# Active Altitude Control System

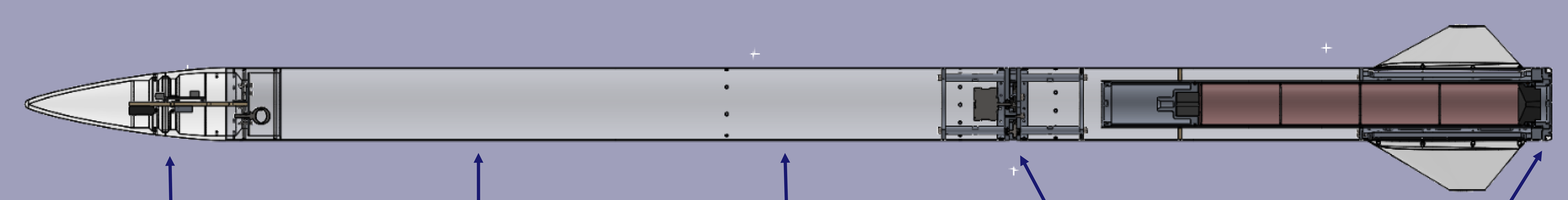
## Bad Altitude – UVic Rocketry

## Overview

The *Active Altitude Control System* (AACS) is a device designed to enable UVic Rocketry (UVR) to attain a specified maximum altitude (apogee) with greater accuracy. It does so by intelligently manipulating the drag properties of the rocket to control the apogee of the rocket.

The AACS is designed for a 4.5" outer diameter rocket equipped with a commercial off-the-shelf motor with an altitude target of 10,000 ft above ground level. The next launch window for this project is at the *2020 Launch Canada* event.

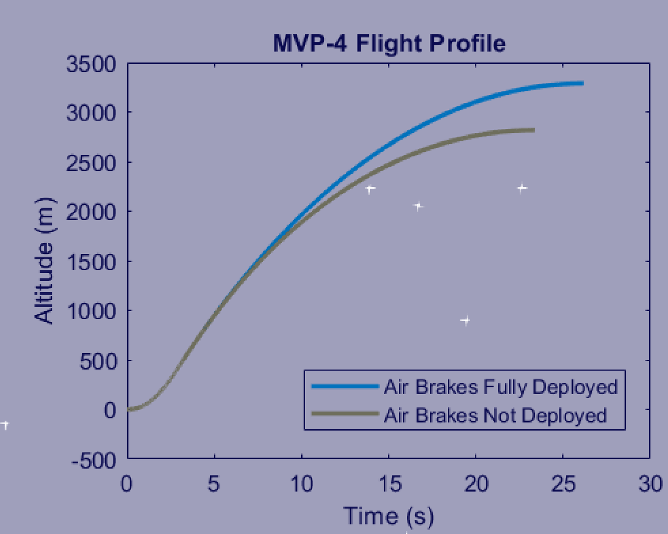
| PARAMETER | VALUE |
|---|---|
| Weight | 5.5 lb |
| Outer Diameter | 4.6 in |
| Height | 11 in |
| Max Flap Exposed Area | 7 in² |
| Max Operating Velocity | 0.7 Ma |
| Max Apogee Adjustment | 1,500 ft |
| Target Apogee | 10,000 ft |

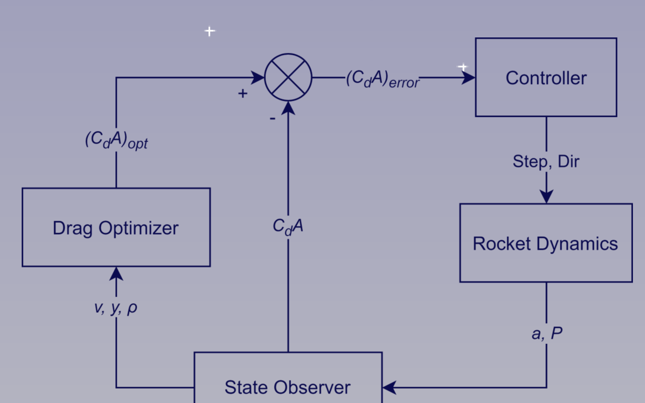


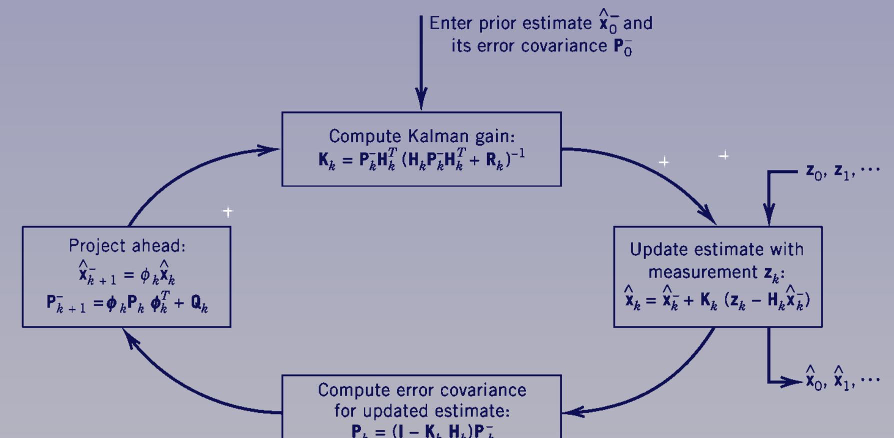

## Control System

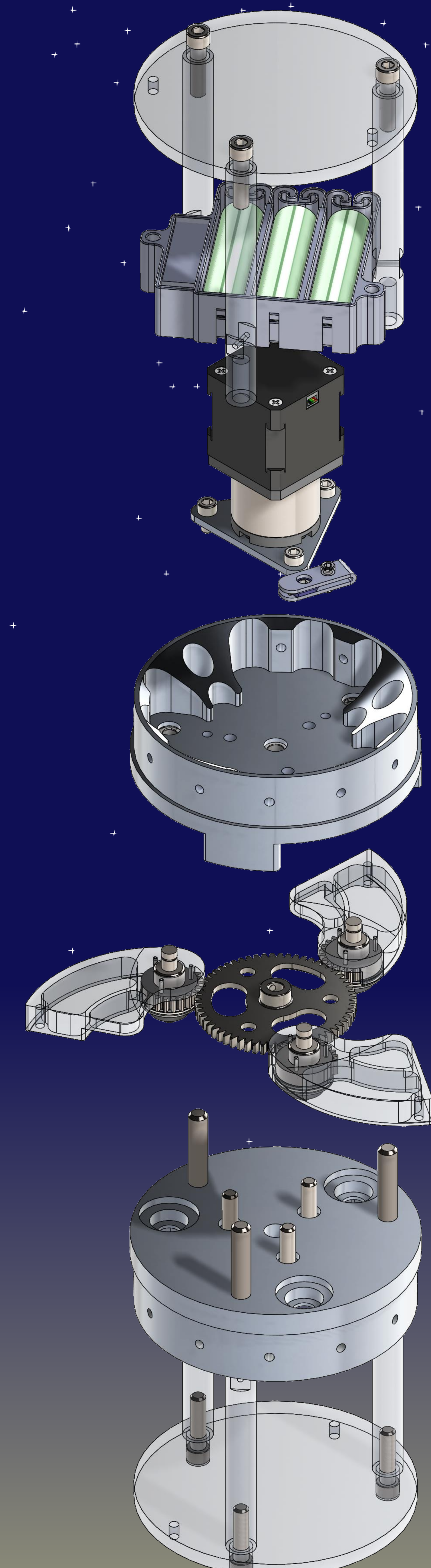
A Raspberry Pi running a Simulink program controls the AACS. Since flight testing was not possible in the scope of this project, processor-in-the-loop testing was performed to validate the control system.

The control system uses a Kalman filter linearized around a nominal trajectory to estimate the state based on sensor data. This state is then used to select an optimal drag coefficient based on 1-DOF trajectory simulation. The error between the ideal and actual drag coefficient is then fed into a proportional controller to actuate the air brake flaps.



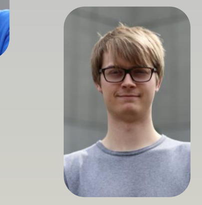



## Meet the Team


Benjamin Klammer
Project Management


Simon Park
Electrical System


Alan Jullien-Corrigan
Control System


Ethan Hansen
Design and Integration

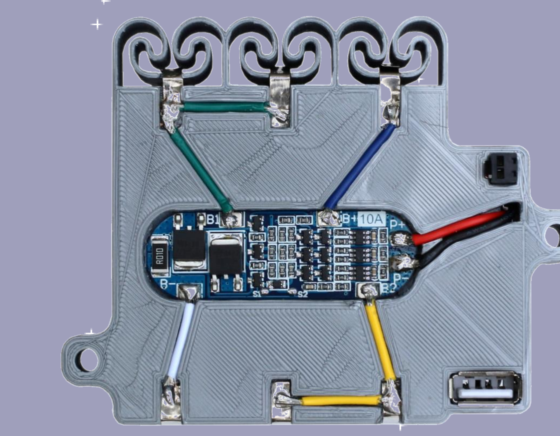

Josef Svorkdal
Design and Manufacturing

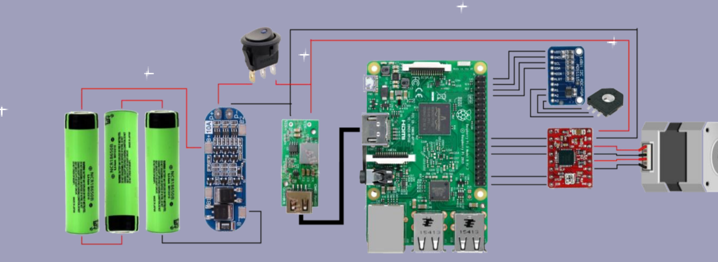
## Electronics

The AACS is powered by a 3S1P li-ion battery pack. A BMS provides balanced 12V discharge up to 13A. A voltage converter steps down the 12V (required for the stepper motor) to the 5V to power the Raspberry Pi and circuit components.

A NEMA-17 stepper motor with a 14:1 gearbox actuates the flap assembly and is driven by an A4988 stepper driver. A rotary position sensor provides feedback on the flap position.

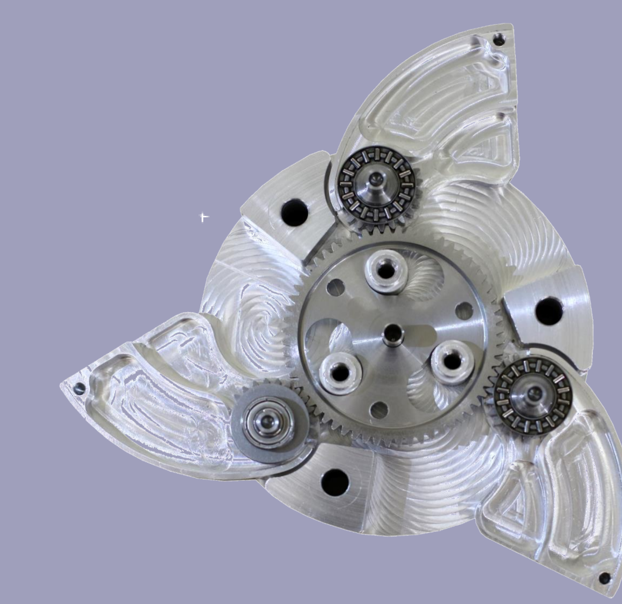
The flight-ready version of the AACS will be equipped with an IMU to measure three-axes of acceleration and angular velocity, as well as a barometer for altitude calculations.

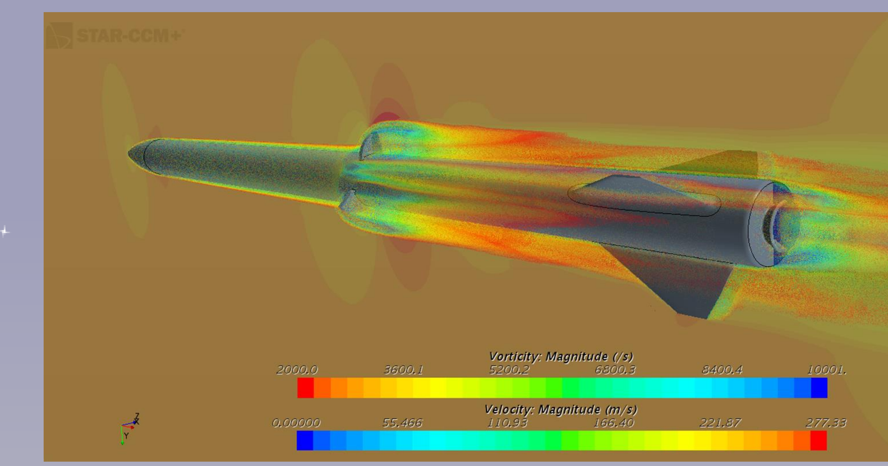


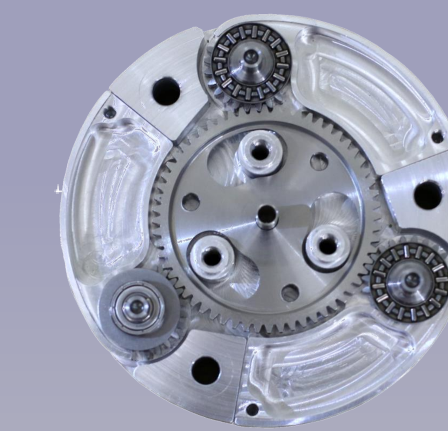


## Gearbox

The motor shaft rotates the sun gear, which actuates the planetary gears fixed to the air brake flaps. CFD and FEA analyses were used to determine the aerodynamic forces on the flaps to properly size the flaps, shafts, and motor. The gearbox components are primarily aluminum except for the steel gears and shafts. Large structural islands are machined into the gearbox to transmit the loads around the rotating flaps.







## Coupler

To ensure easy assembly and rocket structural integrity, the AACS acts as a coupler between the lower and upper fuselages of the rocket. Extensive load case characterization and FEA were performed to ensure the AACS would safely withstand the thrust, aerodynamic, and impact forces that the rocket is expected to experience during flight and recovery.