VTOL-UAV Senior Design Capstone Project

Description:

A Bi-Plane VTOL(Vertical Take off and Landing) UAV(Unmanned Aerial Vehicle) designed to compete in the 2026 C-UAS Competition (June 6-7). Designed by SDSU's Team Quetzal, Joint ME-ECE-AE team.

Summary:

Designed to compete at the competition with the following requirements:

1. UAV shall weigh less than 55lbs per FAA 107 regulations
2. UAV shall have a thrust to weight ratio of 2:1
3. UAV shall be built with a budget of $2,000
4. UAV shall be modular to easily replace parts
5. UAV shall complete 4 out of 8 mission tasks
    1. Package Delivery (Package shall weigh 1kg)
    2. Circuit Time Trial (7 waypoints as fast as possible)
    3. Target Localization (Identify and locate 7 targets)
    4. Package Recovery (Package shall weigh 2kg)
6. UAV shall complete the 4 missions autonomously
7. UAV shall be designed to be manufactured for 3D printing

Problem: The department mandated the reuse of the old avionic units and the propulsion unit due to a $500 budget cap. However, the existing platform could not meet the speed and endurance requirements of the competition. To bridge the gap between project goals and financial constraints, the team pivoted to a dual-track strategy: securing external funding and developing a high-efficiency airframe.

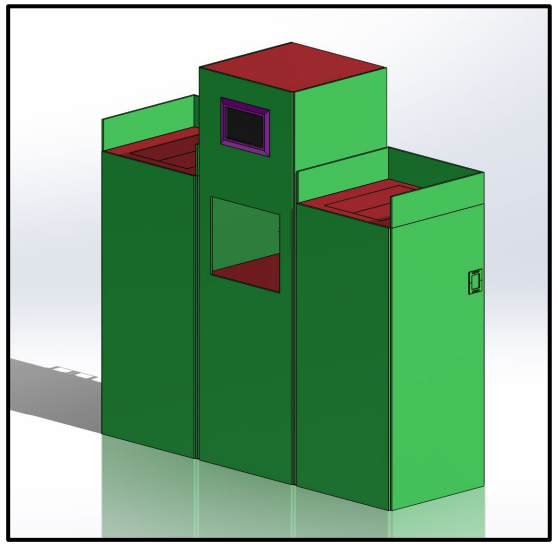
Method: Secured $1,500 in external sponsorship to augment the $500 departmental budget, enabling a custom build. The team designed a Bi-plane VTOL UAV utilizing a "tailsitter" transition profile. Unlike complex tilt-rotor systems, this design uses fixed, upward-facing motors for takeoff and rotates the entire airframe 90° into a horizontal orientation for forward flight.

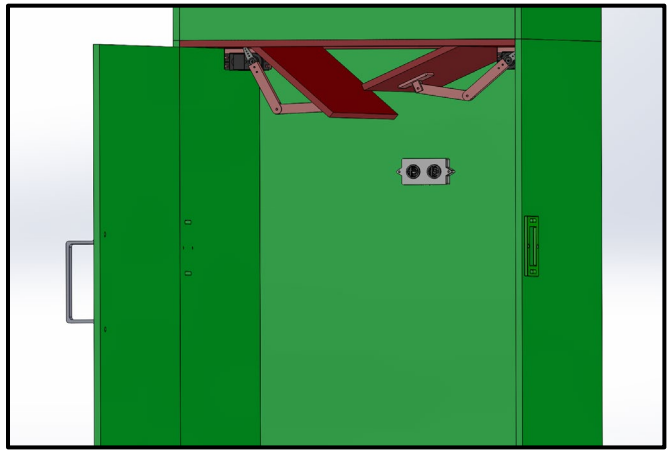
Solution: By transitioning to wing generated lift, the UAV is able to use 100% of motor thrust to propel forward rather than overcoming gravity. This configuration achieved a significantly higher top speed and power efficiency than the previous year's quadcopter. I oversaw the design, fabrication and flight testing, resulting in a successful proof of concept flight and validation of the prototype's aerodynamic superiority.

Engineering Specs:

- Top Speed: 70 MPH
- Weight: 10 lbs.
- Dimension: 4.3 ft x 1.3ft x 1.6 ft
- Flight Time:
    - 18 min (100% throttle)
    - 34 min (65% throttle)
- Payload Capacity: 7 lbs.

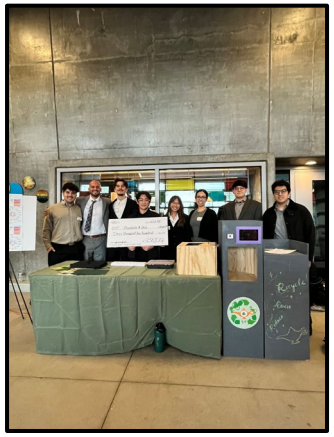
BRDG Innovation Challenge: Smart Trash Bin





Summary:

Designed and engineered an award-winning AI-integrated prototype within a 6-month development cycle for the BRDG Innovation Challenge. While the competition allocated a $2,500 budget, the team successfully delivered a fully functional prototype for only $600, showcasing high cost-efficiency and resource management. I lead the mechanical development, utilizing SOLIDWORKS to create a 3D CAD assembly before transitioning to physical fabrication using plywood and custom 3D-printed components. The project, which features a neural network for automated waste identification and a gamified rewards system, secured 1st place and a $3,500 grand prize.



Problem:

High contamination rates in US waste management are primarily driven by a lack of foundational sorting habits and public confusion. Current disposal methods are passive and unengaging; without immediate feedback or incentives, there is little motivation for the public, specifically the youth, to learn proper classification. This lack of education at a young age leads to lifelong poor waste management habits that persist across generations.

Method:

The team developed a localized AI solution using a Raspberry Pi 5 to handle real-time image processing and user interface tasks.

- **Data Strategy:** To ensure high reliability, we utilized a hybrid dataset, combining established open-source waste data with a custom-labeled library.
- **Engineering:** We trained a neural network to categorize items into three primary streams: solid waste, organic waste, and recyclables.
- **User Authentication:** A digital ID scanning system was integrated to track individual contributions and aggregate data for group-based incentives.

Solution:

The team built an interactive kiosk that transforms waste disposal into a competitive educational game. By requiring users to identify their waste before disposal, the system provides active learning feedback.

- **Operation:** Integrated a servo-driven actuation system with custom 3D printed linkages for automated lid control. To ensure a seamless user experience, ultrasonic sensors were utilized to detect item deposition, providing the necessary feedback to trigger the closing sequence.
- **Performance:** The prototype achieved 90% classification accuracy across all target waste streams.
- **Incentivization:** To drive long-term engagement, the system utilizes a leaderboard-style rewards model where students earn points toward class-wide prizes.