

Two-Stage Launch Vehicle Trajectory Modeling for Low Earth Orbit Applications

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Abstract : This paper presents a study on the trajectory of a two stage launch vehicle. The study includes dynamic responses of motion parameters as well as the variation of angles affecting the orientation of the launch vehicle (LV). LV dynamic characteristics including state vector variation with corresponding altitude and velocity for the different LV stages separation, as well as the angle of attack and flight path angles are also discussed. A flight trajectory study for the drop zone of first stage and the jettisoning of fairing are introduced in the mathematical modeling to study their effect. To increase the accuracy of the LV model, atmospheric model is used taking into consideration geographical location and the values of solar flux related to the date and time of launch, accurate atmospheric model leads to enhancement of the calculation of Mach number, which affects the drag force over the LV. The mathematical model is implemented on MATLAB based software (Simulink). The real available experimental data are compared with results obtained from the theoretical computation model. The comparison shows good agreement, which proves the validity of the developed simulation model; the maximum error noticed was generally less than 10%, which is a result that can lead to future works and enhancement to decrease this level of error.

Keywords : launch vehicle modeling, launch vehicle trajectory, mathematical modeling, Matlab- Simulink

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