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RELIABILITY DESIGN AND FDIR ANALYSIS IN THE HIGHLY CONSTRAINED EMIRATES LUNAR MISSION

Abstract

The compromise of systems reliability as part of space missions is not to be argued. A space mission system can be made as much robust as possible and can be subjected to extreme verification and validation regimes in order to ensure its mission worthiness before flight. In addition, operations can be planned meticulously with many validation levels in order to avoid any human related errors. Accordingly, such a high reliable system will incur massive costs in terms of budgets, resources, development time. In addition, Fault detection, Isolation and Recovery (FDIR) analysis is an essential part of space systems engineering and is performed at different levels in order to improve the baseline designs and lay out proper plans for implementation, verifications-and-validation and operations. Such FDIR analysis processes are well-established where different standards are available to guide systems engineers to conduct proper FDIR analysis. However, such reliability design approaches and FDIR analysis processes start to fall apart when resources get more stringent and constraint levels get higher. Every mission has its own constraints to limit the work of ambitious space mission's systems engineers. Emirates Lunar Mission (ELM) is considered one of such highly constraint missions where it aims to develop new systems in a highly constraint cost and mass budgets within short development time and with ambitious science objectives. ELM aims to develop a 10 Kg lunar rover called Rashid Rover that to be sent to the lunar surface before 2024. An expanse of science instruments carried onboard Rashid Rover along with high percentage of low TRL of different sub systems makes it extremely challenging to achieve mission objectives with high reliability score. Hence, a reliability design approach that takes into account such constraints, embraces compromises, and accepts risks to a certain level is necessary. In addition, the FDIR analysis process has to be revisited to take these reliability compromises into account in order to maximize mission outcomes. This paper presents a customized FDIR analysis process that is specifically made to meet the ELM high mission constraints. In addition, this paper discusses different reliability design choices that were made at the initial stages of the mission in order to arrive to an optimal baseline design that maximizes the mission outcomes. Finally, a design evaluation and mission success criteria is presented in order to evaluate the outcomes of ELM and similar missions along with methods to use such evaluations to improve future missions.