Gyroscopic Rocket Stabilization via Thrust Vectored Control

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This project aimed to address problems inherent in fin-controlled rocketry systems. Common problems include cost, complexity, and size, and this project solved them by creating a simple, low cost and low footprint, non fin-controlled system that could maintain orientation and follow trajectories during ascent. Stability is one of the most crucial components in rocket flight, as instability can easily lead to loss of control. To combat this, the C6 datasheet was used to determine load-bearing points and centers of mass. After the conceptual research, different prototypes were created. Once the mechanical design was finalized, a prototype stabilizer system was created using two TowerPro MG90S servos, a GY-521 accelerometer, and a XIAO SAMD21 running modified firmware, mounted onto a custom circuit board, on a frame, allowing for 20x20° XY rotation within a 2.71” tube footprint. This system used a dual control system, with RECOVERY and STABILIZE modes. After Ziegler–Nichols PID tuning, this prototype successfully stabilized motion during thrust stand and launch tests, correcting in real-time. Over testing there was a best-case response of ~18 ms, on par with the simulated ideal response time of ~17.98001 ms, a difference of ~0.125%. There was a measured deviation of ~±1.086° on measurements, compared to a ~±0.9° simulated deviation for a control cycle, a relative difference of ~20.67%. The system also incorporated a modular design for easy component mounting. The final weight and price were was 65% and 80% in comparison to finned controlled systems. This project’s success suggests that a responsive system with a small footprint could be made low-cost without the use of fins, but it also opens up avenues for future research, including potential neural network integration.

Awards Won: