Mechanical Engineering Undergraduate Honors Research

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TVC Rocket

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**Project:** Thrust Vectoring Control (TVC) Model Rocket

**Overall Purpose:** To advance thrust vector model rocket technology in terms of safety.

**Research goals:**

1. Open source safe rocket testing environment
   1. Question we are trying to answer: **What is a robust method for testing a model TVC system to ensure a safe launch?**
   2. Current method: cold gas testing, unsafe hold down testing.
   3. Proposed Method: 2-DOF test rig with encoders and load cells that collects data regarding rocket dynamics. Simulation model that utilizes this updated dynamics based data in order to help us tune PID constants for the rocket
2. Alternative parachute recovery system
   1. Question we are trying to answer: **Are parachutes deployed by actuation safer and more reliable than black powder deployed parachutes for TVC model rockets?** *What is a reliable and safe method for recovery of TVC style model rockets?*
   2. Current method: black powder charge
   3. Proposed method: servo actuated spring loaded mechanism to release parachute or propellor wings to act as an air brake

**What have we completed in the Fall:**

Goal 1: Test Rig

1. Conceptualized what we wanted to test and a design
2. Completed 90-95% of design in CAD
3. Ordered all components
4. Wrote preliminary data collection/sensor integration software
5. Created Simulink sim to predict controller behavior with rocket

Goal 2: Rocket Design (Now goal has changed to Parachute Deployment)

1. Bought new electronics to replace the old, fried electronics
2. Made PCB for a more reliable wiring scheme
3. Replaced servos and installed the electronics
4. Tested gimbal limits and new electronics, pcb with hold-down test, success.
5. Tested the parachute deployment mechanism design 1 twice, failed
6. Brainstormed new methods to deploy parachute

**Problem List**

1. How to use impact hammer information in conjunction with encoders.
2. Fit Encoder into Outer ring, does it work?
3. Does inner ring design really work? Is there a simple solution that will work better?
4. Gyroscopic sensor drift
5. Need to add a servo to the electronic system

**What needs to be done in the Spring:**

Goal 1: Test Rig

1. Assemble Test Rig
   1. Testing the inner ring, drilling it out for hardware
   2. Testing outer ring, drilling out for hardware and encoder
   3. Design and print a part to hold the encoder to the wood frame
   4. Design electronics enclosure
   5. Flush out any apparent design flaws through iterations of prints, If inner ring or outer ring don’t work redesign and re-print
2. Get Impulse response from rocket using impact hammer
3. Wire up electronics for test rig
   1. Ensure accurate readings from encoders and load cells (calibration)
4. Software for test rig
   1. Turn encoder readings and load cell readings into something useful
   2. Load Cell readings indicate amount of actual force at liftoff we are receiving
   3. Encoders demonstrate angle that rocket is deciding to converge to
      1. Need to implement filters on load cell and encoders
5. Test with a rocket ignition to make sure it holds
6. Integrate sensor data with sim, interpret data to be useful
   1. How to do this?

Goal 2: Parachute Deployment

1. Come up with and decide on a design to pursue
2. Dis-assemble current rocket and decide what can be salvaged
3. Buy new tube, think about new electronics either pcb or an addition to current pcb
4. New electronics enclosure, lower weight
5. Test parachute or prop to make sure it can take the weight of our rocket
   1. Drop off a building and record time of descent
6. Design a parachute mechanism
7. Order parts
8. 3D print newly designed parts
9. Assemble the parachute mechanism
10. Test the parachute mechanism in the rig
11. Test the parachute mechanism with a launch, either with a functioning gimbal or with fins or something