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Abstract: The conventional Mars entry tracks a fixed reference drag profile (FRDP). To improve the landing precision, a novel guidance approach that utilizes an adaptive reference drag profile (ARDP) is presented. The entry flight is divided into two phases. For each phase, a family of drag profiles corresponding to various trajectory lengths is planned. Two update windows are investigated for the reference drag profile. At each window, the ARDP is selected online from the profile database according to the actual range-to-go. The tracking law for the selected drag profile is designed based on the feedback linearization. Guidance approaches using the ARDP and the FRDP are then tested and compared. Simulation results demonstrate that the proposed ARDP approach achieves much higher guidance precision than the conventional FRDP approach.

Keywords: Mars entry; precision guidance; drag tracking; trajectory planning; feedback linearization.

1. Introduction

The successful landing of the Mars Science Laboratory (MSL) indicates that the guidance method inherited from the Earth entry is applicable for Mars entry. Compared with the Viking, whose 3σ landing ellipse is about 100 km, the MSL achieved its desired landing accuracy of 10 km. For future Mars missions such as the sample return and human exploration, a higher landing precision like 100 m is expected (Braun & Manning, 2007; Wolf, et al., 2006). Therefore, the guidance accuracy for the entry phase should also be improved such that a better initial condition is provided for the final landing phase.

Previous guidance methods for Mars entry track a reference trajectory that can fly the vehicle to the target (Li & Jiang, 2014). The Apollo-derived guidance tracks the desired vertical component of the lift-to-drag ratio (Ives, et al., 1998). The guidance law is designed based on the range prediction which is calculated by a simple function. Since the prediction accuracy cannot be guaranteed under high aerodynamic dispersions, the Apollo-derived guidance approach is hard to meet the precision

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