Integrated Spacecraft Autonomous Attitude Control (ISAAC)

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1 Abstract

ISAAC is a 3D-printed pneumatic spacecraft for attitude control system development in a 3-axis gimbal ring. This allows for simulated free-space movement in a controlled test environment. The purpose of this open-sourced controller is to allow students, professors, and researchers to test and train their control algorithms on real hardware in real-time. They will be able to apply the theory from the classroom or their field to a physical system and visualize abstract math. The end goal is to have a website allowing anyone to upload their code and watch it run via live stream. This will support researchers without access to developed hardware to be able to implement and test their algorithms in real-time. Along with supporting undergraduate students interested in learning satellite attitude control and professors like Dr. Drakunov and Dr. MacKunis, who can use it in their classes.

The spacecraft uses a pneumatic system to mimic cold gas thrusters by making use of the school's compressed air supply (Fig. 1) as a means of propulsion. The compressed air being delivered is at $\approx$ 100 psi with an output equal to that. The delivery system uses solenoids to control the thruster, stabilizing the craft. As a safety measure, the apparatus is stored and operated inside a large test cell with an onboard blow-off valve. The hardware consists of custom Arduino PCB's, a Raspberry Pi, an Inertial Measurement Unit (IMU) for total orientation data, and a university approved battery as a power supply. Along with these features, the craft is entirely 3D printed, including the mounts for the components in order to be accessible to more research.

The attitude controller will be integrated into the website ***easycontrols.org*** (Fig. 2) which will allow anyone who is interested, both students and researchers alike, to upload their python control algorithm and watch it run on hardware in real-time. The website has built-in functions and examples, allowing the user to easily create their algorithm. Developing this apparatus will not only enable us to continue research into attitude control algorithms but gives our team and others a test bed to prove theory and simulations while supporting others who may not have the funding and means to develop hardware.

2 Appendix

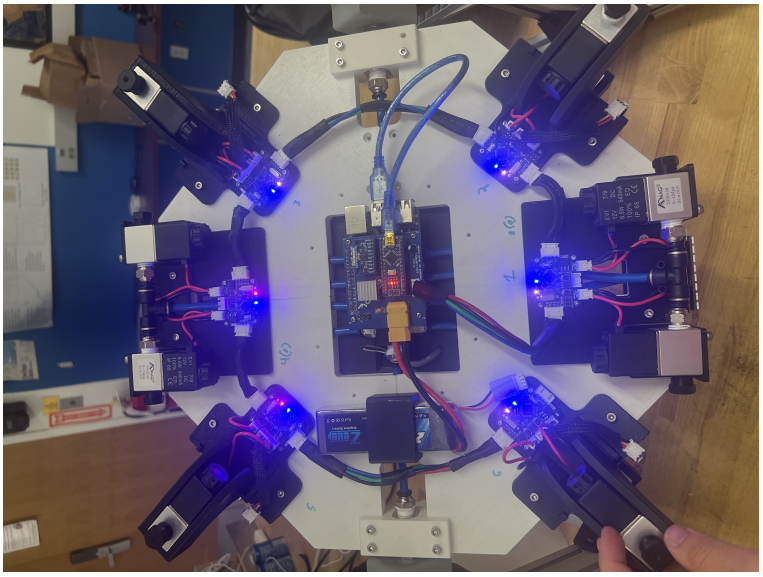

Figure 1: *1-D Version of 3D Printed ISAAC*

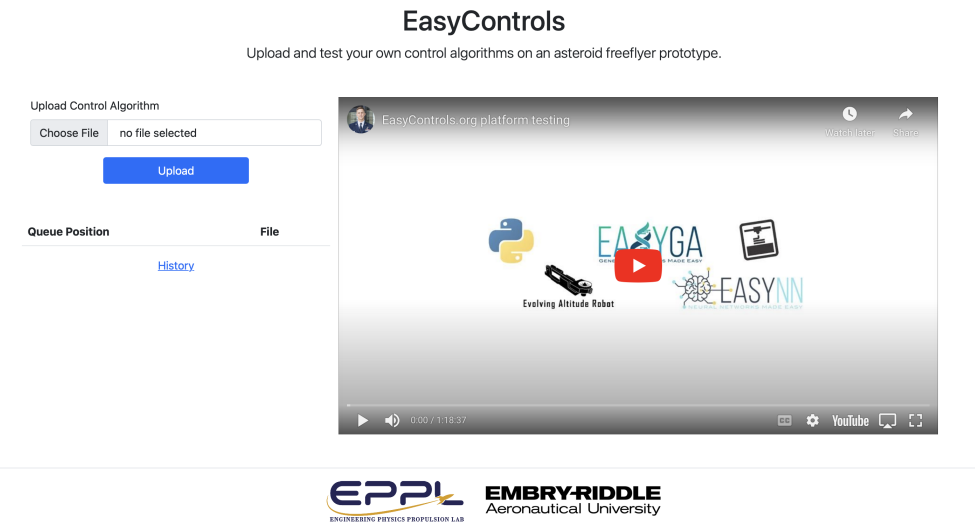

Figure 2: *Website* ***easycontrols.org*** *to Upload Code*