Pose Estimation of Mobile Robots Based on the Integration of IMU and Vision

Abstract

Pose estimation of mobile robots is pivotal in solving the localization problem. Due to the unavailability of GPS in indoor environment, IMU- and vision-based methods are often utilized. However, the pose acquired with data coming from single sensor is prone to the effects caused by environmental perturbation and mobile robots themselves and are therefore lacking in accuracy and robustness. As a result, multi-sensor fusion problem has drawn attention globally. This project will fuse the vision and IMU information in the filtering framework in order to improve the accuracy of the pose estimation system.

First and foremost, experiments have been conducted for single-sensor estimator. It turns out that estimator may fail insofar as accuracy, which results from IMU measurement drift and double integration, feature loss and photometric error respectively.

Secondly, fusion algorithm under the Kalman filtering framework has been put forward. Through the linear and non-linear model of robot and the subsequent selection of observer variable and noise parameter, the orientation information from IMU and position information from RGB-D odometry have been fused and correct pose is still made possible where there exists feature loss.

Consequently, in order to tackle the single model influence towards tracking accuracy, an Interactive Multiple Model (IMM) consisting different kinematic models has been used. After sub-model design and Markov transition matrix assignment, models adaptively switch among each other when robot mode changes. Therefore, accurate description of robot movement is acquired. Empirical analyses of pose estimation based on IMM estimator suggest that pose drift could be corrected during each sampling period and pose accuracy has been further improved.

The fusion of both visual and inertial information under the filtering framework could overcome problems which single-sensor system have and improve the accuracy of pose estimation.

Keywords： Pose Estimation; RGB-D; IMU; Kalman Filter; Interactive Multiple Model (IMM)