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Human Exploration of Mars (2)

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IDENTIFICATION OF HUMAN LANDING SITES ON MARS WITH A SWARM OF WIND-DRIVEN MOBILE IMPACTORS

Abstract

Human missions to the red planet have seen a spike in interest over the past two decades. However, future human Mars exploration missions require not only the development of advanced technologies but also the collection of extensive, planetary-scale datasets of Mars, which are not met by current mission concepts. The timeline towards settlements on Mars can be accelerated through a swarm of wind-driven mobile impactors to systematically explore the Martian surface on a large scale for sites with a high interest of resources, scientific interest, and safety for a human exploration mission.

The Tumbleweed Mission is a low-cost Mars surface mission using a swarm of wind-driven mobile impactors to generate planetary-scale, long-term surface datasets of Mars. It is used to scout a variety of areas of Mars and identify potential landing sites while bringing down the cost of robotic Mars exploration significantly. This paper aims to investigate the use of such rovers to prepare for human exploration of Mars.

A science case is developed to obtain relevant data regarding surface and climate characteristics, as well as landing site properties. First, the architecture of the Tumbleweed Science Mission is provided for context, followed by the requirements, constraints, and capabilities of a Tumbleweed Rover swarm with regard to the characterization of landing sites for human mission potential. Such rovers allow greater flexibility and distance in exploring a plethora of sites on Mars as their ability to maneuver through rough terrain provides global coverage of the Martian surface. Various sites can be categorized for their potential to harbor human missions and infrastructure by measuring the quantity of resources and water, as well as surface material composition. The in-situ assessment of atmospheric and climate properties to measure the atmospheric and near-surface dust population provides essential knowledge on the safety of landing sites. In addition, taking terrain measurements such as altitude, rock distribution, and roughness ensures

the safety of potential landing sites.

The characterization of various sites across different latitudes and longitudes using Tumbleweed rovers provides a better understanding of such sites for human exploration with regard to three main factors: in-situ resource utilization, scientific interest, and safety. As a result, we consider the Tumbleweed science mission to be feasible to survey various areas of Mars and characterize them for human landing sites. The data obtained will be used to better prepare for the human exploration and settlement of Mars.