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PRECISE POWER DESCENT FAULT TOLERANT CONTROL OF A LUNAR LANDER

Abstract

This paper addresses the problem of powered descent control of a lunar lander during its final landing phase, where soft and precise landing at the target site is required along with fault tolerant capability. In the literature, this problem has been solved by considering a fully actuated lunar lander. Recently, landers are designed as complex systems with several onboard payloads and subsystems for completing demanding mission tasks. There are increasing constraints on mass budget and space availability onboard a lander. In order to meet these requirements, a novel controller using a pair of gimballed thrusters is proposed. The proposed fault tolerant controller for each thruster has three control inputs (thrust and two gimbaled angles) to control the six degrees of motion of a lander; these control inputs are non-affine. The proposed controller is designed based on variable structure control technique augmented with a high order filter, an immersion and invariance-based mass estimator, and a sliding mode angular velocity observer. The cases involving faults in thrust magnitude (fixed and null) andtwo gimballed angles (fixed, null and constant rates) are considered. The stability analysis using Lyapunov theory and the results of the numerical simulations along with Monte Carlo simulations of the system show that the precise landing of the lunar lander using the proposed fault tolerant controller is feasible even in presence of thruster faults.