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RESEARCH ON LIGHTWEIGHT SLAM ALGORITHM FOR AUTONOMOUS SENSING OF ON-ORBIT-SERVICE ROBOT

Abstract

The autonomous perception technology is the foundation of on-orbit intelligent operations and control. The autonomous exploration of complex scenes in perception problems is inseparable from Simultaneous Localization and Mapping (SLAM) technology. However, the insufficient datasets of on-orbit spacecraft make it difficult to verify the performance of SLAM systems. Furthermore, due to the influence of the dynamic Earth, the current SLAM method performs poorly when using space images with Earth background for pose estimation, resulting in reduced robustness. Additionally, the limitations of spaceborne computing resources and power consumption make it difficult to provide real-time dense mapping capabilities. In this paper, we propose a method for constructing the SpaceSim-Dataset for flyaround observation and approach inspection missions in space environments. This method employs the Unity3D engine to generate RGBD+IMU sequence data of the observed spacecraft to simulate real-world scenarios. Moreover, we also propose a lightweight DVIO-Fusion SLAM algorithm based on RGBD information. By using depth information to filter out the Earth background in the space scene and by fusing visual-inertial odometry with depth information, the accuracy and robustness of pose estimation are improved. At the same time, we use the TSDF (Truncated Signed Distance Function) implicit surface extraction algorithm with an effective block selection strategy in the viewing frustum surface zone to quickly build a dense map with a resolution of 5 mm on the CPU platform. The SLAM algorithm proposed in this paper can establish clear shape characteristics of objects online under continuous observation in space scenes. It's worth noting that the algorithm is not based on GPU, which means it can be executed in real-time on the CPU platform. This research provides an effective solution for the lightweight computing requirements of spaceborne platform tasks.