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SATELLITE ROUTING WITH QUANTUM ANNEALING: COLLECTING SPACE DEBRIS AND ON-ORBIT SERVICING

Abstract

Optimizing satellite routes for multiple space debris collection and multiple on-orbit servicing can be a very complex problem due to the large number of variables and constraints that need to be taken into account. Factors such as the location and movement of the debris and servicing targets in the orbit, the capabilities of the satellite, and the constraints on the satellite's fuel and power usage all need to be considered. Additionally, the problem may be further complicated by the need to consider multiple objectives, such as minimizing fuel usage while maximizing debris collection or servicing coverage. Classical approach to solve this problem includes heuristics and metaheuristics methods like Genetic Algorithm, Particle Swarm Optimization, Ant Colony Optimization and mixed-integer programming. In the current paper, we plan to implement Quantum annealing based algorithm for optimizing satellite routes. It is a quantum computing method that can be used to optimize satellite routes. The principle behind quantum annealing is to use quantum-mechanical effects to find the global minimum of a function. In the context of satellite routing, this function would represent the cost or energy required for a satellite to travel a certain route. The satellite's routes would be represented by variables in the function, and the quantum annealer would use quantum-mechanical effects to search for the lowest-energy route, which would correspond to the optimal path for the satellite to take. We plan to use Ising model to implement quantum annealing for satellite routing. It can used to represent the cost function as a set of binary variables interacting with each other through pairwise interactions. The interactions between the variables would represent the different constraints and objectives of the routing problem, such as fuel usage and debris collection. The goal would be to find the configuration of variables that minimizes the cost function, which corresponds to the optimal satellite route. A complete mathematical model will be generated, and numerical analysis will be performed based on the presented technique.