Firing Control Optimization of Lateral Propellant Impulse Thrusters for Trajectory Correction Rockets

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Abstract: The impact point dispersion of rockets can be reduced greatly by configuring a finite number of lateral propellant impulse thrusters around the center of mass of a rocket and using the lateral force to change the velocity direction of a rocket directly. The firing time and firing phase angle are two key parameters on the performance of trajectory correction. This paper establishes the 6-DOF trajectory model of a rocket with lateral force, and presents an optimum control scheme of firing time and firing phase angle by taking impact point deviation as optimum objective function which takes account of the difference of longitudinal and horizontal correction efficiency, firing delay, roll rate, flight stability, etc. Simulations indicate that this control scheme can assure lateral propellant impulse thrusters be activated at time and phase angle when the correction efficiency is higher. The variations of rocket impact point dispersion are analyzed with different impulse and number of lateral propellant impulse thrusters. It is shown that the impact point dispersion is mainly influenced by the total impulse of lateral propellant impulse thrusters deployed, and steadily decreases as the total impulse is increased. The impulse, number and firing interval need to be optimized to insure the flight stability of rockets and lateral propellant impulse thrusters activated at time when the correction efficiency is higher.

Key words: trajectory correction; rocket; lateral propellant impulse thruster; firing control