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MANUAL ROVER OPERATIONS IN THE ERA OF AUTONOMOUS SYSTEMS

Abstract

In an era where autonomy is considered a key enabler for planetary exploration, the nature of some missions may impose limits on the level of autonomy that can be featured in a spacecraft. These limits are mainly due to the high risk conditions implied because of the uncertain environment. The increased cost on hardware and software development and the consecutive extensive testing plan play another role on these limits. In this paper, we focus on missions with such limits taking into account that it is practical to conduct tele-operation from the ground station. In particular, we explore the use of autonomy in assisting the operator to conduct mission operations, and in the case of rover operations to allow the operator to make the right decision at the right time while tele-operating the rover at real time. To do that, we propose a system that builds an understanding of the constraints of the mission, environment, and rover design, interpret and analyze the incoming Telemetry, and then provide mission-critical status of the rover and recommend Telecommand to execute based on the plan under execution or based on a contingency being experienced by the rover. The proposed system utilizes an inference engine that infers a new knowledge about the rover's condition based on a rule set. The rule set is defined according to the different constraints imposed. The incoming Telemetry will be analyzed against the rule set and new information will be deduced for the operator to consider in real time. A use case is the detection of a power degradation through the received Telemetry. Since the cause of such a fault can vary (due to internal hardware faults or external such as regolith contamination of the solar panel), the system can guide the operator to perform further investigation to narrow down the potential causes. This can be performed by suggesting commands for the operator to execute and based on the received response the inference engine can decide on what is the most likely cause. An example of a command is to switch to a redundant hardware if available or simply compare the power generation with another solar panel. In order to make the system aware of the context and all constraints, an ontology is proposed to be used by the system.