Combining Edge and One-Point RANSAC Algorithm to Estimate Visual Odometry

Van-Dung Hoang, Danilo Cáceres Hernández, and Kang-Hyun Jo

Graduated School of Electrical Engineering, University of Ulsan, Korea
{dungvanhoang,danilo}@islab.ulsan.ac.kr, acejo@ulsan.ac.kr

Abstract. In recent years, classical structure from motion based SLAM has achieved significant results. Omnidirectional camera-based motion estimation has become interested researchers due to the lager field of view. This paper proposes a method to estimate the 2D motion of a vehicle and mapping by using EKF based on edge matching and one point RANSAC. Edge matching based azimuth rotation estimation is used as pseudo prior information for EKF predicting state vector. In order to reduce requirement parameters for motion estimation and reconstruction, the vehicle moves under nonholonomic constraints car-like structured motion model assumption. The experiments were carried out using an electric vehicle with an omnidirectional camera mounted on the roof. In order to evaluate the motion estimation, the vehicle positions were compared with GPS information and superimposed onto aerial images collected by Google map API. The experimental results showed that the method based on EKF without using prior rotation information given error is about 1.9 times larger than our proposed method.

Keywords: Omnidirectional camera, edge feature matching, one-point RANSAC, motion and mapping.

1 Introduction

Autonomous vehicle and mapping are an important research in various applications, e.g. path planning and mapping, intelligent transport, and surveillance systems. Some progresses have been made in this field during the last few years. In recent years, many methods have been developed for navigation, visual odometry[1],[2]. Some researchers used vision only, e.g. monocular camera, stereo camera, and catadioptric camera for visual odometry or used only electro-magnetic devices, e.g., Inertial Measurement Unit (IMU), wheel odometer, and laser rangefinder sensors. Other researches combined both electro-magnetic devices and vision systems for improving accuracy and absolute transformation estimation.

The related works are separated into several categories. In the first approach group, the early researches proposed vision odometry method using a single perspective camera [3, 4]. Other authors proposed methods using the binocular camera [5, 6]. Because of angle of view limitation, some authors used the omnidirectional camera. Typically, the omnidirectional vision based odometry systems were presented in [7-10]. The basic

D.-S. Huang et al. (Eds.): ICIC 2013, LNCS 7995, pp. 556–565, 2013.

principle of these approaches is feature point correspondence and epipolar geometry constraint. The main obstacle of this approach is accumulative error over time. The global trajectory is acceptable if vehicle moves in indoor environments, or in special outdoor environments. The trajectory will be diverged compared with the ground truth when vehicle moves on long distance without any prior information. This is also a challenge for the incremental methods of visual odometry or Simultaneous localization and mapping (SLAM). Moreover, the scale of trajectory process is ambiguous if a monocular vision is used. In the second approach group integrate multi-magnetic sensors in the system[11],[12]. Normally, GPS receiver is used for global position, IMU or wheel odometers are used for the local position estimation. These methods often yield the correct results on the large-scale scene. However, GPS is not always correct under environment occurring high obstacle-high building in urban. This is also a challenge for localization, navigation without vision systems. In recent years, the combination of the two methods mentioned above is considered as the solution to overcome these disadvantages. Some authors, typically in [13],[14],[15] proposed methods based on the fusion of the vision system and the electro-magnetic devices. The results were significantly improved. Due to limited of precision of sensors and additional ambient noise, there is location and mapping estimation errors. Over time, the errors will also be accumulated when the vehicles move in the large scale scene. Therefore the final global trajectory and map will be diverged and distorted. The system can yield the accurate results in short distance of movements or integrating with information from Global Positioning System (GPS) receiver. In recent years, several filter technique were applied to deal with this problem, e.g. (Extented) Kalman filter, particle filters.

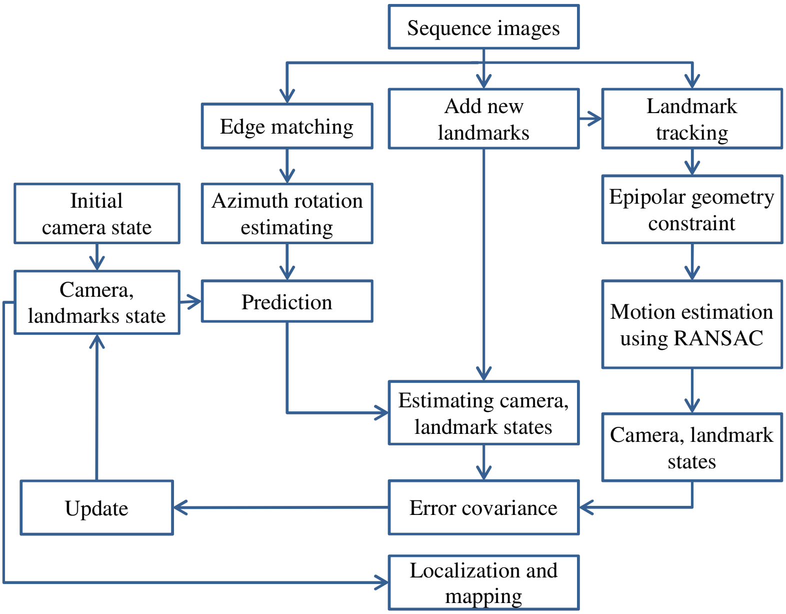

Fig. 1. The method proposed for vehicle motion estimation and mapping