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ESCAPE TRAJECTORY ANALYSIS OF MANNED VEHICLE WITH SELF-CONTAINED PROPULSION SYSTEM

Abstract

Escape with self-contained propulsion system is a major trend in escape system design of manned vehicles. Comparing with traditional launch abort system, escape with self-contained propulsion can increase payload and reduce cost. Escape trajectory analysis is key technique for escape with self-contained flight. In this study, focusing on pad escape and ascent escape cases, trajectory analysis is performed based on different propulsion strategies, including several characteristics of altitude, downrange and orientation. This study will provide technique references for manned vehicle escape system design.

For pad escape case, trajectory altitude, downrange and escape direction angle are analysized for typical situation. Escape trajectory altitude is mainly determined by the working time of main engine; escape downrange is mainly determined by the pitch angle command planning; escape direction angle is proportional to the working time of yaw attitude thrust engines. Escape with different direction angle can be realized by selecting proper working time of the yaw attitude thrust engines.

For ascent escape, trajectory analysis is performed for the critical phase of max dynamic pressure. Trajectory and attitude information of a launch vehicle is selected to describe initial condition at escape time, including position, velocity and attitude. Afterwards, relative distance between launch vehicle and manned vehicle, escape load, and avoidance trajectory are analysized on these conditions. Relative distance between launch vehicle and manned vehicle increases by the increment of initial escape altitude and initial escape velocity; max load decreases by the increment of initial escape altitude; avoidance trajectory can be designed by yaw attitude thrust engines which adjust main engine thrust direction, and by this strategy, escaped manned vehicle can keep safe distance from the launch vehicle.