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Author: Mrs. Sepideh Faghihi
Ryerson University, Canada, sepideh.faghihi@ryerson.ca

Mr. Siavash Tavana
Ryerson University, Canada, siavash.tavana@ryerson.ca
Dr. Anton de Ruiter
Ryerson University, Canada, aderuiter@ryerson.ca

AUTONOMOUS ON-ORBIT INSPECTION OF COMPLEX SPACE STRUCTURES IN DEEP SPACE ENVIRONMENT

Abstract

On-orbit inspection is a key element of all in-space servicing missions. Specifically, Autonomous inspection would be a significant breakthrough in spacecraft guidance during proximity operations. This paper presents a new autonomous inspection planning algorithm, called Random Bi-directional Inspection Tree (RBIT) for On-Orbit Inspection of complex space structures, performing under kinematic/dynamic motion constraints of deep space conditions. RBIT employs an asymptotically-optimal sampling-based technique, to quickly and effectively solve the planning problem and incorporates bi-directional search to increase its convergence rate. The algorithm guarantees probabilistic completeness by generating an optimal inspection trajectory with decreasing cost. Given a complete knowledge of the structure and inspector's dynamics, RBIT provides a full coverage inspection path by passing over all points of the volume of interest while simultaneously and accurately inspecting the space structure and avoiding collision with obstacles. Previous approaches divided this path planning problem into two steps, namely Art Gallery and Traveling salesman problems, which are difficult or impossible to be applied to a robot with differential constraints working in a cluttered high-dimensional environment. Contrarily, RBIT effectively handles differential constrains of the inspector robot and the complexities of the environment. Simulations are provided as a validation of the achieved inspection performance.