IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

Author: Dr. Yufei Guo
Northwestern Polytechnical University;National Key Laboratory of Aerospace Flight Dynamics, China, guoyfzyyy@163.com

Dr. Zixuan Zheng
Northwestern Polytechnical University;National Key Laboratory of Aerospace Flight Dynamics, China, z.zheng@nwpu.edu.cn
Mr. Kai Li
Northwestern Polytechnical University;National Key Laboratory of Aerospace Flight Dynamics, China, 532723709@qq.com
Prof. Jianping Yuan
National Key Laboratory of Aerospace Flight Dynamics,Northwestern Polytechnical University,Xi'an, China, jyuan@nwpu.edu.cn

A MULTI-ROBOT PATH PLANNING METHOD BASED ON IMPROVED CONFLICT SEARCH FOR COMPLEX LUNAR ENVIRONMENT

Abstract

In various countries' lunar exploration plans, multi-robot will become an important part of lunar exploration and lunar base construction missions, such as the International Lunar Research Station Program jointly initiated by China and Russia. Path planning is the key technology to ensure the successful completion of missions by multi-robot, and its planning results directly affect the efficiency of tasks execution. At present, there are relatively few researches on robot path planning for lunar environment, and most of them are based on 2D environment. These studies only consider obstacle information in map, and do not comprehensively consider the influence of external environment such as illumination and terrain on path planning, which has certain limitations in complex lunar environment. In order to improve the safety and efficiency of path planning for multiple lunar robots, this paper proposes a multi-robot path planning method based on improved conflict search that is suitable for the lunar complex environment. Firstly, the complex environment of the lunar surface is described by the rasterized lunar digital elevation map, and the trafficability of the grid area is defined by combining the constraints of lunar robots, and the mathematical model of the lunar surface illumination intensity and the robot motion constraint model are established. Then, an improved D*Lite traversal path planning algorithm based on inner spiral is proposed to quickly and efficiently obtain the environmental map of the area to be detected. Finally, the classical Conflict-Based Search (CBS) algorithm for multi-robot path finding is improved. In the low-layer search, the energy cost function considering the constraints of lunar terrain and illumination is used to search the optimal path for each lunar robot based on the improved bidirectional A* algorithm. In the high-layer search, conflict types and resolution schemes are defined, and the prioritization-based conflict coordination strategy is designed to resolve conflicts among multiple lunar robots more reasonably. The simulation results show that the proposed algorithm can obtain the collision-free optimal path of each lunar robot. Compared with the classical CBS algorithm, the search efficiency of the improved algorithm has been significantly improved, and with the increase of the number of robots, the efficiency of the improved algorithm is more obvious.