POINT CLOUD REGISTRATION FOR INDOOR MAPPING USING TIME-OF-FLIGHT CAMERA

Kenta OCHIAI[1], Masafumi NAKAGAWA[1]

[1]Shibaura Institute of Technology
3-7-5, Toyosu, Koto-ku, Tokyo, Japan, me12019@shibaura-it.ac.jp

Abstract: Disaster monitoring requires for a safety and rapidity. 3D measurement, such as photogrammetry and laser scanning, can satisfy these requirements in a structure inspection and modeling. Aerial photogrammetry and laser scanning are applied to 3D data acquisition in damaged outdoor environments. Recently, the ground-based disaster monitoring also requires 3D data acquisition in indoor environment.

Generally, we estimate sensor position using Global Navigation Satellite Systems (GNSS) directly. On the other hand, position estimation in indoor environment is impossible to use GNSS signals. Thus, 3D data acquisition in indoor environment achieves to estimate rotation and translation parameters using Inertial Measurement Unit (IMU). An integration of line laser scanner and IMU can acquire accurate 3D data. However, the position estimation using IMU is unstable in the current states.

Therefore, we focus on the simultaneous localization and mapping (SLAM) approach. Many SLAM applications using line laser scanner and cameras have developed for autonomous robots. However, 3D data acquisition using the line laser scanner depends on a performance of IMU. Cameras are affected by brightness changes in environments. Thus, we also focus on distance-added range data and point cloud acquisition.

First, a handheld time-of-flight camera (TOF camera) is used to acquire distance-added range data and point cloud in real time. The TOF camera can acquire point cloud data from continuous viewpoint. Moreover, we focus on scattered debris and broken glass in indoor environment after earthquake. We can use these objects as feature points for SLAM procedure. However, the TOF camera is affected by mirror reflection effect caused by glass. Therefore, noise data are detected and deleted to conduct feature extraction for 3D model alignments.

Second, we propose a point cloud data alignment methodology based on Iterative Closest Point (ICP) algorithm and SLAM approaches. However, conventional ICP and SLAM use only geometrical features. In other words, we are difficult to align simple planes. Thus, image matching using intensity values taken from TOF camera are integrated into a feature matching for a stable 3D data alignment.

Then, we conducted an experiment to create an indoor map based on SLAM and ICP procedures using the TOF camera. Finally, even if measured area is in indoor environment, we have clarified that 3D point cloud are registered without IMU and GNSS.

Keyword: Iterative Closest Point, Simultaneous Localization and Mapping, Indoor mapping, 3D point cloud data registration