SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
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TURNOVER MANEUVER CONTROL AND GUIDANCE FOR VERTICAL LANDING OF REENTRY VEHICLE

Abstract

In ISAS/JAXA, a fully reusable sounding rocket is proposed as one step for the future full-fledged reusable transportation system. This vehicle aims to be low in cost and to be high frequency of experimental opportunities by its reusability. The enlargement of the flight profile flexibility could acquire the high qualities of the experimental conditions. This vehicle is a fully reusable vertical take-off and vertical landing (VTVL) rocket vehicle. And this has the capability of ballistic flight to the altitude over 120 km and returning to the launch site. In the flight sequence, the vehicle takes off vertically and cuts main engine off about 100 seconds later, and reaches to an altitude about 120 km during the ballistic flight. After that, the vehicle entries into atmosphere and decelerated by aero braking, and vertically lands to the launch place. In landing phase, this vehicle makes a turnover maneuver from a nose-first entry attitude. This makes it possible to achieve the deceleration and soft landing by its main engine thrust. As for the inversion maneuver of the vertical landing vehicle, the aerodynamic turnover maneuver is considered. After turnover maneuver, control torque of a reaction control system (RCS) stabilizes the vehicle in a tail-first attitude before a re-ignition of main engines. In this paper, the turnover maneuver control for the nose first entry of the vehicle is numerically simulated and then the guidance strategy for the vehicle is considered. It is important for the guidance that the vehicle attitude could be stabilized after the turnover maneuver. By the given moment torque of the RCS, it is needed for the vehicle to maintain the attitude at 180 degree of angle of attack. And it is also important to guide the vehicle to the launch site for landing under the constraints of minimizing the fuel consumption. To achieve the soft landing without the extra-large command, it is considered the along the nominal trajectory for the right before the landing. Based on these turnover simulations and the guidance strategy, it is considered to demonstrate the glide tests using the small sized vehicle model. In this demonstration, the technical problems for the turnover maneuver as for the vehicle dynamics and guidance control strategy are investigated and the guidance and control method is modified for the practical use to achieve the system requirements.