Paper ID: 88150
student

IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Interactive Presentations - IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (IPB)

Author: Mr. Ahmet Nuri Yılmaz
Istanbul Technical University, Türkiye

Dr. Melahat Cihan
Samsun University, Türkiye

COMPREHENSIVE SIMULATION OF ROCKET FLIGHT TRAJECTORIES WITH ACTIVE CANARD CONTROL FOR DESCENT PATH CORRECTION

Abstract

This study presents an analysis of the implementation and effectiveness of active canard control in low-altitude, unguided sounding rockets. It is aimed to improve and correct the landing trajectory of rockets in the horizontal plane by integrating active canard control with a detailed six-degree-of-freedom (6DoF) flight simulation model. The model employs the fourth-order Runge-Kutta method for the numerical integration of the rocket's equations of motion. This facilitates the study of various flight dynamics over time, including altitude, speed, acceleration, pitch angle, and other critical flight parameters. The simulation includes dynamic changes of the center of pressure and center of gravity and allows accurate evaluation of the stability and performance of the rocket throughout the flight. It also dynamically considers the aerodynamic flight parameters of the rocket to increase the accuracy of the simulation. The study focuses specifically the trajectory in post-apogee that shows how active canard control can significantly correct. The rocket's control system modifies its aerodynamic characteristics by adjusting the canard angles, which helps maintain the required descent path by changing the pitch and yaw angles according to the real-time flight dynamics. It employs a feedback loop to detect and correct any deviations from the intended path, ensuring that the descent trajectory remains predictable and under control. This adjustment and correction process allows for a stable descent, adapting continuously to varying flight conditions. This thereby improves landing area accuracy compared to traditional ballistic free-fall approaches. The research underscores the potential of canard controls to decrease dispersion and enhance the effectiveness of rocket recovery operations. In addition to providing a comprehensive rocket flight simulation, it also offers a new approach to using and simulating the canard control effect to improve recovery strategies in rocket design.