Vision Based Simultaneous Localisation and Mapping for Mobile Robots

Abstract:

The ability of a robot to localise itself and simultaneously build a map of its environment (Simultaneous Localisation and Mapping (SLAM) or Concurrent Mapping and Localisation (CML)) is a fundamental characteristic required for its autonomous operation. Classically laser and sonar sensors have been used for performing SLAM but during the last decade a significant amount of research has been carried out on SLAM using vision sensors. Vision Sensors/Cameras are low-cost, light and compact, easily available, offer passive sensing, have low power consumption and provide rich information about the environment enabling the detection of stable features. These features make cameras very attractive to be used for SLAM.

Different types of imaging systems have been used to carry out SLAM including single cameras, stereo camera pairs, multiple camera rigs and catadioptric sensors. A single acquisition from a single camera only provides direction of the observed features while one acquisition from a stereo pair can provide 3D location of the observed features. Catadioptric sensors offer a 360° field of view but with non-uniform spatial resolution while multiple camera rigs can provide large fields of view with uniform spatial resolution. Similarly different types of features are extracted from the environment including point features, edge/line features and some SLAM approaches exist which do not explicitly extract any features from the environment. As a SLAM system starts, landmarks for SLAM can be initialised in an undelayed manner as in case of a stereo or multiple camera rig, or by using artificial targets at the start. In contrast, the landmarks are initialised with some delay when a single camera is used to perform SLAM without the use of any artificial target because multiple acquisitions from a single camera are required to compute 3D location of the observed features. Different algorithms have been used to perform SLAM including Extended Kalman Filtering, Particle Filtering, biologically inspired techniques like RatSLAM, and others like Local Bundle Adjustment. Similarly, vision based SLAM has been carried out with and without using the wheel odometry information. Each of the above described approaches to solve different issues involved in performing SLAM have their own pros and cons and one approach can be more suitable for a specific application than others.

A framework for development of a synthetic dataset is presented which can permit the implementation and hence testing and evaluation of different vision based SLAM techniques. Implementation of Extended Kalman Filtering based SLAM on the developed data set is also presented.

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