Federal University of Pernambuco

BSc Computer Science

Graduation Project Proposal

A study on visual SLAM techniques with applications on robot perception

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1 Context

A classical problem in mobile robotics refers to the ability of a robot to simultaneously localize itself while at the same time map its surroundings, a problem often called Simultaneous Localization and Mapping (SLAM). Robots need to solve this problem for performing various tasks, such as vacuum cleaning, lawn mowing, autonomous driving, tour guiding [5, 6, 7].

In the literature, a large variety of solutions to this problem were proposed. These approaches can be classified into two main categories, filtering and smoothing [1]. Filtering approaches deal with SLAM as a state estimation problem in which the state includes the position of the robot and the map. The state is updated as the robot gathers measurements from the physical world, and these measurements are integrated into the current state of the robot, yielding a better estimation of the map and robot's position in such map. Approaches like these are, hence, incremental in nature and commonly referred to as on-line SLAM methods. Examples of such methods are particle filters, Kalman and information filters [4]. In contrast, smoothing approaches optimize the whole trajectory of the robot based on the full set of measurements gathered throughout its history. Because of this, these approaches are often said to address the full SLAM problem, typically using least-square error minimization techniques [1].

Different types of sensors are commonly used to provide input for SLAM solutions. Classically, laser and sonar sensors have been widely applied for 2D SLAM, providing distance measurements to obstacles nearby, such as walls and other objects. Laser sensors have been also used for 3D SLAM, in which the robot's position now lies in space and the map becomes a reconstruction of the whole 3D scene [1, 6]. Throughout the last decade, a number of researchers began to approach the SLAM problem with mainstream and low cost sensors, such as RGB cameras [3, 8, 9], and RGBD sensors, such as the Microsoft Kinect [10, 2]. This initiative opened up a range of new possibilities in the field, paving the way towards the usage of cheaper hardware for robotic applications.

Nonetheless, although SLAM is a relatively mature problem, and in several aspects a solved problem by now, there are still important issues that need yet to be overcome. For instance, most SLAM proposed solutions assume that the environment is static, i.e. the world remains still when adopting an external inertial frame of reference. It is easy to see that this is not the case in many situations, particularly in indoor or domestic scenarios where, very often, there will be humans moving around and changing object locations in the world constantly. This static assumption commonly compromises mapping and localization quality when robots need to actuate in dynamic environments, such as houses and shopping centres. Another issue which is currently being dealt by many researchers [3, 9, 2] tackles the problem of scalability for larger maps, and longer periods of operation. In addition, when compared to laser sensors, lower cost depth sensors such as the Microsoft Kinect add extra operational constraints for robots, as depth measurements are less precise and can be obtained from narrower distance limits from the sensor.

2 Purpose

The goal of this work is to perform a study on a number of state of the art solutions for the SLAM problem for mobile robots. The first aspect that is going to be considered for this study is the ability of dealing with dynamic environments such as the aforementioned in the previous section. The second aspect refers to the ability of tackling large scale mapping by these approaches. Lastly, ways of overcoming low cost depth sensor limitations are going to be studied by means of combining RGB information in the acquired measurements when depth data is not available.

This study will serve as a starting point for the design of a SLAM approach which intends to attack current issues of state-of-the-art techniques, particularly when dealing with dynamic and large scale environments using low cost sensors. The results of this study are going to be embedded in a mobile robot platform and tested in an indoor environment following an experimental approach.

Finally, the results of this study are going to be incorporated to the current code base for robot perception research of the Voxar Labs.

3 Schedule

Tasks	**Apr**				**May**				**June**				**July**			
Bibliography review																
Analysis of existing solutions for SLAM																
Implementation of SLAM solution on robotic platform																
Evaluation of solution in indoor environments																
Preparation of report and monograph defense																

4 References

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5 Potential Supervisory Committee

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6 Signatures

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