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RESEARCH ON SPATIAL NON-COOPERATIVE TARGET CAPTURE TRAJECTORY PLANNING METHOD BASED ON MULTI-STRATEGY PARALLELISM

Abstract

In the context of an escalating frequency of space-related activities, there is an increasing accumulation of space junk in orbit, which poses a significant threat to the safety of spacecraft launches and ongoing space activities. Consequently, the capture and removal of non-cooperative targets in space has become a critical component in ensuring the safety of space activities. The employment of space manipulators has become pervasive in space missions, owing to their advantageous flexibility and robust operational capabilities. The trajectory planning of the manipulator's end is instrumental in the successful execution of non-cooperative target removal in space. The autonomy and intelligence requirements of space manipulators are gradually increasing, as the complexity of the space environment and mission requirements are also increasing. The currently commonly used planning methods make it difficult to meet the increasingly complex mission requirements. In response to this challenge, this paper presents a multi-strategy Wolf Pack Algorithm Based on Information Interaction (MS-WPAII). MS-WPAII employs the Chebyshev chaotic mapping method to initialize the population, integrating it with the theory of reverse evolution to enhance the dispersion of the initialized population and optimize its quality. In the siege phase, the information interaction between individuals and the fittest individuals within the population is enhanced to improve the algorithm's local search capability and planning efficiency. Furthermore, to ensure the search capability throughout the optimization process and to improve the accuracy and efficiency of planning, MS-WPAII adaptively adjusts the search direction of wolf detection during the wandering phase. Furthermore, MS-WPAII implements a multi-strategy updating mechanism that dynamically chooses various updating methods based on the age of the individuals in the population, utilizing the Metropolis criterion to determine whether to execute a mutation strategy. This approach helps to circumvent the potential risk of the population attaining a local optimum. The simulation results demonstrate that MS-WPAII exhibits superiority over numerous prevalent algorithms with regard to planning accuracy and efficiency. Specifically, MS-WPAII is shown to be capable of generating safe and feasible trajectories at a lower cost and faster speed. This validates the effectiveness and feasibility of using MS-WPAII for trajectory planning of space manipulators to capture non-cooperative targets.