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A REINFORCEMENT LEARNING APPROACH FOR THE AUTONOMOUS ASSEMBLY OF IN-SPACE HABITATS AND INFRASTRUCTURES IN UNCERTAIN ENVIRONMENTS

Abstract

As the frontier in space science and exploration advances, the construction and repair of structures and equipment on astronomical bodies is becoming imperative. Autonomy will be necessary to facilitate the accurate assembly and maintenance of structures in orbit and on the surfaces of the Moon and Mars; however, robust autonomy requires advances in path planning and decision making in uncertain dynamic environments without reliable teleoperation assistance. Autonomous assembly and maintenance is thus a Partially Observable Markov Decision Process (POMDP) problem. In this paper, a novel reinforcement learning solution will be discussed and evaluated as a solution to the POMDP with an emphasis on framing the states in such a way that the model can be reduced in dimension and solved without losing the required fidelity. The proposed state space will be evaluated with reinforcement learning through simulations of an applicable autonomous assembly task with stochastic elements. Future work will incorporate hardware-in-the-loop tests and further evaluate the state space while increasing the complexity of the assembly tasks.

Keywords: Reinforcement Learning, Autonomous Assembly, Stochastic Modeling, Lunar Structures