Development of a High Altitude Visual Orientation Control (HAVOC) System for Balloon Payloads

J. Stark, Q. Booker, A. Roberts, M. Downey, T. Marshall, E. Golley
Advisor: Dr. Richard Tantaris

Introduction

HAVOC is a system intended to control the orientation of a weather balloon payload. Balloon payloads are valuable research tools but are inherently unstable during flight. Recording video of the upper atmosphere is difficult due to the uncontrolled nature of payload rotation. HAVOC solves this issue by using high-pressure air (HPA) thrusters to control payload orientation and a small form factor camera to record video during flight.

Objectives

1. Control payload rotation above 15km
2. Maintain camera orientation within a 90° target range
3. Operate above target altitude for a minimum duration of 5 minutes

Previous Findings

During the UAH Space Hardware Club’s Two-Month training program in Fall 2019, balloon payloads used limited amounts of CO₂ gas to control their rotational velocity in order to obtain better quality video footage.

The data from one of these payloads is shown below in Figure 1. The payload attempted to keep its rotational speed within an acceptable threshold represented by the red dotted lines. This data established a positive proof of concept for controlling payload rotation and is now being built upon with HAVOC.

Hardware

Fast-acting solenoid valves control the flow of gas to two nozzle sets
Series of pneumatic regulators step down tank pressure to operating pressure
High pressure carbon fiber tank supplies air to system
Carbon fiber lever arm increases maximum torque generated by nozzles
3D printed nozzles increase gas exit velocity

Conclusions

The HAVOC payload will enable the recording of stable video from balloon flights. Through this research, we will gain a better understanding of factors that influence the stability of a payload on a balloon line and be able to transfer this knowledge to other balloon research flights. A prototype is currently under construction.

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