Paper ID: 24124
student

SPACE EXPLORATION SYMPOSIUM (A3)
Poster Session (P)

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DYNAMIC MODELING AND MOBILITY ANALYSIS OF THE TRANSFORMING ROVING-ROLLING EXPLORER (TRREX) AS IT TRAVERSES RUGGED MARTIAN TERRAIN

Abstract

All planetary surface exploration missions thus far have employed traditional rovers with a rocker-bogie suspension. These rovers can navigate moderately rough and flat terrain, but are not designed to traverse rugged terrain with steep slopes. The fact is, however, that many of the most scientifically interesting missions require exploration platforms with capabilities for navigating such types of chaotic terrain. This issue motivates the development of new kinds of rovers that take advantage of the latest advances in robotic technologies to traverse rugged terrain efficiently. This work analyses one such rover concept called the Transforming Roving-Rolling Explorer (TRREx) that is principally aimed at addressing the above issue.

Biologically inspired by the way the armadillo curls up into a ball when threatened, and the way the golden wheel spider uses the dynamic advantages of a sphere to roll down hills when escaping danger, the TRREx rover can traverse like a traditional 6-wheeled rover over conventional terrain, but can also transform itself into a sphere, when necessary, to travel down steep inclines, or navigate rough terrain. This paper investigates the mobility of the TRREx when it is in the rolling mode, i.e. when it is a sphere and can steer itself through actuations that shift its center of mass to achieve the desired direction of roll. A mathematical model describing the dynamics of the rover in this spherical configuration is presented, and actuated rolling is demonstrated through computer simulation. This work highlights the contribution of the spherical rolling mode to the enhanced mobility of the TRREx rover and how it could enable challenging surface exploration missions in the future.