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ONBOARD WAYPOINT PLANNING BASED MARS PREDICTIVE ENTRY GUIDANCE WITH PATH CONSTRAINTS

Abstract

The predictive entry guidance method emerges and has been focused on in recent years for the potential of dealing with unexpected circumstances onboard automatically and improving delivery accuracy during Mars atmospheric entry phase. For the design of predictive entry guidance, one of the difficulties to be faced with is to satisfy the path constraints including load factor, heat flux, etc. In view of path constraints satisfaction through Martian atmosphere, a method of planning waypoint onboard is introduced to enhance the capability of predictive entry guidance to meet both of the path constrains and the terminal accuracy at the same time. As far as the knowledge of authors, in predictive entry guidance, the methods presented up to now on solving path constraints are based on the idea of tracking the ceiling of the constraint passively when it is to be reached, and it may result in the saturation of guidance command. However, the idea of onboard waypoint planning is to deal with the path constraints actively and prospectively by taking full use of the predictive capability of guidance algorithm. First of all, the sufficient condition of satisfying path constraints is presented in the altitude-velocity space analytically, with the exponential density model of Martian atmosphere. On the basis of this sufficient condition, when path constraints are predicted to be violated, the waypoint planning algorithm is adopted to generate a waypoint and then the vehicle will be guided to fly to it firstly to guarantee the path constraints. With one or several times of waypoint planning, the vehicle will pass through the period during which path constraints may be violated and finally fly to the predetermined position of parachute deployment. With the piecewise predictive guidance process, both of the path constraints and the terminal constraints will finally be met. Moreover, the onboard calculation load of numerical integration will be relieved and the error accumulation of model uncertainties during the numerical integration will be reduced by inserting the waypoint with the cost of the waypoint generation only.