Integrated Control System For Active-Fin Control Rocket Stabilization and Guidance

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INTRODUCTION

Modern rockets need precise stability and guidance for mission success. This project developed an active fin system using real-time IMU data and PID algorithms to stabilize a sounding rocket. CFD-optimized fins provide superior stability versus passive systems. This project demonstrates the feasibility of low-cost guided rocketry for research and commercial applications.

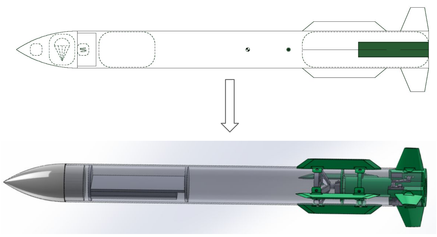

Figure 1: Rocket Design

METHODOLOGY

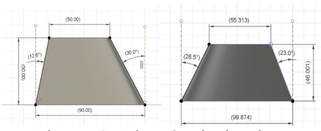

Figure 2: Fins Optimization

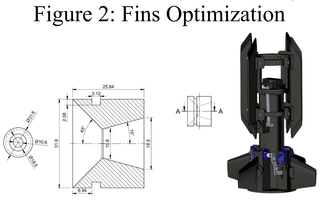

Figure 3: Nozzle and Servo Housing Design

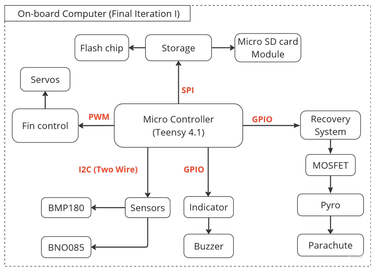

Figure 4: OBC Block Diagram

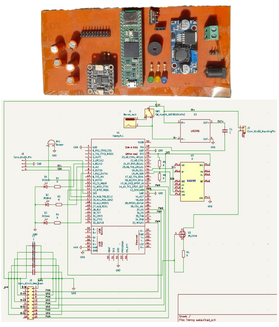

Figure 5: PCB Design (top) and Schematics (bottom)

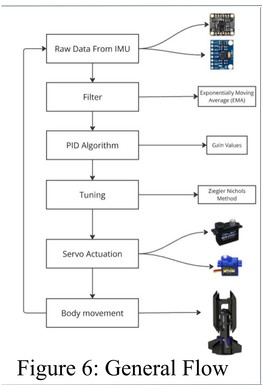

Figure 6: General Flow

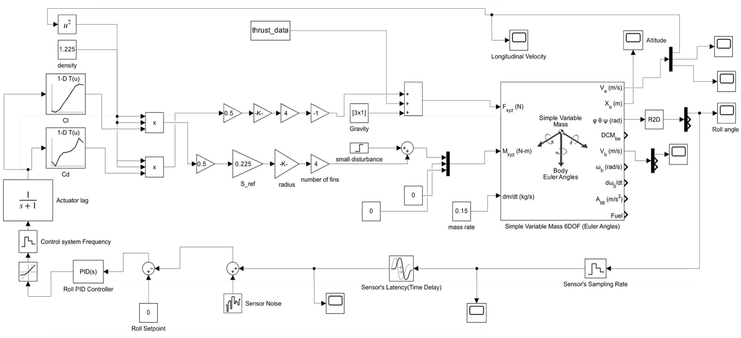

Figure 7: Mathematical model

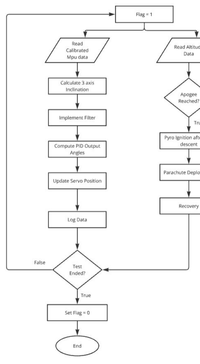

Figure 8: Flight Algorithm

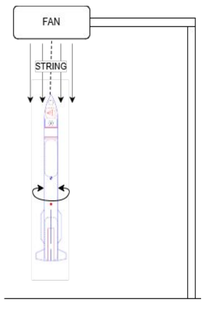

Figure 9: Roll Test

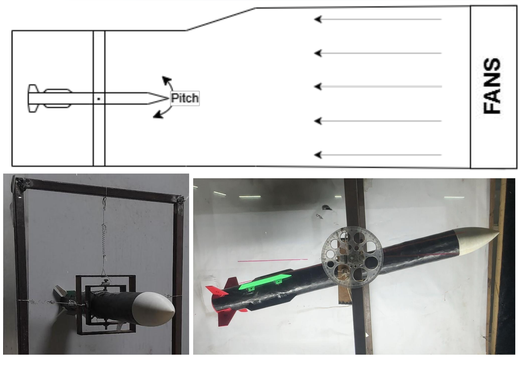

Figure 9: Pitch Test in Wind Tunnel (WT)

RESULT

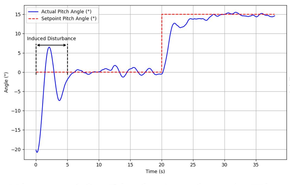

Figure 10: Pitch Angle v/s Time (Single setpoint)

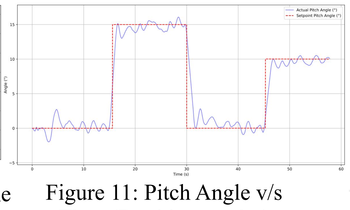

Figure 11: Pitch Angle v/s Time (Double setpoint)

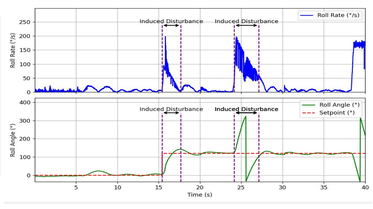

Figure 12: Roll Angle v/s Time

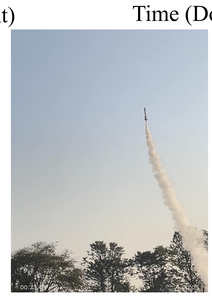

Figure 13: Launch Stand (left) and Flight Test (right)

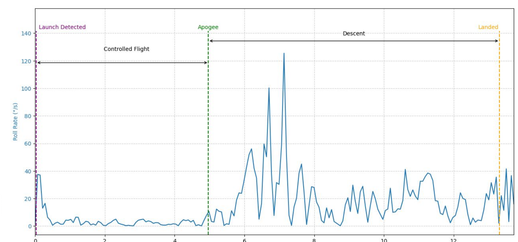

Figure 14: Roll Angle v/s Time Data in Flight Test

The roll control flight test confirmed proper roll moment control, validating the PID tuning algorithm and mathematical model. Additionally, wind tunnel pitch tests yielded promising results, further verifying the control algorithm and suggesting a successful flight test.

IMPACT AND FUTURE ENHANCEMENT

This system enables precise payload delivery for research and commercial uses, especially weather monitoring and small satellite deployment. Future work includes implementing Model Predictive Control and developing multi-stage designs for higher altitudes.