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Author: Mr. Jeremy Straub
University of North Dakota, United States

MULTI-TIER EXPLORATION CONCEPT DEMONSTRATION MISSION

Abstract

The multi-tier mission concept proposed by Fink, et. al. [1] stands ready to produce a paradigm shift in planetary exploration. For a mass budget only slightly larger than many conventional missions the science return can be increased dramatically. The multi-tier mission concept, fundamentally, involves one or more large interplanetary spacecraft depositing numerous smaller craft into the desired research area. Several deployment scenarios are suggested by [1, 2]. Perhaps the most interesting and complex involves each tier deploying the components of its sub-tier: the orbital tier craft would deploy one or more aerial tier craft that would deploy one or more ground craft.

This paper presents a demonstration mission concept and a collaborative control framework for a multi-tier mission that incorporates elements from all three of the aforementioned tiers. A simulated satellite, launched as a high altitude balloon payload, will serve as an analog for the orbital tier (alternately, an existing satellite could be used). The simulated orbital element will supply data that will be evaluated by the control software, based on defined science goals, for aerial and ground craft deployment. The craft for each tier (a small UAV for the aerial tier and several small rover-type robots for the ground tier) would be manually deployed to the selected location; autonomous control would commence immediately after deployment. While manual override would be available for safety and compliance reasons, the use of teleopeation is not desired or expected. The heterogeneous aerial and ground craft will collaborate to assess desired characteristics of the target area. The proposed demonstration mission would validate the collaborative control framework and supply initial action-cost values that could be further refined with in-analog-situ testing in preparation for a planetary mission.

Existing work on a multi-tier mission, including simulator models, is also discussed. The relevant mass cost values for each simulated mission concept and projected science return are presented. The utility of the proposed test mission for validating the real-world applicability of the results of this simulation work is discussed in detail.

References:

[1] W. Fink, et al., "Tier-Scalable Reconnaissance Missions for the Autonomous Exploration of Planetary Bodies," Proceedings of the 2007 IEEE Aerospace Conference, 2007. [3] W. Fink, et al., "Robotic Test Bed for Autonomous Surface Exploration of Titan, Mars, and Other Planetary Bodies," Proceedings of the 2011 IEEE Aerospace Conference, pp. 1-11, 2011.