Project proposal on

AUTONOMOUS ROBOT USING SLAM TECHNIQUE

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Abstract

Mobile robots are expected to perform complicated tasks that require navigation in complex and dynamic indoor and outdoor environments without any human input. In order to autonomously navigate, path plan, and perform these tasks efficiently and safely, the robot needs to be able to localize itself in its environment based on the constructed maps. Mapping the spatial information of the environment is done online with no prior knowledge of the robot's location; the built map is subsequently used by the robot for navigation. Recently, there has been considerable excitement about the use of technology from the robotics and autonomous vehicle industries for indoor mapping where GPS or GNSS are not available. This technology is called SLAM, Simultaneously Localization and Mapping. It is a process where a robot builds a map representing its spatial environment while keeping track of its position within the built map. The aim of the project is to build an robot capable of performing SLAM technique, using easily available low cost RGBD camera.

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Chapter 1

INTRODUCTION

The word Robot is usually used to refer a mechanical agent that performs one or more tasks in which it mimics a human either through programming or commands. Autonomous or remote controlled devices that are capable of taking surveillance, photographs, mapping etc.

SLAM is one of the most widely researched sub-fields of robotics. The term SLAM is as stated an acronym for Simultaneous Localization And Mapping. SLAM is concerned with the problem of building a map of an unknown environment by a mobile robot while at the same time navigating the environment using the map. In robotic mapping and navigation, simultaneous localization and mapping (SLAM) is the computational problem of constructing or updating a map of an unknown environment while simultaneously keeping track of an agent's location within it. While this initially appears to be a chicken-and-egg problem there are several algorithms known for solving it, at least approximately, in tractable time for certain environments. Popular approximate solution methods include the particle filter, extended Kalman filter, and Graph SLAM. The robot uses on board sensors to construct a 3d map of its surrounding based on its visual sensors. It uses wheel optometry which is used to get accurate location of the rover and also has a HD camera which helps in providing a live video feed. The robot can be controlled manually or can be forced autonomously to go to a specific destination. The robot will also be capable of carrying payload. Robot localization requires sensory information regarding the position and orientation of the robot within the built map. Each method involves some major limitations, so proper sensor fusion techniques have been deployed to overcome the constraints of each sensor alone. The simplest form is to use wheel odometry methods that rely upon encoders to measure the amount of rotation of wheels. In those methods, wheel rotation measurements are incrementally used in conjunction with the robot's motion model to find the robot's current location with respect to a global reference coordinate system. The most significant error source is wheel slippage in uneven terrain or slippery floors. IMU is also used to measure the linear and rotational acceleration of the robots. However, it can still suffer from factors like extensive drift and sensitivity to bumpy ground.

1.1 CATEGORY

Assistive technologies

1.2 OBJECTIVES

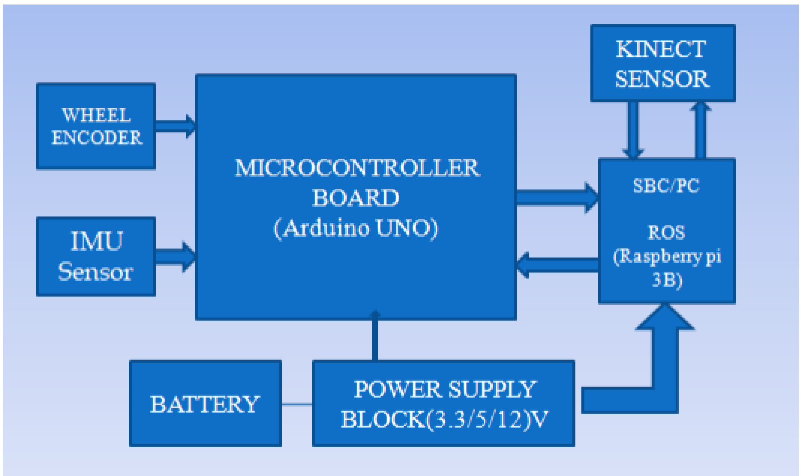
Our aim is to develop a rover which will be capable of constructing 3D maps of the surroundings and it will also be able to carry payload autonomously to any specific location. The rover works as an assistant, the rover provides a live video feed from the remote location. The robot uses on board sensors like 3D cameras and compass to get exact and accurate locations and the robot can be used to carry pay loads.

The following are a set of hardware requirements to be met by this robot:

- The robot will be able to carry a maximum payload of 5 kg
- The robot will travel at a speed between 0.25 m/s and 1 m/s
- The ground clearance of the robot will be greater than 3 cm.
- The robot must be able to work for 2 hours continuously.
- The robot will be able to move and avoid obstacles.
- The robot height should be between 40 cm.
- The robot should be of low cost. Dept.

Chapter 2

BLOCK DIAGRAM



The main block diagram of the robot is shown above; this block diagram can be divided in 3 subsystems namely:

1. Motion control system.

2. Video transmitting system.

3. 3D Mapping system.

The robot should be modular and simply in design which should be easy to make any adjustments or even replace any components. So having a single processor to perform the entire task can be done but if any damage to the processor or the electronics will cause the whole rover to malfunction and will be of no use. To overcome this drawback we have subdivide into different subsystems. The robot's movement is controlled by two Direct Current (DC) gear motors with an encoder. The two motors are driven using a motor driver. The motor driver is interfaced into an embedded controller board,which will send commands to the motor driver to control the motor movements. The encoder of the motor is interfaced into the controller board for counting the number of rotations of the motor shaft. This data is the odometry data from the robot. There are ultrasonic sensors, which are interfaced into the controller board for sensing the obstacles and measuring the distance from the obstacles. There is an IMU sensor to improve odometry calculation. The embedded controller board is interfaced into a PC, which does all the high-end processing in the robot. Vision and sound sensors are interfaced into the PC and Wi-Fi is attached for remote operations.

2.1 HARDWARE COMPONENTS

- Arduino UNO (ATMEGA328P)
- Raspberry pi 3B (ARM A51)
- Kinect sensor
- IMU sensor
- Geared DC Motor With Wheel encoder
- Ubuntu 16.04 (Xenial)
- ROS (Robot operating system)
- Python Point Cloud Interface
- Open Mesh
- LibreCAD

2.2 LIST OF OPEN SOURCE SOFTWARE AND HARDWARE

Name of Software/Hardware	Type	Type of License
Robot Operating System (ROS)	Open source	BSD License
Python	Open source	BSD and GPL Compatible
Ubuntu 16.04	Open source	GNU General Public License
Point Cloud Library	Open source	BSD License
OpenNI	Open source	BSD License
OpenCV	Open source	BSD License
LibreCAD	Open source	GPLv2
Arduino Uno	Open hardware	Creative Commons Attribution Share-Alike
Raspberry Pi	Open hardware	Creative Commons Attribution Share-Alike

2.3 COST OF PROJECT

Name of the components	Cost
Arduino MEGA(ATMEGA 2560)	900/-
Raspberry pi 3B(ARM A51)	5,480/-
Kinect sensor	12,000/-
IMU sensor	150/-
Geared DC motor with encoder (two motors)	3,500/-
Motor driver	1,800/-
Robot chassis fabrication	1,500/-
Li po supply unit(Battery)	1,990/-
Total cost	27,320/-

2.4 URL

After completion of the project respective files will be hosted on Github repository.

2.5 BENEFITS AND OUTCOME OF PROJECT

Autonomous robot performs complicated tasks that require navigation in complex and dynamic indoor environment without any human input. An autonomous mapping and navigation system will be designed which could autonomously map an indoor area like an office environment and later use the same map to autonomously navigate to the specified location by the user.A robust state machine is implemented to achieve the objective of autonomous mapping. Localization and mapping algorithm like SLAM will be effectively used to get reasonable and accurate maps of the desired area.

The Simultaneous Localization and Mapping (SLAM) problem can be defined as a process where a robot builds a map representing its spatial environment while keeping rack of its position within the built map. Mapping is done online with no prior knowledge of the robot's location; the built map is subsequently used by the robot for navigation. SLAM is a key component of any truly autonomous robot.

2.6 SCOPE FOR FUTURE IMPROVEMENT

As a future improvement LiDAR can be used to create 3D Maps with higher precision and more accuracy with wide-area scanning capability. To make the robot compatible for outdoor environments, GPS and GNSS sub systems can also be added onboard.

CONCLUSION

An autonomous mapping and navigation system will be designed which could autonomously map an indoor area like an office environment and later use the same map to autonomously navigate to the specified location by the user. A robust state machine will be implemented to achieve the objective of autonomous mapping. Localization and mapping algorithm like SLAM will be effectively used to get reasonable and accurate maps of the desired area. In future LiDAR could be used to recreate 3D Maps with higher precision.

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