Self-Securing Mechanism for VTOL Autonomous Vehicle

Project Talon

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Project Overview

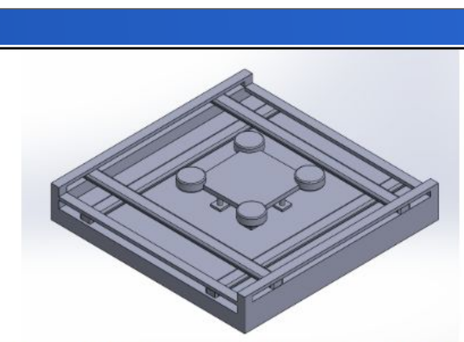
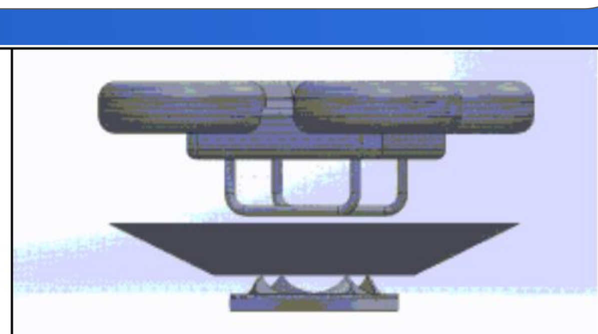
The purpose of this project was to create a landing pad for a VTOL autonomous aircraft to land on and be locked in place without human interaction. A self-securing landing mechanism will enable multiple autonomous flights for an extended period of time with no human interaction required.

System Requirements

1. Drone shall be able to successfully land on, lock into, unlock, and take off from the home base without human interaction.
2. Home base shall be able to rigidly secure the landed drone until the drone is ready to take off again.
3. The home base shall be able to be transported, assembled, and deployed by 4 Project Talon Team members within 1 hour.
4. Home base shall be able to support the weight of the final drone design both statically and dynamically.
5. The home base shall be designed to function in an outdoor environment for extended periods of time without human interaction, maintenance, or repairs.
6. Drone shall be able to successfully land in day and night time conditions
7. Home base shall operate in various weather conditions.

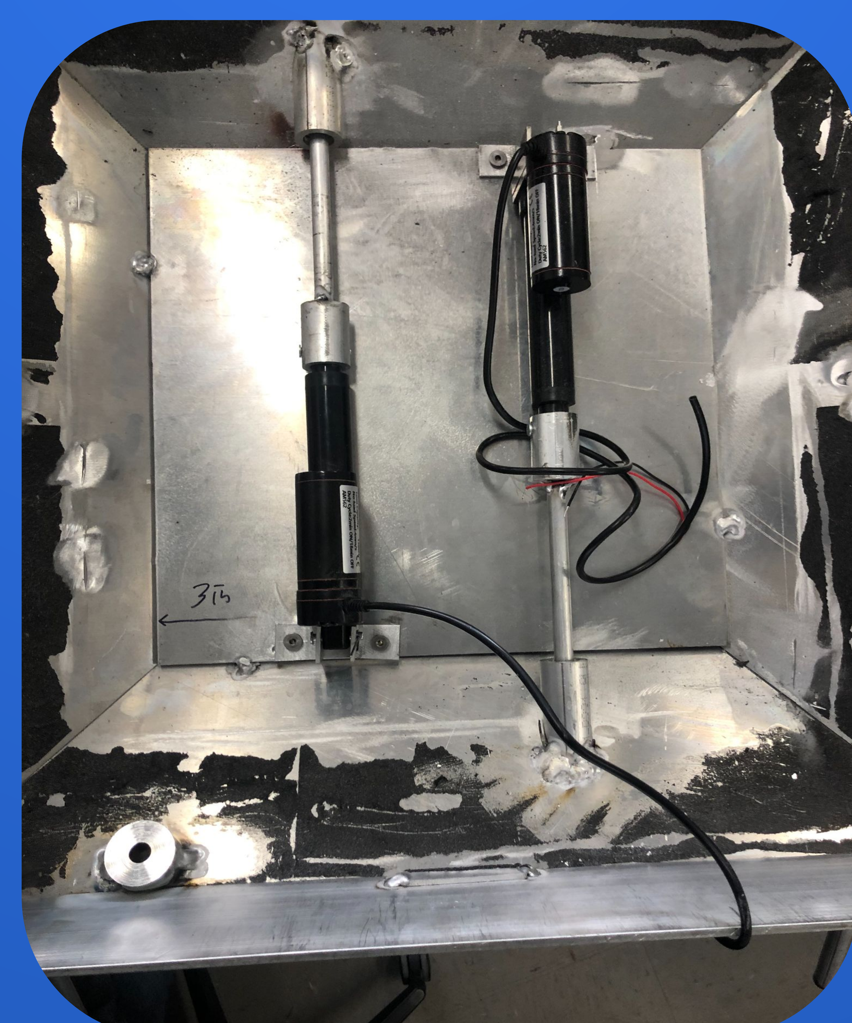
Landing Pad Design Choice

A pyramidal structure was chosen for our landing pad design. Considerations that lead to this design included a large margin of error for the drone, mechanical alignment of the drone due to the interaction between the legs and the pyramid, and simplicity of manufacturing and assembly.

Landing Pad Design Trade Study							
Qualities	Weight (%)	Pyramid		Parallel Securing Arms in X & Y		Guiding Cone and Orientating Base	
		Score	Justification	Score	Justification	Score	Justification
Machinability	15	5	Easy manufacturing	4	Accurate tolerancing required	2	High level of difficulty
Costs	5	5	Exterior can be made from one sheet	3	2 steppers, 2 gears, 1 Sheet of metal	4	Machined from large billets
Complexity	10	5	Cam actuated securing pins	2	Two axes being secured in sequence	4	Multiple motors to secure drone, otherwise, no moving parts.
Control System	25	4	Logical mechanical feedback from pyramidal design	5	Large flat surface good for mounting sensors	3	No mechanical feedback from design. No space for sensors
Margin of Error	25	4	1/2 the distance between the drone's legs.	5	1/2 the distance between the drone's legs.	3	<1inch horizontal margin of accuracy.
Serviceability	5	5	Fewest number of parts	2	Highest actuator complexity	4	Multiple motors to secure drone, otherwise, no moving parts.
Weather Resistance	15	5	Mechanical components are protected. No build up areas	1.5	Multiple components require environmental protection	3	Much consideration must be given to drainage.
Weighted Totals	100	4.5		3.775		3.05	

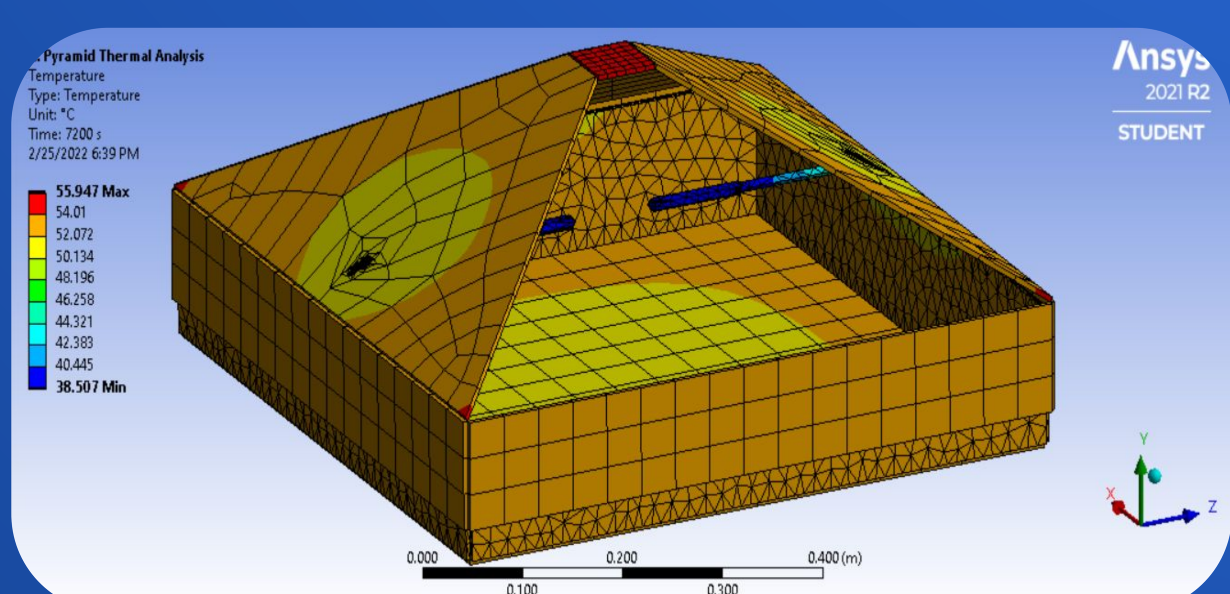
Securing Mechanism

Two **linear actuators** extend two pins out through the pyramid shell and over the horizontal bars of the drone's landing legs.



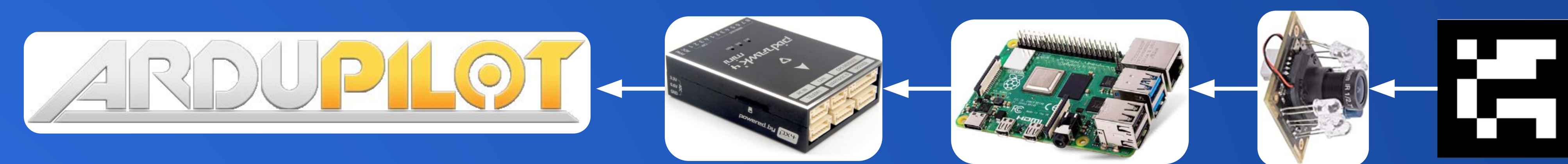
Thermal Design

The operational temperature ratings of the enclosed electronics drove the thermal design choices of the pyramid. It was decided that **insulation** would maintain interior temperatures within an operable range while not exposing the interior components to rain, sand, or dust from the environment.

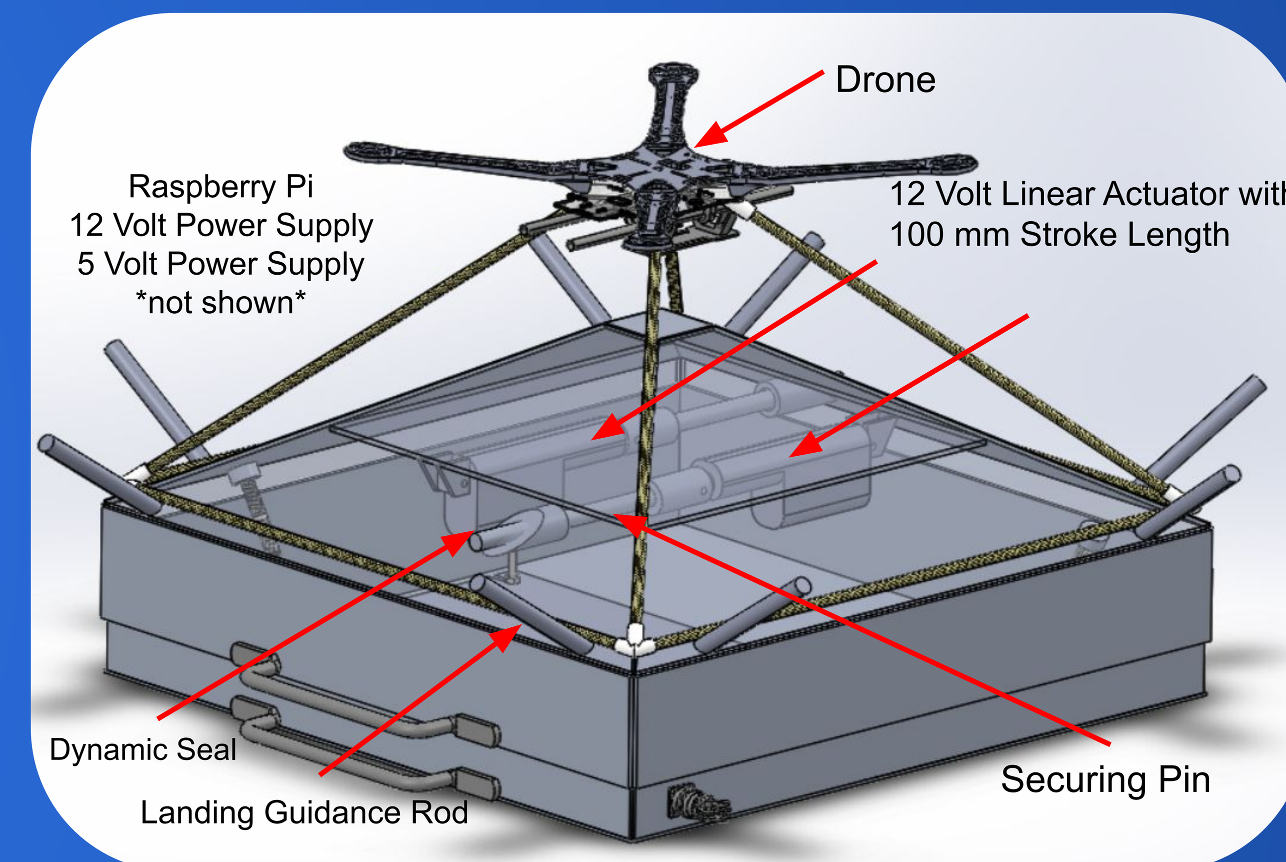


Drone Navigation & Guidance

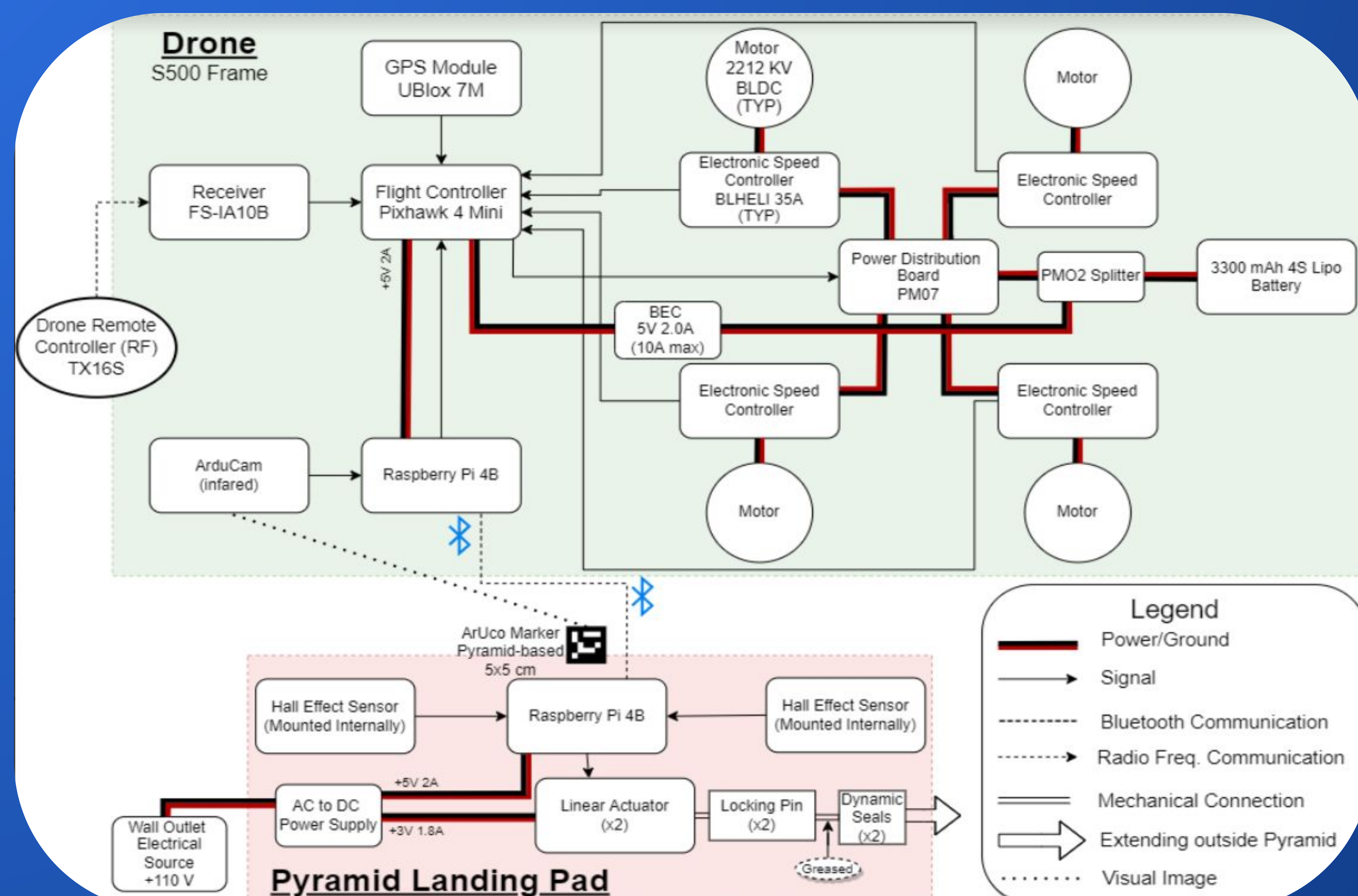
Autonomous control of the drone was accomplished via existing flight control software, **ArduCopter**, and existing hardware, **Pixhawk** flight controller. The drone utilized the **OpenCV** library in conjunction with an infrared, drone-mounted camera, and pyramid-mounted ArUco marker to locate, navigate, and land. A python script running on a drone-mounted Raspberry Pi computes the positional data and interacts with flight control software to land.



Landing Pad Component View



System Level Diagram



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