Indoor Localization System for Mobile Robots

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Abstract:
Robots have been gaining popularity due to the fact that they tend to deliver tasks at a much more greater pace and lesser energy usage. Over the last decade I has been widely helping human labors in factories for carrying out tasks, carrying out basic home tasks and also in the medical field for carrying out surgeries. The problem of generating maps with mobile robots has received considerable attention over the past years. In this proposed system, the problem of creating maps with mobile robots in dynamic environments are considered. The robot will perform the mapping process based on two operating modes, Scanning and Mapping mode and Navigation mode. The scanning process will be accomplished in two steps, Scanning and Matrix generation. While the Navigation will be one in two steps, Direction algorithm and (x,y) algorithm. Communication regarding their position information in the environment between the autonomous mobile robots is achieved using Bluetooth technology.

Keywords: SLAM (Simultaneous Localization and Mapping), GPS, IR sensor.

I. INTRODUCTION

Localization is defined as the process of finding the location of an object or person relative to some user defined space. In a GPS system, this space is the Earth and each GPS coordinate uniquely defines a location on the Earth. Other localization systems operate on a local space, such as a city or building. The localization technologies like GPS based systems that operate on a large scale are not suitable for smaller scaled environments like buildings. The GPS system can provide localization only in outdoor environments and has limitations to being used indoors. This is due to various reasons including multipath and signal blockage that occurs extensively when this system is being used indoors. Robots are being widely used in the current era, as they tend to deliver tasks at a much more faster pace and relatively lesser energy consumption. Autonomous Mobile Robots are robots that can perform a desired task in an unstructured and unknown environment without continuous human intervention. SLAM (Simultaneous Localization and Mapping) is a technique used by robots and autonomous vehicles to build up a map within an unknown environment (without a prior knowledge) or to update a map within a known environment (with a prior knowledge from a given map), while at the same time keeping track of their location through the environment. The primary objective of the proposed system is to build two mobile robots, which with the help of an algorithm will build a map of the surrounding indoor environment (occupancy grid map) in MATLAB. This helps achieve localization and hence navigation. We aim at enabling communication between the two mobile robots using Bluetooth Technology regarding their position.

II. PROPOSED METHODOLOGY

- Block Diagram

Fig.1 describes the block diagram of the mobile robot. Arduino Uno is the microcontroller used in this project. To it several motors as well as sensors have been interfaced. Bluetooth HC-05 Module assists the wireless communication between the mobile robot and a host PC. It can also facilitate the communication between two robots. DC motors are
utilized for the movement of the robot in the workspace. Sharp IR Range Finder 2Y0A21F67 is used to measure the distance between object and the robot (i.e. within 180 degrees angle range). To get a wider sweep angle of the IR sensor, it has been mounted on a servo motor. It takes continuous distance reading and reports the distance as an analog voltage. Sharp IR Range Finder 2Y0A21F67 has a distance range of 10cm (~4") to 80cm (~30").

- Algorithm for localization and navigation of mobile robot

Algorithm for Localization and Navigation of Mobile Robots:
The robot will perform mapping process based on two operating modes:

i. Scanning and Mapping : 180° scanning; Matrix generation
ii. Navigation: Direction algorithm; (x,y) algorithm.

The robot will start its operation from any one corner of the room. At this point the robot will have (0,0) block position and will be facing towards ‘NORTH’ direction as per predefined algorithm. The (x, y) block position will be transmitted to the Bluetooth enabled host PC having MATLAB via HC-05 Bluetooth module.

Scanning:

180° scanning: The sharp IR sensor mounted on servomotor shaft will capture 25 different samples at one position in the form of range. The average of these 25 readings is stored. This is done in order to increase the accuracy of the distance measurement. The servomotor shaft will rotate with an increment of 5°. The parameters (x,y,a,r) will be transmitted for first block to the host PC, where, r =distance of the ultrasonic sensor from the obstacles in cm and a=angular position of servo motor shaft in degrees. Samples are then taken at the three angular positions (0°, 90° and 180°) to determine the number of blocks in left, forward and right direction. Depending upon these samples, robot will assign ‘0’ to obstacle/wall and ‘1’ to free space block.

Navigation:

Direction algorithm: The pointer will be initially pointing towards north at the start of the mapping process. Whenever he robot turns, the pointer will be incremented or decremented by 1 depending on the direction it is facing. For every right turn the pointer will be incremented by 1 and will move in east direction, as referred from figure 2. Accordingly, the robot will upgrade its current direction which will be simultaneously sent to the host PC for display.

(x,y) algorithm:

Depending upon direction the robot will calculate its current block position (x,y) value as shown in figure 3. If the robot moves in the east, west, north or south direction, it will increment its x co-ordinate value, decrement x co-ordinate, increment y co-ordinate or decrement y co-ordinate respectively.

Figure 3. (X,Y) Algorithm

III. RESULT ANALYSIS

Sharp IR rangefinder sensor is mounted on a servo motor with the help of a metal clamp as shown in Fig.5. The built mobile robot is as seen in figure 6. Communication between mobile robots is achieved using two HC-05 Bluetooth modules, one on each robot. These modules will either be configured as Master or Slave. One of the robot is made to travel a particular path after which its (x,y) block position along with its orientation is sent to the other robot via its HC-05 Bluetooth module.
module. The other robot receives this data, calculates the shortest free path to the first robot and travels to it.

Figure.5. IR sharp range finder sensor clamped on servo motor

Figure.6. Mobile Robot

Figure.7. lawnmower traversing

The Master robot moves in a lawnmower fashion as shown in figure 7. The occupancy grid map obtained is as shown in figure 8. It is used to know the presence of obstacles in the blocks that make up the environment.

Figure.8. Occupancy Grid Map in Matlab

IV. CONCLUSION

An Autonomous Mapping Robot is an efficient means to map a particular indoor environment or area by localizing itself. It also detects the obstacles and navigates itself in an area by avoiding the obstacles. Occupancy grid map of the area are plotted on MATLAB accurately. The data transmitted by robot will be sent to host PC via Bluetooth HC-05 modules in order to create the map. Also, communication between two mobile robots is achieved via Bluetooth technology.

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V. REFERENCES


