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A NOVEL PATH PLANNING METHOD BASED ON ADAPTIVE GENETIC ALGORITHM FOR THE OTTR IN DEEP SPACE EXPLORATION

Abstract

In the field of deep space exploration, land inspection and detection robots are a crucial tool for detecting the terrestrial environment on the surface of stars. With various complex terrain environments on the surface of different stars, traditional robots, such as wheeled robots, crawler robots, and legged robots, encounter the risk of overturning. The Open-Chain Tetrahedron Tumbling Robot (OTTR) is an innovative land inspection and detection robot that can achieve continuous tumbling motions in any direction through its own spatial structure transformation. It has the advantages of high stability and flexibility. Path planning serves as a fundamental requirement for robots to achieve optimal movement. In contrast to traditional mobile robots, the trajectory formed by the OTTR's movement is composed of triangular meshes. Currently, the path planning algorithms commonly used for mobile robots are not applicable to the path planning of OTTR. To tackle the above problems and to meet the requirements of OTTR's path planning, an adaptive genetic algorithm-based path planning approach is proposed. According to the mechanical structure of the OTTR, a form of tumbling motion is proposed. Based on this motion principle, the trajectory of OTTR as a triangular mesh is verified. Furthermore, the pose coordinates of OTTR are established in a triangular grid map, while the transformation relationship between the triangular grid map and the Cartesian coordinate system is presented. According to the triangular mesh map, a path planning method based on adaptive algorithm genetic algorithm is developed. Finally, the proposed method is verified experimentally by using MATLAB software and OTTR, and its path planning performance is compared with that of Dijkstra algorithm and A* algorithm. The experimental results illustrate that, the proposed method can realize the optimal path planning of the OTTR and has better performance than the two algorithms mentioned above. The path planning method implemented in this paper lays a crucial foundation for the motion control of OTTR, and provides a theoretical basis for robotic land exploration of complex environments in deep space exploration.