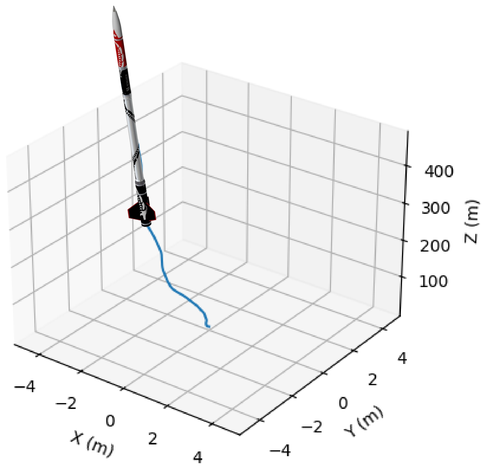
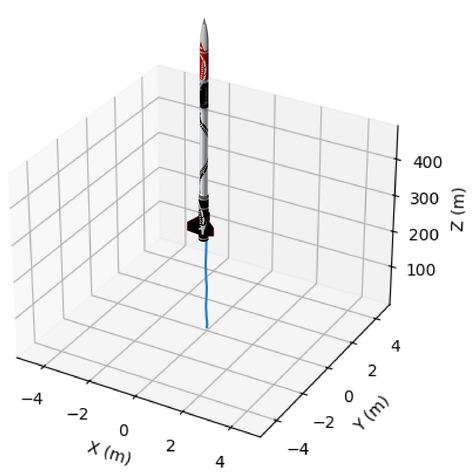
T.V.C
Thrust Vector Control





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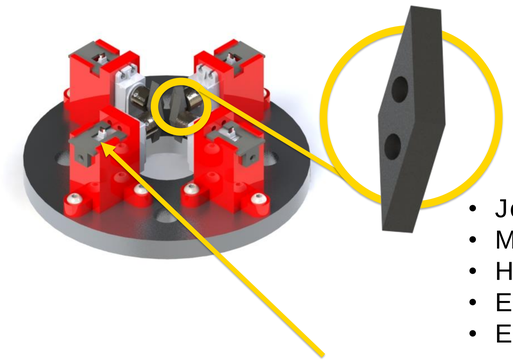
Problem

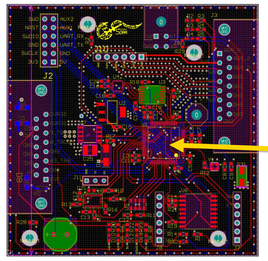
- Normal methods fail to control the vehicle in outer space or at high speed
- T.V.C helps rockets change direction accurately without needing big fins or wings
- The university's rocket team wants to add this ability to their rockets
- How can we do this without putting expensive rockets in danger?

Control System



- Jet vanes redirect exhaust
- Made from graphite
- High strength material
- Excellent heat resistance
- Easy to manufacture

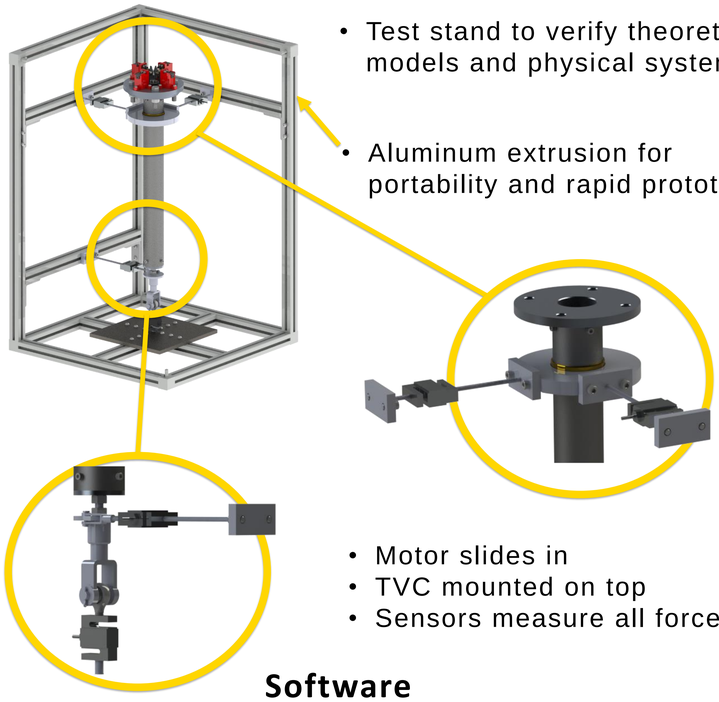
- Servos control angle of the vanes
- Allows for maneuvering in all directions



Avionics monitor and control direction and position

- STM32F4
- 2 IMU
- GPS
- Barometer

Verification



- Test stand to verify theoretical models and physical systems
- Aluminum extrusion for portability and rapid prototypes
- Motor slides in
- TVC mounted on top
- Sensors measure all forces

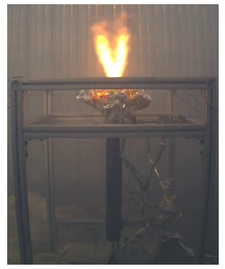
Software

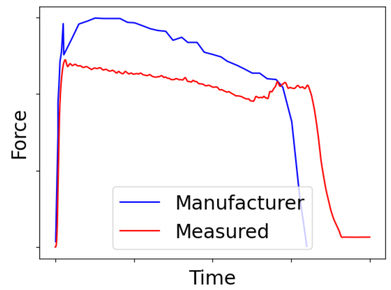
- Calibrates sensors
- Collects data
- Analyzes forces

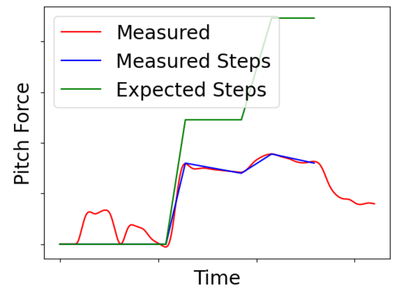
Results

Vanes Neutral

Vanes Deflected







- Thrust used to accelerate
- No side thrust created
- No changes in direction

- Reduced acceleration
- Some side thrust created
- Creates change in direction

Validation

- Cyber physical system simulates real flight with live data
- Allows testing and tuning of software before flying
- Reduces risk of losing flight vehicle

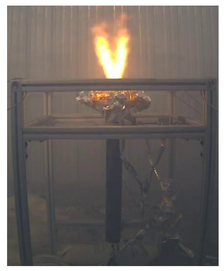
1) Simulator ignites motor

2) Flight path adjusted

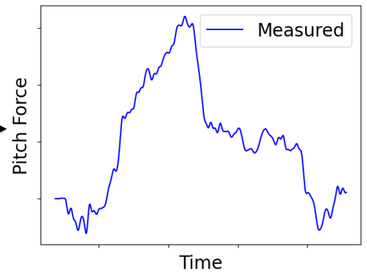
3) Control system determines course correction

Proportional
Integral
Differential

4) Vanes redirect thrust



5) Sensors read thrust changes



6) Sensor data used to update simulation

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