Optimizing Aero-Stability in Model Rockets Using Advanced Flight Algorithm and Servo-Actuated Thrust Vector Control

Valdes, Rodrigo (School: Harmony Science Academy - El Paso)

Traditional model rockets lack technology because their construction relies on simple physics and handcrafted components. When human mistake occurs, it can have a cascading effect that has a significant impact on the rocket's trajectory because even the tiniest deviations can have a significant effect. Furthermore traditional fins have a short lifespan, and when they pass their lifetime they are no longer of use. This means an increase in cost and waste that can be avoided by advanced systems like these. This project studies how if traditional model rocket fins were removed and we added a control system alongside a gimbal and custom avionics would it be able to self stabilize? To achieve this I took the approach of first making custom flight avionics that were made based on functionality necessities. In conjunction with the custom avionics came the gimbal that was 3D printed and a flight algorithm that consists of a kalman filter, PID, quaternions, and a variety of safety and functionality features. All of this put together made up what is known as the thrust vector control system (TVC) allowing us to control the angle of the rocket. Throughout testing it was found that the SD card would disconnect mid flight due to the high vibration state of the vehicle. This led to the control system and algorithm to stop being used as it no longer went through the state machine mid air. My findings conducted in my project prove that self stabilization throughout model rockets is achievable with the use of an advanced flight algorithm alongside its custom avionics and gimbal. These results could prove helpful and useful across model rocket organizations or clubs as it provides higher functionality while at the same time providing cheaper costs.

Awards Won:

Air Force Research Laboratory on behalf of the United States Air Force: Glass trophy and USAF medal for each recipient

Air Force Research Laboratory on behalf of the United States Air Force: First Award of $750 in each Regeneron ISEF Category, FOR 2023 ONLY: EBED WILL HAVE TWO

Office of Naval Research on behalf of the United States Navy and Marine Corps: The Chief of Naval Research Scholarship Award of $15,000

University of Texas at Dallas: Scholarship of $5,000 per year, renewable for up to four years