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APPLICATION OF PLURAL MOMENTUM EXCHANGE IMPACT DAMPERS TO LANDING GEAR SYSTEMS

Abstract

This paper discusses landing response control methods of planetary exploration spacecrafts on the basis of momentum exchange principles. For example, honeycomb materials used in the cantilever design that dissipate shock energy by plastic deformation have been used. However, if it is tested on the Earth, it cannot be used in a real mission. In addition to this, sky crane used in MSL (Mars Science Laboratory, NASA) is the mechanism that can land safely and precisely. But in this method, high-cost mission cannot be avoided. Then, this paper introduces the momentum exchange impact damper (MEID) that absorbs the controlled object's momentum with extra masses called damper masses. MEID enables as to reuse the mechanism and reduce the mission cost. The authors have studied on U-MEID (Upper-MEID) that launches the damper mass upward, L-MEID (Lower-MEID) that drops the damper mass downward and G-MEID (Generalized-MEID) that combines U-MEID and L-MEID. In a single-axis (SA) model, the effectiveness of G-MEID has been already verified by simulations. However, in the SA model, the rotational motion and tripping of the spacecraft have not been addressed yet. In this paper, to discuss the two dimensional analysis, a two-landing-gear-system (TLGS) model that equips plural MEIDs is introduced. In this case, different from the authors' previous studies, when each landing gear lands, each MEID is launched. This mechanism can realize advanced control specifications in comparison with the conventional one that all the MEID are launched simultaneously. For example, the MEID on the gear landing firstly plays as L-MEID and reduces the controlled object's acceleration. The other MEID on the gear landing secondly function as U-MEID to reduce rebound height of the second contact. This paper verifies that the proposed mechanism can be applied to more practical response of spacecraft for preventing tripping and rebound.