Evaluation Method of Spherical Marker Arrangement for LiDAR-SLAM using a Robot Simulator

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ABSTRACT

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has been promoting a project to develop innovative unmanned construction technologies for construction projects on the lunar surface. The development of unmanned surveying and remote construction technologies is essential for ground surveying in the initial phase of a lunar base construction project. However, due to the extreme temperature changes and space radiation in the lunar environment, it is difficult to conduct conventional surveying using a total station. Moreover, conventional Simultaneous Localization and Mapping using LiDAR (LiDAR-SLAM) is suitable for 3D measurement in a non-GNSS environment. However, the LiDAR-SLAM is not suitable for Lunar surfaces due to poor geometric features with regolith. Therefore, we proposed to use spherical markers as landmarks with LiDAR-SLAM to improve the performance of self-position estimation. However, the design of marker placement has not been discussed. Therefore, we focus on an experiment on spherical marker arrangement for LiDAR-SLAM to evaluate relative accuracy. In this study, we propose a method for performance evaluation of the arrangement of spherical markers used in LiDAR-SLAM by using a robot simulator to reconstruct an experimental field to simulate the Lunar surface simulation. In our experiment, we acquire point clouds of simulated Lunar surfaces using LiDAR mounted on a prototype rover. Moreover, we selected Webots as a robot simulator. Through our experiment, we confirmed the impact of the relative distance between the spherical markers and the LiDAR on the accuracy of the marker's center position estimation and the rover's self-position estimation.

Keywords: LiDAR, SLAM, Robot simulator, Unmanned surveying