Abstract No: SC-05 **Smart Computing**

An optimized solution for mobile robot navigation for dynamic office environments using active simultaneous localization and mapping

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Abstract

It is a very tedious process to develop a methodology for indoor navigation of mobile robots when it comes to environments with dynamic obstacles. So the objective of this research is to find an optimal solution for mobile robot navigation in indoor environments, specifically in an office environment. Instead of traditional line following methods, here an application with fully autonomous navigation plan with active Simultaneous Localization and Mapping (SLAM) techniques is presented. Proper localization, mapping techniques and a location identification method using April tags or labels embedded in the generated map can be used. The research was conducted by using affordable equipment such as wheel encoders, Inertial Measurement Unit (IMU) and a low cost Light Detection and Ranging (LIDAR) sensor and have used Robot Operating System (ROS) as a tool to implement the solution.

Keywords: Indoor navigation, LIDAR, ROS, SLAM

Introduction

Autonomous navigation is a trending topic these days and lots of research has been conducted in this area. When it comes to indoor navigation traditional methods like path following still prevails because further studies should be done before implementing modern approaches. Usage of GPS is hindered in indoor environments and that is a huge barrier for localization. The problem with traditional approaches is that they are heavily dependent on the environment, so when the environment changes the entire system need to be revamped. Simultaneous Localization and Mapping (SLAM) techniques use the environment to localize the robot which is more appropriate for such applications. Since the odometry of the robot which gives the position of the robot is often erroneous, and therefore cannot rely directly on the odometry.

SLAM is the ability of a robot to localize itself in an unknown environment while incrementally building a consistent map of that environment. Nowadays there are many applications based on SLAM including self-driving cars, unmanned aerial vehicles, autonomous underwater vehicles, planetary rovers, newly emerging domestic robots and even inside the human body (Mountney et al., 2006).

The primary software platform that was used to build this system is ROS (Quigley et al., 2009). This platform integrates all the computational and input/output nodes of the robot and is entirely based on Linux. In the ROS community, many developments have been carried out in the field of autonomous navigation. Thrun et al. (2005) describes the basic theories related to autonomous mapping and navigation. Wong and Jarvis (2004) and Zaman et al. (2011) further describes the complexities and procedures of indoor robotics navigation.