Real-Time Stereo Visual SLAM

Vision based simultaneous localisation and mapping (SLAM), which utilises one or more cameras to simultaneously map an environment and localise the camera within the environment has recently been shown to work in real-time and operate autonomously in small scale environments. If a robust SLAM algorithm is available it is possible to fuse SLAM with 3D reconstruction techniques in order to align partial 3D reconstructions of scenes and hence obtain large 3D reconstructions of scenes. To date, the combination of these disciplines has not received much attention, but the approach is extremely valuable for autonomous robotics applications where the inherent characteristics of the partial 3D reconstructions obtained mean that traditional surface registration techniques are inapplicable.

Aim

In this thesis we aim to implement a robust vision based SLAM algorithm which can be further developed to operate in real-time on an autonomous underwater vehicle (AUV). We have investigated the best approach based on the state-of-the-art and propose that the algorithm should be based on an extended Kalman filter (EKF). Landmarks will be described by both 3D features and robust 2D features such as SIFT or SURF. In addition, an algorithm for estimating motion based on optical flow or point tracking will also be incorporated into the system.

Task

The state-of-the-art implementations of real-time stereo and monocular vision based SLAM will be studied along with the relevant background material. This includes the strengths and weaknesses of the various filters applicable to SLAM such as the Kalman filter, extended Kalman filter, particle filter, unscented Kalman filter and information filter; different approaches to landmark description and mapping such as 3D registration of point clouds, SIFT features, SURF features and image patches; and motion estimation techniques such as optical flow and point tracking. The main goal is to identify the approach which will provide a robust SLAM algorithm which can be applied in a variety of different small scale environments but can also be further tuned for use in an AUV.

In this way, if time permits the algorithm can be qualitatively tested on the Nessie AUV in the 2008 student autonomous underwater challenge Europe (SAUC-E). In this case, the algorithm would have to be refined to operate in real-time on the hardware of the AUV and some pre-processing steps may be required to obtain acceptable quality images.

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