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PIECEWISE PREDICTIVE GUIDANCE METHOD BASED ON FUZZY LOGIC SYSTEM FOR LUNAR MISSION SPACECRAFT

Abstract

A novel predictive guidance method based on fuzzy logic system for the lunar spacecraft is presented to meet the requirements in real time control and precision landing. The flight characteristic of the lunar spacecraft at the balanced attack angel is analyzed. Along the way, the three-degree-of-freedom motion equation for reentry is established. A piecewise predictive approach is subsequently proposed and the fuzzy logic system is adopted to improve the real-time performance of the predictive guidance law.

First, the reference trajectory is established in the reentry corridor to supply reference states for piecewise predictive guidance law design. The absolute value of bank angel, which is the control variable, is designed as the piecewise linear functions of energy parameter, and these functions contain the information of velocity and altitude. The reversal of bank angel is determined by the method of azimuth error boundary. The piecewise predictive points are presented and longitudinal and latitudinal errors are computed at each predictive point. These errors combined with altitude parameter are used as inputs of the fuzzy controller which is designed to generate guidance commands.

The required time for predictive guidance algorithm is mainly influenced by two factors: the computation time of every iteration step and iterations for guidance command generation which is determined by the iterative algorithm. The proposed method greatly reduces the time of generating predictive guidance commands. Simulation and experimental results indicated that the piecewise predictive guidance algorithm could meet the requirement of real-time and had strong robustness to the initial errors and uncertain conditions.