HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
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OPTIMISING THE HUMAN VARIABLE: MULTIDISCIPLINARY DESIGN OPTIMISATION FOR HUMAN ROBOT COOPERATION ON PLANETARY EXPLORATION MISSIONS

Abstract

The CHARM model was designed to provide a decision making strategy for the selection of a human-robotic space exploration mission to the martian surface. In this model, mission scenarios with similar objectives are considered, reflecting the need for different levels of human-robotic cooperation (HRC). Each scenario is decomposed into a series of interdisciplinary attributes, organised into science and life science, social and political, economic, and technical categories. Subsequent work by the authors derived a decision making strategy suited to lunar exploration missions. Both were aligned with the objectives stated in the MEPAG and ISECG roadmaps and attempted to provide a justified mission selection methodology. The robustness of CHARM model was tested following the incorporation of attribute scoring inputs from industry experts. A Monte Carlo analysis demonstrated the sensitivity of the model to human opinion and current socio-political will. The purpose of this article is to further study the human element in the optimisation process. Unlike the empirical parameters used in conventional multidisciplinary design optimisation (MDO) problems, human response (or behaviour) towards autonomous systems (and otherwise) is still an inexact science. Despite several theories, there remains a lack of a standardised measuring system for human behaviour. Given the context of an environment, human behaviour is predictably random under certain constraints, and predictably predictable under normal circumstances. Both cases lend an element of uncertainty to the outcome of any HRC mission. To address this limitation in the current CHARM model, it is elaborated further to formulate a formal MDO problem. The objective of this problem is specifically targeted at the design of planetary exploration missions requiring the cooperation of humans and robotic systems. The result provides an optimisation problem typically managed by the numerous human agents responsible for the respective disciplines. To test the robustness of the optimisation outcomes a genetic algorithm is developed to simulate the human responses. The results of this work demonstrate that a systems optimisation problem can be formulated which provides solutions to mission parameter selection, both outside of and in addition to engineering constraints. With the understanding that such problems are extremely sensitive to human factors relating to all mission design attributes, the model robustness is tested extensively by the modelling of human behaviour.