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# THE RESEARCH OF INTELLIGENT PARALLEL APPROACH FOR SPACE DEBRIS GRASPING MANIPULATOR TRAJECTORY PLANNING

**Abstract**

As well known that an increasing number of end-of-life spacecraft occupy limited space orbits, generating a large amount of space debris, which poses a serious safety hazard to spacecraft launches and space activities. Therefore, active removal of space debris is an important prerequisite for ensuring the safety of space activities. Space manipulators are widely used in space missions due to their advantages of good flexibility and strong operational capability, and trajectory planning at the end of the manipulator is key to completing space debris removal missions. Considering the complexity of the space environment and the mission requirements, the autonomy and intelligence requirements of space manipulator are gradually increasing, and the currently commonly used planning methods are difficult to meet the increasingly complex mission requirements. In response to this challenge, this paper presents a Multi-Strategy Genetic Algorithm for parallel mechanism (MSGAPE). MSGAPE improves population initialization by employing Chebyshev mapping, thereby increasing population quality. It also improves population diversity by introducing an inverse population. During individual selection, MSGAPE incorporates elite strategy and binary bidding tournament strategy to retain superior individuals and mitigate the risk of local optimization. In addition, MSGAPE employs a multi-method parallel strategy during the variation phase to mitigate the risk associated with relying on a single method. This parallel multi-method strategy guards against a reduction in search power due to a single mutation, while the Metropolis Acceptance Criterion determines whether a mutation occurs. Furthermore, in the crossover stage, MSGAPE integrates a double crossover strategy to dynamically adjust the crossover and mutation probabilities based on a threshold, thus ensuring adaptability. The method is applied to the simulation of space debris grasping, the simulation results demonstrate the superior planning accuracy and efficiency of MSGAPE compared to several commonly used algorithms. In particular, MSGAPE demonstrates the ability to generate safe, feasible trajectories at reduced cost and faster speeds, thus confirming the validity and feasibility of its application in trajectory planning for space debris grasping by space robot arms.