Abstract

This thesis addresses challenges in autonomous mobile robot navigation, focusing on dynamic obstacle estimation and collaborative localization using visual sensors. It presents an efficient method for obstacle estimation using only depth images from RGB-D sensors, introducing a novel u-depth map for detection and a restricted v-depth map to improve dimension estimation. Additionally, a tracking algorithm is proposed to monitor obstacles across frames while they remain in the robot's field of view.

For collaborative localization, the thesis proposes a client-server-based SLAM framework. Robots are equipped with monocular, stereo, or RGB-D cameras and inertial sensors for visual-inertial odometry, while a central server handles tasks like loop closure, map merging and optimization. The system switches to visual odometry when inertial data is noisy, addressing issues like pose drift from incorrect feature selection or loss of camera tracking due to sudden motion.

Given the limitations of RGB-D sensors for long-range obstacle detection, this research extends the use of u-depth and restricted v-depth maps to LiDAR point clouds. This allows efficient obstacle estimation without the need for resource-intensive processes such as ground plane segmentation or 3D clustering, which are typically used in existing 3D LiDAR systems.

The proposed methods are validated through experiments on multiple simulated, real-world, and open-source datasets, as well as real robot tests, confirming their accuracy and efficiency.

Additionally, the thesis presents a visual inspection system for pre-flight aircraft inspection using autonomous drones. The system adapts to different aircraft models with minimal manual intervention, collaborating via LiDAR-inertial measurements and applying the obstacle estimation method to avoid obstacles. Two UAVs, equipped with RGB-D cameras, successfully completed the inspection in less than 10 minutes during simulations.