes cost-effectiveness, safety, and reliability while meeting industry standards for lithium-ion protection.

25 Accessible Soil Moisture Sensor System for Small Farmers

Students: **Cisty Vue, Ranbir Mann**
Mentor/Advisor: **Dr. Soumyasanta Laha**

Project Summary: The purpose of the project is to supply small farmers with easy-to-use soil sensor system to help them manage their water resources. The system will also allow farmers to remotely monitor their crop so that they will only need to be there if work is really needed. The project is based on a small survey conducted with 36 small farmers to gain insight into some of their challenges. The survey results show that there are challenges in using these technologies from those not so "tech-savvy." The survey also shows that there is a need for help managing water resources as well as simple and easy to use and understand technology to be more accessible for some of the farmers who are not so tech-savvy.

26 Agriculture-Based Renewable Energy Source via Portable Photovoltaic Cells and Digital Twin Applications

Students: **Bailey Wooten, Johnnie Cerda, Mac Leal**
Mentor/Advisor: **Dr. Woonki Na**

Project Summary: In recent years, solar has been growing as a means of generating electricity to power homes, cars, and many other things. Solar is still not as popular in agriculture as many would think. If solar were the main source of energy for the agriculture industry, as other industries, then the amount of renewable energy would increase greatly. This project will take this idea head-on and apply smart renewable energy to irrigation, which is one of the key parts of agriculture. This will be accomplished by integrating a ESP-32 micro-controller to an irrigation system that runs on solar acting as a battery management system (BMS). Information from the micro-controller will then be sent to the cloud using Internet of Things (IoT) to allow farmers to monitor the data. The physical implementation will be verified using a hardware-in-the-loop (HIL) software to safely test the micro-controller to ensure proper operation before implementation in the field.

27 Autonomous Enclosed-Rotor UAV for Target Detection and AR Visualization in High-Risk Environments

Students: **Nicholas Amely, Alexander Moreno Gonzalez, Eliasim Fragoso**
Mentor/Advisor: **Dr. Gregory Kriehn**

Project Summary: This project develops an autonomous indoor drone with protective enclosed rotors and augmented reality (AR) visualization for search-and-rescue and tactical operations in hazardous environments. The drone uses an RGB camera to detect people and objects behind walls, navigating autonomously without GPS by using computer vision and mapping technology. Real-time video and sensor data stream wirelessly to a Meta Quest 3 VR headset, where custom software displays a 3D reconstructed environment. An integrated artificial intelligence system identifies and highlights humans, animals, and objects of interest within the AR view. Built for under \$1,000, the system enables operators to safely explore dangerous or unstable buildings remotely. The three-phase development includes drone construction, autonomous flight integration using a Raspberry Pi computer, and intelligent target detection capabilities.

28 Autonomous Turret with AI Object Tracking

Students: **Jose Bravo, Fernando Solorzano, John Garcia**
Mentor/Advisor: **Dr. Hovannes Kulhandjian**

Project Summary: This project is a fully autonomous turret system designed to identify, track, and target drones. The turret system consists of two integrated subsystems: the targeting software and the mechanism hardware. The software is built using the YOLOv8 object detection model, acquiring data and code from a repository; the object detection system is also trained by supplying image data to the model's database. The hardware is a two degree-of-freedom pan and tilt system that maneuvers the camera and armament using a gear and pulley belt drive system. The frame and body of the turret system was 3D printed using edited prefabbed models. The turret system is run by a Raspberry Pi 5, which handles the computational processing of the software and controls the stepper drivers to operate the belt drive systems.

29 Computer-Upgraded Mouse

Students: **David Medina, Alejandro Zepeda, John Herrera**
Mentor/Advisor: **Dr. Nan Wang**

Project Summary: The Micromouse competition, founded by IEEE in the late 1970s, is an international robotics challenge that requires teams to design and program autonomous robots that explore and solve an unknown maze, reaching the center in the shortest possible time. Our team will develop an original micromouse, the "Computer-Upgraded Mouse," competing under Fresno State's IEEE chapter. We plan to use a set of infrared sensors to detect walls and use a flood fill algorithm to be able to autonomously navigate terrain, with potential scalability for real world terrain navigating applications. The use of computer vision, in conjunction with solving algorithms will allow for the most optimal path being selected when solving the maze.

30 Embedded Vision Prosthetic Hand

Students: **Anthony Nichols Jr., Fernando Hernandez, Manjot Dhanda**
Mentor/Advisor: **Dr. Woonki Na**

Project Summary: This project is a wearable prosthetic hand that uses a small onboard computer and a camera to help choose how to grasp everyday objects. The system runs a lightweight YOLO object detection model on a Raspberry Pi 5. Instead of only identifying items, the program groups them into handling types, such as a gentle pinch for fragile objects or a full wrap grip for larger ones. To avoid sudden movements, the software checks detections across multiple frames and requires consistent confidence before the hand reacts. An Android app allows the user to confirm actions, switch modes, or manually control the hand when needed, while the prosthetic continues basic operation on its own. The goal is to reduce the effort required to operate a prosthetic by letting the device assist with grip decisions, demonstrating a practical approach to assistive robotics using low-cost hardware.

31 FPGA Based Optimal Robot Control System (FPGA-ORCS)

Student: **Lawrence Rede**
Mentor/Advisor: **Dr. Shuo Wu**

Project Summary: Development of a FPGA based Robotic Optimal Control System: including traditional and AI/ML control schemes testbenches, with the ability for rapid reconfigurability to test multiple control schemes depending on the end robotic system. This methodology allows to save on overall CMOS die space compared to traditional non FPGA based SOC design for Robotics and control systems. The target board for implementation is the DE1-SoC FPGA Development board, allowing for multiple on and off board actuation and measurement devices to be used to implement the various control schemes.



32 Gesture Controlled FPV Drone

Students: **Juan Aragon, Jocelyne Solano, Logan Bradshaw**
Mentor/Advisor: **Roger Moore**

Project Summary: Recently, there has been an increase of FPV drones used for various different tasks including search & rescue, geographical mapping, precision crop monitoring, and commercial videography. FPV drone technology has allowed people to obtain footage of locations inaccessible to humans. In this project, a drone will be capable of being controlled in two different ways: gesture control and remote control. By utilizing gyroscopic controls, the user has more control over the movement of the drone. It is also more intuitive than the standard control scheme for drones, allowing more widespread usage. In addition, the drone can automate its flight by utilizing user-set waypoint missions that determine where the drone will depart and land. The drone will use a Pixhawk flight control system, and the controller will use a Pi Pico 2W to send control signals to the drone based on which gesture occurs.

33 Industrial Building Management System

Students: **Tue Do, Daniel Perez Castellanos**
Mentor/Advisor: **Roger Moore**

Project Summary: This project presents the design and implementation of a portable Industrial Building Management System (IBMS) that demonstrates how modern buildings can be monitored and controlled efficiently using low-cost embedded technology. The system simulates an industrial environment with four independent rooms, each equipped with sensors to track temperature, air quality, lighting, and occupancy. A centralized controller processes this data and displays it through a user-friendly interface, allowing real-time monitoring and control of lighting, ventilation, alarms, and safety features. By integrating distributed sensors, automated control logic, and centralized visualization, the project highlights how intelligent building systems can improve energy efficiency, occupant comfort, and safety. Although developed as an academic prototype, the system reflects real industrial architectures and serves as a scalable, hands-on example of modern building automation principles.

34 MetavoltVR-AI: An AI Enhanced Student Developed VR Circuit Building Application

Students: **Nicholas Amely, Jesus Leyva**
Mentor/Advisor: **Dr. Wei Wu**

Project Summary: Engineering is facing a critical workforce shortage while students are struggling with traditional lecture-based instruction in foundational courses. MetavoltVR-AI addresses these challenges by combining Virtual Reality (VR) with Artificial Intelligence (AI) to create personalized, immersive learning experiences for engineering students. Building on a successful VR prototype developed by the research team, this project enhances the platform with two AI capabilities: a rule-based adaptive system that tracks student performance and adjusts difficulty in real-time, and a natural language processing interface that provides instant answers to student questions during VR sessions. Targeting first-year engineering students, MetavoltVR-AI aims to increase engagement, improve conceptual understanding of logic gates and circuits, and support underrepresented students who face barriers in traditional engineering education. This project demonstrates how emerging technologies can make engineering education more accessible, engaging, and effective for diverse learners.

35 Mini Power Grid

Students: **Jose Placencia, Arian Rostami, Alejandro Alvarado**
Mentor/Advisor: **Roger Moore**

Project Summary: This project focuses on the design and implementation of a low-voltage solar-powered DC microgrid for small-scale distributed energy applications. The system operates on a nominal 40–50 V DC bus and integrates a photovoltaic (PV) source, a DC–DC converter with maximum power point tracking (MPPT), regulated DC outputs, and a low-voltage single-phase micro-inverter for AC loads. An STM32 microcontroller is used for real-time voltage and current sensing, PWM generation,

and closed-loop control of the power converters. The MPPT algorithm dynamically adjusts the converter duty cycle to maximize power extraction under varying irradiance conditions. Simulation and experimental testing are performed to evaluate voltage regulation, efficiency, and system stability. The resulting design demonstrates a modular and scalable microgrid architecture suitable for educational and low-power renewable energy applications.

36 Non-Invasive Blood Glucose Monitoring

Students: **Nick Pierce, Jacob Lira, Rafael Garcia-Gallardo**
Mentor/Advisor: **Dr. Soumyasanta Laha**

Project Summary: Diabetes management relies heavily on regular monitoring of blood glucose levels, traditionally performed through invasive finger-prick methods. While accurate, these techniques can cause discomfort, risk of infection, and reduced patient compliance over time. To address these limitations, recent research has focused on developing non-invasive glucose monitoring systems that can estimate glucose concentrations without the need for blood extraction. Non-invasive approaches typically use electromagnetic, optical, or acoustic spectrometry to detect physiological changes correlated with glucose levels. This project aims to design and evaluate a hybrid non-invasive glucose monitoring system that integrates electromagnetic and optical sensing, with plans to later incorporate acoustic spectrometry. The electromagnetic subsystem will analyze variations in blood permittivity and conductivity, while the optical subsystem will measure light absorption in the near-infrared region. Data from these systems will be processed using advanced machine learning algorithms, including Linear Regression, Random Forests, Support Vector Machines, and Convolutional Neural Networks. The goal is to determine the most accurate and efficient sensing modality for implementation in a compact, wearable, and energy-efficient device to improve comfort and accessibility for diabetic patients.

37 PCB Assembly Line

Students: **Ashmeet Singh, Sydney Rivera**
Mentor/Advisor: **Roger Moore**

Project Summary: This project recreates a small-scale printed circuit board (PCB) manufacturing assembly line, integrating automated quality inspection and component assembly. The system consists of two primary modules: a machine vision-based quality inspection module that uses machine learning to verify PCB trace accuracy, and a pick-and-place module that positions surface-mount device (SMD) components onto the board. A programmable logic controller (PLC) is designed from scratch using OpenPLC to coordinate system operation, sensor integration, and actuator control. Camera systems are trained to detect PCB faults and ensure accurate component placement. The system emphasizes real-world industrial automation practices, including sensor integration, closed-loop control, and modular system design to improve reliability and scalability.

38 Regenerative Braking Electric Bicycle

Students: **Jose Sahagun, Laith Khoury, Kai Cayetano**
Mentor/Advisor: **Dr. Woonki Na, Roger Moore**

Project Summary: This project focuses on the design and implementation of a regenerative braking system for a 48 V, 1000 W electric bicycle to improve energy efficiency and sustainability. The system recovers kinetic energy lost during braking and pedaling and converts it into electrical energy that is stored in the battery via a supporting capacitor bank. The design integrates a rear-hub motor, bidirectional DC–DC buck/boost converter, bidirectional DC–AC inverter, capacitor bank, and an ESP32-based control system. Custom power-electronics hardware and printed circuit boards are designed, built, and tested to safely manage power flow during both propulsion and braking. System performance is evaluated through measurements of voltage, current, power, and charging efficiency. This project provides hands-on experience with power electronics and control systems while demonstrating practical applications of regenerative energy recovery in electric transportation.

ELECTRICAL AND COMPUTER ENGINEERING



39 Smart Energy Router

Students: **Jose Chavez, Andres Cardenas, Anirudh Nishtala**
Mentor/Advisor: **Roger Moore**

Project Summary: The Smart Energy Router is designed to actively monitor and manage power distribution across residential energy nodes, including solar arrays, the utility grid, and battery storage. This system integrates a custom designed 12V-to-20V DC-DC boost converter and sensing circuits to optimize energy allocation, all of which is intended to be programmed with python on a Raspberry Pi. By prioritizing energy consumption during off-peak hours and utilizing stored reserves, the router reduces consumer utility costs and eases demand on public utilities. The system is engineered to manage a 400W household load and 50W solar input while functioning as a zero export system to comply with safety and facility regulations. It demonstrates a cost-effective, scalable solution for enhancing residential energy independence through hardware and software integration.

40 Wearable Blood Pressure Monitor Device

Students: **Jacob Arias, Anuk Amarasinghe, Upek Amarasinghe**
Mentor/Advisor: **Dr. Soumyasanta Laha**

Project Summary: Our project is a wearable blood pressure device that will be able to display the required information onto an app on your smart phone with bluetooth. We are trying to make our product more affordable and also more accurate with its measurement for our users. To achieve this we will be utilizing the ESP32-S3 micro controller integrated with a high precision SparkFun pulse oximeter and heart rate sensor to collect our real time data. Our targeted users will be anyone that will be wanting to check on their heart effortlessly throughout the day so they can easily integrate it into their daily routine.



MECHANICAL ENGINEERING



41 Agrivoltatics

Students: **Cesar Aranibar, Alexa Alvarado, Angel Gama, Harman Kaur, Lucio Rangel**
Mentor/Advisor: **Dr. Yuanyuan Xie**

Project Summary: Agrivoltatics is a relatively new and innovative approach that integrates photovoltaic (PV) energy systems with agricultural land use. The core concept involves installing solar panels above actively farmed areas, whether crop fields or grazing lands, so that solar energy can be harvested without significantly disrupting agricultural operations. This dual-use system aims to maximize land efficiency by simultaneously supporting both food and energy production. As the global demand for clean energy increases and the availability of arable land becomes more limited, agrivoltatics presents a promising strategy for sustainable development. This project focuses on incorporating our solar technology into an agricultural environment and developing a dual-use system that improves both crop productivity and renewable energy generation. By evaluating shading levels, soil moisture retention, and panel output under various field conditions, the system is engineered to maximize photovoltaic performance. The system incorporates sensors and monitoring technology to track panel efficiency, record solar and wind conditions, and support analysis of their effects on crop production.

42 AIAA and IEEE Airbrakes Project

Students: **Corbin Obata, Carlos Cortes, Niqui Empis, Jonah Rayne, Jennifer Rosales, Alondra Perez-Ramirez**
Mentor/Advisor: **Dr. Deify Law**

Project Summary: The AIAA Fresno and IEEE Fresno Airbrakes project aims to create an electronically-controlled airbrake system for rocketry to hit a target altitude. The mechanical design uses a 7-link system to deploy and retract the braking system. Extension of the brakes' pedals induce drag within the rocket by increasing the rocket's cross-sectional area during ascent. The increase of drag allows us to slow and stabilize the rocket to reach the target apogee (maximum altitude of the rocket). For electronics, this project features an integrated flight computer centered on the Raspberry Pi Pico 2 W. Utilizing MicroPython, the system executes real-time sensor fusion and PID logic by processing data from a BMP390 altimeter and MPU-6050 IMU. This firmware calculates predicted apogee to modulate a high-torque MG996R servo. Power is supplied by a Tattu 2S LiPo and Micro BEC, ensuring stable 5V delivery for precise actuation and robust data logging during high-velocity flight.

43 Compact Autonomous Robot for Car Trunk Entry/Exit

Students: **Alonso Camarillo, T.J. Fuentes, Gabriel Gamez Martinez, Simardeep Sahota, Gary West**
Mentor/Advisor: **Dr. The Nguyen**

Project Summary: Transporting heavy items to or from a vehicle can be physically demanding and unsafe, especially for people with limited mobility. The objective of this project was to design a compact robotic system capable of safely entering and exiting a car's trunk after assisting with baggage. The system was required to meet size, budget, and weight constraints, while maintaining safety and reliability. Designing involved defining customer needs, reviewing prior art, establishing functions and subsystems. The final design integrated a tracked mobility base, and a suction-based, articulated arm mount. Safety considerations were applied through engineering standards, including ISO and IEC. CAD models were developed to verify the system packaging, feasibility of constraints, and articulation. The concept demonstrated its viability, providing the foundation for future design and compliance with real-world deployment. Up to Projects Day, a prototype that can move to and from the trunk will be complete, demonstrated on a sedan.

44 Development of Enhanced UAV-based Drilling System Using Downward Thrust Generation

Students: **Aaron Millwee, Brianna Vidrio, Rayne Saucedo, Ethan Le, Dana Martinez, Austin Duffy, Jake Velicescu**
Mentor/Advisor: **Dr. Alaeddin Bani Milhim**

Project Summary: This study presents the design and experimental validation of a quadrotor-based drilling platform that leverages the use of reversed propeller thrust to enhance soil drilling effectiveness. The system employs a single low-speed DC motor (30 rpm) to generate auger rotation, while reversed motor polarity is used to produce controlled downward thrust



that supplements the drone's weight and existing actuation. The prototype uses open-source software, commercially available components, and 3D-printed parts. Experiments were conducted indoors in silty sand-topsoil mixtures with controlled strength levels (0.5 kg/cm² to 3.5 kg/cm²) and moisture contents of 35 % to 95 %, drilling to depths of 5 cm to 15 cm. Across three applied thrust levels, 0.75 kg, 1.13 kg, 2.27 kg, and a no-thrust condition, the trials demonstrate that drilling speed increases with applied thrust and decreases with soil strength. Experimental results demonstrate that the addition of reversed thrust increases the effective downward force, leading to improved drilling effectiveness. A three-dimensional analysis of drilling speed as a function of thrust and soil strength confirms that the added downward thrust effectively compensates for increased soil resistance, leading to higher penetration efficiency. These results validate the feasibility of thrust-reversal-assisted drilling and establish a foundation for future UAV drilling platforms incorporating autonomous thrust control and optimized auger geometries for operation in stronger and more heterogeneous substrates.

45 Effects of Thickness and Transformation Temperature of Nitinol Strips on Bending Properties

Students: **Kaitlyn Rockholt, Taylor Witrado**

Mentor/Advisor: **Dr. The Nguyen**

Project Summary: Nickel-titanium alloy metals (nitinol) exhibit the unique properties of the shape memory effect and superelasticity, making them uniquely suited for biomedical engineering applications. As a shape memory alloy, nitinol is able to recover its original shape when heated past its austenitic transformation temperature after deformation in its martensitic state. The superelastic property of nitinol allows the metal to remain elastic even under large deformation above the austenite temperature. This study tests for nitinol's bending properties, focusing on the effect of thickness and transformation temperature on its mechanical properties. This will provide information that can then be applied to biomedical devices such as ankle-foot orthoses, stents, eyeglass wear, and vascular guidewires.

46 Experimental Testing and Performance Analysis for ThermeShade

Student: **Bryan Mejia-Sanchez, Jose Ramblas, Mitchel Hamilton, Anahuic Reyes, Jonathan Camarena**

Mentor/Advisor: **Dr. Yuanyuan Xie**

Project Summary: This project develops and validates a testing framework to evaluate the real-world performance of ThermeShade, a market-ready window shade designed to reduce solar heat gain while preserving outdoor visibility and natural light. The testing approach focuses on key performance metrics relevant to commercial applications, including room air and surface temperatures, humidity, light transmission, HVAC energy usage, installation feasibility, and product durability. Controlled experiments are to be conducted in adjacent, south-facing on-campus rooms to closely replicate realistic operating conditions and isolate the effects of the shade. Data is collected using calibrated thermal, humidity, and energy-monitoring instruments and analyzed quantitatively and qualitatively. Rather than redesigning the product, this work delivers a repeatable, data-driven testing protocol and performance assessment to verify manufacturer claims, identify areas for improvement, and support informed decision-making for future commercial deployment of ThermeShade.

47 Experimentation and Simulation of Near-Infrared Light Penetration in Models of Oral Tumors for Near-Infrared Photoimmunotherapy

Students: **Samantha Schilling, Karen Martinez**

Mentor/Advisor: **Dr. Gemunu Happawana**

Project Summary: For over half a century, cancer treatment has primarily consisted of surgery, chemotherapy, and radiotherapy. While semi-effective, they all possess serious side effects, weakening the body's natural immune system and damaging nearby cells. Due to this, a major focus of cancer researchers has been uncovering cures to cancer that cause less harm to the body. One recent discovery is the use of near-infrared photoimmunotherapy (NIR-PIT), a treatment form that uses NIR light and an antibody photoabsorber-conjugate (APC) to induce selective necrotic cell death in targeted cancerous cells. Our research focuses on tracking and testing methods of evenly spreading NIR light throughout oral tumors in order to make NIR-PIT treatment more effective. We aim to create a mathematical model of the spread of NIR light throughout an oral tumor in order to help researchers simulate and optimize NIR-PIT treatment for oral tumors.

48 Force Moment and Energy Analysis of a Three-Point Drawbar (Plough) for an Autonomous Farm Tractor

Student: **Shiva Sudireddy**

Mentor/Advisor: **Dr. Gemunu Happawana**

Project Summary: This project develops a force-moment-energy model for a drawbar that is to be integrated to an autonomous farm tractor. The analytical analysis has been performed on the three-point linkage system. This study includes black soil properties (high cohesion and adhesion, variable moisture sensitivity) and ploughing depths ranging from 3 to 6 inches. Free-body diagrams are prepared for the hitch, main frame, and each of the four moldboards by resolving soil-tool interaction into horizontal, lateral, and vertical components. A full three-point hitch analysis is then carried out to determine the two lower-link forces and the upper-link force, along with the associated reaction moments at key joints. The forces and moments on the linkages of the drawbar are formulated for operating speeds up to 12 kmph, allowing dynamic load transfer to be captured during motion. The resulting linkage forces, moments, and power demand are compared with tractor traction and hydraulic capacity to verify safe operation and to identify critical load cases needed for designing and adjusting the proper sensor system for the implement that has to be integrated to an autonomous tractor.

49 Fresno State Rocketry NASA USLI Payload 2026

Students: **Anthony Souza, John Herrera, Ryan Kane, Juan Ramos, Keagan Ott, Isaac Lay, Robert Flath**

Mentor/Advisor: **Dr. Deify Law**

Project Summary: DROP (Deployable Rover for Observation and Prospecting) is a self-deploying rover payload that jettisons from the launch vehicle during drogue deployment and remains tethered and protected until ground contact. After touchdown, the rover separates from the rocket using the Tender Descender 3 (TD3) system and then drives a short distance away from the airframe. Extendable support legs rotate the chassis into a vertical orientation, enabling an auger-based drill to extract at least 50 mL of soil within a 15-minute operational window. Onboard sensors subsequently measure soil pH and electrical conductivity. All mission events are time-stamped and logged to verify system performance, demonstrating autonomous separation, controlled descent, rover self-stabilization, and in-situ soil analysis.

50 Generating Hydropower at a Non-Powered Dam

Students: **Daniel S. Peckham, Alexis Publico, Angel Martinez, Marshal Spohn, Zander Clugston, Johnathan Herren**

Mentor/Advisor: **Dr. Yuanyuan Xie**

Project Summary: This project will evaluate the feasibility of retrofitting hydropower generation at the North Fork Dam near Auburn, California, an existing debris-control arch dam with an established reservoir. The objective of this project is to determine whether a non-hydropowered dam in California can be converted to include hydroelectric generation while maintaining its original function and minimizing environmental and structural impacts. The project begins with a review of the selected dam's characteristics and operational constraints. Multiple retrofit designs are investigated and screened based on expected flow, constructability and anticipated financial requirements. Based on the site analysis and the leading design alternative, a conceptual hydropower system will be developed to evaluate turbine selection, water conveyance and routing, and potential power output. Numerical calculations and simulations are performed to estimate energy output at expected flow conditions. When possible, scale model testing is used to validate assumptions and compare alternatives. The results of this project are expected to provide a structured feasibility assessment of a potential hydroelectric retrofit at North Fork Dam and to identify key technical and economic factors influencing the viability of similar non-powered dam conversion projects.



51 Marine Energy Harvesting System

Students: Hailey Messmer, Carlos Garnica, Jonathan Gutierrez, Emilio Martinez, Isaiah Pineda-Fernandez, Anthony Souza
Mentor/Advisor: Dr. Yuanyuan Xie

Project Summary: This project presents the development of a compact ocean energy harvesting system designed to generate electrical power from moving water currents. The system uses a horizontal-axis turbine to convert the kinetic energy of flowing water into rotational motion, which drives a generator to produce electricity. The design emphasizes a compact and modular structure suitable for laboratory testing while representing principles used in larger marine energy systems. Analytical modeling and simulation were used to evaluate expected performance and guide geometry selection for stable and efficient operation. The prototype is designed for manufacturability using additive manufacturing methods and corrosion-resistant hardware, enabling repeated testing and future design improvements. The system serves as a scalable platform for studying small-scale marine renewable energy generation and improving turbine efficiency in low-flow environments.

52 Mobile Arm Support

Students: Ryan Rojas, Matthew Mendoza, Jose Jimenez, Zaid Srouji
Mentor/Advisor: Dr. The Nguyen

Project Summary: The Active Mobile Arm Support (MAS) is a powered assistive device designed to help individuals with muscular weakness improve upper-limb movement. Many current arm supports rely on passive mechanisms, such as springs or counterweights, which can hold the arm up but do not actively assist the user in moving. The goal of this project was to design a table-mounted system that assists with shoulder elevation and elbow positioning during everyday tasks. The device uses a three-degree-of-freedom linkage made from lightweight aluminum tubing to balance strength and weight. The mechanical components were designed using load and stress analysis, then checked using finite element analysis to ensure safe operation. A microcontroller-based control system coordinates the motors and power distribution to provide smooth motion. The system demonstrates reliable assisted movement and shows how mechanical design and embedded control can be combined in a practical rehabilitation device.

53 Prosthetic Hand

Students: Briyan Lucatero, Andrei Catalan, Prabal Angrish, Osvaldo Ruiz-Villegas
Mentor/Advisor: Dr. The Nguyen

Project Summary: This senior design project presents a redesigned below elbow prosthetic arm focused on improving comfort, efficiency, and ease of use based on direct feedback from amputees. Interviews with users at a prosthetic clinic in Lemoore, California, along with insights from online amputee communities, guided the design toward increasing comfort, simplifying attachment and reducing friction. These priorities led to a redesign of the prosthetic's mechanical and user-interface features to improve daily usability and reliability. The final design is lightweight, ergonomic, and mechanically efficient, enabling smoother motion and stronger, more dependable grasping while minimizing user fatigue. A new attachment approach replaces traditional socket based systems to improve comfort and reduce pressure on the residual limb. Overall, the project delivers an affordable, user centered prosthetic solution that enhances long term wearability and quality of life.

54 Robotic Helper and Guard

Students: Johan Moua, Allen Sanchez, Daniel Ornelas, Carlos Jimenez
Mentor/Advisor: Dr. The Nguyen

Project Summary: Package theft and residential burglary impose significant financial and emotional burdens on homeowners across the United States. An estimated 120.5 million packages were stolen in 2023, resulting in more than \$15 billion in losses, alongside more than 839,000 reported home burglaries. This project proposes an autonomous, non-lethal robotic security system designed to patrol home exteriors, identify unauthorized individuals, and deter criminal activity. The system integrates four coordinated subsystems: chassis and mobility, package handling, weapon firing, and AI-based control. The

design emphasizes affordability and practicality through an off-the-shelf tank-style chassis, a simplified, garbage-truck-inspired robotic arm for package retrieval, an electronically actuated gel blaster for controlled, non-lethal deterrence, and an AI vision pipeline supported by remote GPU inference. The resulting prototype aims to autonomously patrol, verify identity, issue escalating audio warnings, and deploy non-lethal force as needed, providing a practical approach to reducing theft-related losses.

55 Robotic Peach Harvester

Students: Natalie Maciel, Joel Velez, Carlos Vasquez, Alexander Ellis, Chathura Samarakoon
Mentor/Advisor: Dr. Ho-lung Li

Project Summary: This project presents an AI-vision-guided robotic peach-harvesting system designed to mitigate critical labor shortages while enhancing agricultural efficiency and sustainability, particularly within high-density orchard environments. The proposed solution integrates a 5-DOF robotic mechanism, featuring a specialized suction-based harvesting gripper to eliminate fruit bruising and a custom extension arm optimized for maximum workspace reach and mobility. To ensure precise operation, the computer-vision subsystem uses a deep-learning architecture for real-time fruit detection and 3D localization, integrated with the robotic arm's motion controller via a Robot Operating System (ROS) framework. This architecture enables autonomous path planning and adaptive grip execution based on continuous visual feedback. The ultimate objective is to significantly reduce harvest cycle times, minimize fruit damage rates, and provide a scalable, cost-effective framework for transitioning to fully autonomous, intelligent orchard management in the Central Valley and beyond.





56 Central California Engineering Design Competition Winning Design

Students: **Morgan Ctibor, Alejandro Gutierrez, Madison Gonzales, Avnique Kaur Gill, Zhenhong Li**
Mentor/Advisor: **Roger Moore, Eduardo Torres**

Project Summary: Introduction to Engineering students participated in the Central California Engineering Design Challenge, which involved the design, construction, and testing of a vehicle capable of transporting a payload of up to 50 pennies per run, representing 50 passengers. A run was considered successful if the vehicle ascended the ramp without falling off the ramp. Within a limited timeframe and under specified cost constraints for construction materials, the objective was to develop the most efficient and cost-effective vehicle possible. Multiple design concepts were evaluated, and the final model was produced after considering key performance factors and conducting several trial-and-error tests. The winning team's design utilized a supercapacitor to supply power and was able to deliver all "passengers" to the highest region of the ramp in the minimum number of runs, earning the highest possible income score.

57 Toy Car for Beau

Students: **Gabrielle Torres, Hunter Fraser, Kaitlyn Rockholt**
Mentor/Advisor: **Dr. The Nguyen**

Project Summary: This project aims to design, model, and fabricate a 3D-printed toy car that meets the needs of a six-year-old boy with KIF1A-Associated Neurological Disorder (KAND), a neurodegenerative genetic disorder that causes visual impairment, limited mobility, developmental delays, and other impairments. A manually pushed toy car that he will be able to sit inside of, similar to ones made by Little Tikes or Step2, will be uniquely designed to fit his needs, focusing on accessibility, safety, and durability. Engineering considerations include a push handle, a lap seatbelt, a solid bottom to avoid foot drag, and plenty of leg room. Other features include aspects like cupholders and storage for usability. This toy car will demonstrate how engineering can be used to create custom, accessible products that focus on user needs.



58 TransitHub-AI-Powered Geospatial Platform for Transit Accessibility and Equity Analysis

Student: **Pratham Aggarwal**
Mentor/Advisor: **Dr. Aly Tawfik**

Project Summary: Advancements in AI and geospatial analytics offer new opportunities to address transportation equity. This research introduces TransitHub, a novel AI-powered platform designed to visualize and assess transit accessibility across the United States. Unlike traditional tools relying on static schedules, TransitHub leverages Google APIs to harvest real-time performance metrics for millions of addresses, fusing them with census-level socioeconomic data. The platform features a "drill-down" interface utilizing K-Means clustering to automatically segment regions into performance quadrants, effectively identifying "transit deserts" and "equity gaps." Furthermore, it integrates a Retrieval-Augmented Generation (RAG) architecture and a Planner-based AI chatbot, enabling users to query complex database schemas using natural language to generate instant, data-backed insights. By bridging the gap between abstract statistics and actionable policy, TransitHub provides a scalable decision-support system for optimizing infrastructure planning nationwide.



F3 (FARMS FOOD FUTURE) INITIATIVE



59 An Agent-Based Model for the Analysis of Groundwater Usage and Replenishment

Students: **Jaden Luna, Jose Eduardo Rodriguez**
Mentor/Advisor: **Dr. Jorge Pesantez**

Project Summary: Groundwater supplies roughly 40% of the water used by Californians, rising to 60% during drought years. This reliance on groundwater can lead to overdrafting, resulting in dry wells, subsidence, pollution, and more. These effects are limited by groundwater replenishment, where water is pumped back into aquifers. This study focuses on modeling groundwater consumption and replenishment with an agent-based model (ABM) approach. An ABM simulation enables a comprehensive evaluation of groundwater demand and supply. The model planned by this study would be able to identify trends in groundwater users represented by agents, potentially showing early signs of overdrafting, and replenishment efforts may be needed. Results are expected to inform users about where and when high consumers might occur and identify areas where groundwater issues could arise due to overdrafting.

60 Deep Learning-Based Geometric Characterization and 3D Localization of Oranges and Stems in Field Environments

Students: **Andrei Catalan, Kinnoree Pasha**
Mentor/Advisor: **Dr. Alaeddin Bani Milhim**

Project Summary: Complex agricultural environments, including fruit overlap, leaf occlusion, and variable lighting, limit the effectiveness of traditional image processing methods. This research implements an RGB-D camera and YOLOv8 instance segmentation to improve citrus fruit and stem recognition in field conditions. Segmentation masks are post-processed using contour-based centroid extraction to obtain stable pixel targets, which are converted to metric distances using depth measurements and calibrated camera intrinsics for 3D localization. A dataset of 1,159 images collected at Fresno State farms was augmented to 3,391 images using brightness, saturation, and exposure variations, and manually labeled into orange and stem classes for supervised training. On the held-out test set, the model achieved a mean average precision at 50% overlap of 88.0%, with 99.0% for oranges and 76.0% for stems, demonstrating robust fruit segmentation and reliable stem discrimination for autonomous harvesting applications.

61 DeltaX Robot Autonomous Weed Detection and Elimination for SARDOG

Students: **Daniel Remington, Armanjit Gill, Brandon Wilbur**
Mentor/Advisor: **Dr. Hovhannes Kulhandjian**

Project Summary: The DeltaX Weed Removal robot was developed to support Fresno's agrarian community. Its primary goal is to remove weed pulling, a repetitive and labor-intensive task, so farmers can devote their time to other important duties on the field. The robot's main function is to detect and remove weeds using an AI-based vision system and a flexible robotic DeltaX arm. The AI model will be trained on a large sample of pictures of weeds native to Fresno, California. DeltaX is controlled via a Raspberry Pi using a ROS2 framework. ROS will be programmed to coordinate navigation, image processing, and motor movement. The project will involve a DeltaX arm, a CPU coordinator (Raspberry Pi/Thor Jetson), the YOLOv9 AI detection system, and a MiDaS depth-detection model paired with ROS2. Our project aims to demonstrate the positive impact that robotics can have on agricultural productivity.

62 Development of an Electrodialysis-Based Water Treatment System for Selective Ion Removal and Recovery of Phototoxic Contaminants

Students: **Hovhannes Torikyan, Gurkeerat Singh, Miguel Sanchez, Dominic de Castro**
Mentors/Advisors: **Dr. The Nguyen, Dr. Sankha Banerjee**

Project Summary: This project evaluates, automates, and optimizes an electrodialysis reversal (EDR) system for precise ion separation from saline and brine streams. EDR is a membrane-based electrochemical process that selectively transports ions across alternating cation- and anion-exchange membranes under an applied electric potential, producing dilute and

concentrate streams. The work focuses on improving reliability, controllability, and experimental repeatability through system-level enhancements. A key objective is developing an automated control architecture using a programmable logic controller (PLC) and operator interface to regulate pumps, valves, and system monitoring. This automation aims to improve safety, scalability, and consistency while reducing manual intervention. Concurrently, computational fluid dynamics (CFD) simulations using ANSYS tools and OpenFOAM examine transport behavior within the hydraulic loop and membrane channels, identifying inefficiencies such as flow nonuniformity or pressure losses. Integrating experimental operation with simulation-guided design adjustments supports development of a more robust, efficient, and scalable EDR platform.

63 Precision Citrus Harvesting Robotic System for Controlled Stem Length

Students: **Brendan Chinnock, Andrei Catalan, Alexander Ellis, Daniel Yang, Nicole Oliva, Juan Espinoza, Caleb Banhe**
Mentor/Advisor: **Dr. Alaeddin Bani Milhim**

Project Summary: This project focuses on the development of a precision citrus harvesting robotic system capable of cutting fruit with a controlled residual stem length. Controlled stem length is critical to maintain the fruit quality and market value during post-harvest handling and distribution. The system addresses increasing agricultural labor shortage and improves harvesting efficiency. The system consists of a mobile platform, a 6-DOF Fairino robotic arm, an RGB-D camera, and a custom-designed end-effector. This end effector incorporates three TPU-filament gripper fingers for compliant fruit grasping and an integrated shearing mechanism for controlled stem cutting. Using a machine learning-based fruit recognition system, the robotic manipulator positions the end-effector in contact with the target fruit. A novel motion strategy incorporating lateral and vertical vibrations is applied to align the stems within the shears blade for precise cutting. Once the stem is cut, the fruit is automatically harvested and deposited into a collection bin. Field experiments validated the system's performance, achieving a 95% harvesting success rate with an average cycle time of 40 seconds per fruit. The residual stem length consistently met the 2-mm target, satisfying post-harvest quality requirements.

64 Remote Sensing-Based Leak Detection in Agriculture

Student: **Aaron Millwee**
Mentor/Advisor: **Dr. Alaeddin Bani Milhim**

Project Summary: Water loss from undetected leaks in agricultural irrigation systems poses significant economic and environmental challenges. Irrigation pipes and hoses are often shallow or surface-level, vulnerable to damage from equipment, and difficult to monitor across systems that may span hundreds of acres. This research reviewed non-invasive water leak detection and localization methods, with emphasis on acoustic techniques, ground-penetrating radar (GPR), infrared (IR) thermography, and microwave remote sensing. Acoustic approaches, including leak noise correlation and hydrophone-based detection, effectively identify leak-induced vibrations in plastic pipes but require close proximity to the pipeline, limiting their feasibility for large-scale agricultural deployment. GPR detects leaks by exploiting dielectric contrasts associated with soil moisture anomalies; however, its performance is highly dependent on soil composition, moisture variability, calibration, and ground proximity, making it impractical for aerial platforms. IR thermography enables rapid, wide-area monitoring by identifying surface thermal anomalies, but its reliability is affected by environmental factors such as solar radiation, soil moisture conditions, and vegetation cover, leading to false positives when used independently. Passive microwave remote sensing provides broad soil moisture measurements but lacks the spatial resolution required for precise leak localization. Overall, the literature indicates that no single method can provide reliable and cost-effective detection across diverse agricultural conditions. Future work will investigate a hybrid approach combining drone-mounted, low-cost IR imaging for wide-area detection with localized soil moisture verification through targeted drilling and moisture sensing performed by the same drone at suspected leak locations.



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