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 of a cold gas thruster-controlled probe in a controlled test environment. The purpose of this open-sourced control platform is to allow students, professors, and researchers to test and train their control algorithms on real hardware in real-time. The end goal is to have a website allowing anyone to upload their code and watch it run via live stream. The spacecraft uses a pneumatic system to mimic cold gas thrusters by using compressed air as a means of propulsion. The compressed air being delivered is at 100 psi with an output equal to that. The delivery system uses solenoids to control the thrust, stabilizing the craft. The hardware is simple and consists of custom Arduino printed circuit boards, a Raspberry Pi, an Inertial Measurement Unit (IMU) for total orientation data, and 2 LiPo batteries. The craft is entirely 3D printed, including the mounts for the components, in order to be accessible for future research and upgrades. The attitude controller will be integrated into the website **easycontrols.org**, 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 create their algorithm easily. An example for proof of concept of this system has been the application of a sliding mode controller in one axis of the gimbal rings. Future work can include the application of more modern control methods for students and facilities to display and follow. Examples include using genetic algorithms for PID value tuning in one axis and the application of a simple Neural Network meant to hold orientation in one axis.

Abstract Summary

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 using compressed air as a proxy for cold gas propulsion. The controller is integrated into a website, **easycontrols.org**, allowing professors, students, and researchers to test and train their control algorithms on real hardware in real-time. The entire body and a few components are 3D printed along with the gimbal rings. The hardware consists of custom Arduino printed circuit boards, a Raspberry Pi, an Inertial Measurement Unit (IMU) for total orientation data, and 2 LiPo batteries. The website has built-in functions and examples, allowing the user to create their algorithm easily. Some examples of proof of concept of this system are the application of a sliding mode controller, using genetic algorithms for PID value tuning, and the application of a simple Neural Network meant to hold orientation all in one axis of gimbal rings.