Robotic Delivery System
with
Simultaneous Localization and Mapping

Functional Description and Complete System Block Diagram

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Introduction

The purpose of the Robotic Delivery System with Simultaneous Localization and Mapping (SLAM) is to locate a user with a wireless remote and bring them an object upon request. This system could be used for any purpose such as simply bringing someone a drink to increasing productivity of a company by delivering packages. This could be particularly useful to increase the freedom of those who are immobilized due to sickness or disability. Our implementation will bring the user a drink, but this foundation will allow for further development of more useful applications which require more complicated mechanical interfaces.

The goals of the project are to develop WiFi signal strength acquisition software, robotic obstacle avoidance software, localization and mapping software, and best path algorithm software which will all assist in the WiFi based navigation of the Robotic Delivery System. The Pioneer p3dx will be our robotic platform. Optionally, a web based server will be created to allow for real time robot tracking by multiple users.

Functional Description

Upon startup, the Robotic Delivery System with SLAM will search for known WiFi signals an associated map file. If known signals are found, the robot will localize itself using this map, a filtering technique, and signal strengths. If no known signals are found, the robot will go into an initial mapping mode. The robot's original position will be considered the home base to which it will return when idle. The startup mapping mode will start by finding the closest wall and will begin following it. This will define an outline of the robot's environment, which will be saved on the robot in a new map associated with the WiFi signals found. After the startup routine is completed the robot will return to the home base and enter idle mode until it receives a signal from the user.

The user will use a program installed on a laptop to send a signal to the robot that they want a drink. The program will find the users position using the WiFi signal strength acquisition software and send it to a server on the robot. The robot will then identify the best path to the user and go into navigation mode. In navigation mode the robot will execute the path found while using the obstacle avoidance software to get to the user. The mapping software will also be continuously updating to optimize the map of the robot's environment. When the robot arrives at the user's position it will wait for either the user to pick up the drink or for a certain amount of time to pass until it returns to home base.

Functional Block Diagrams

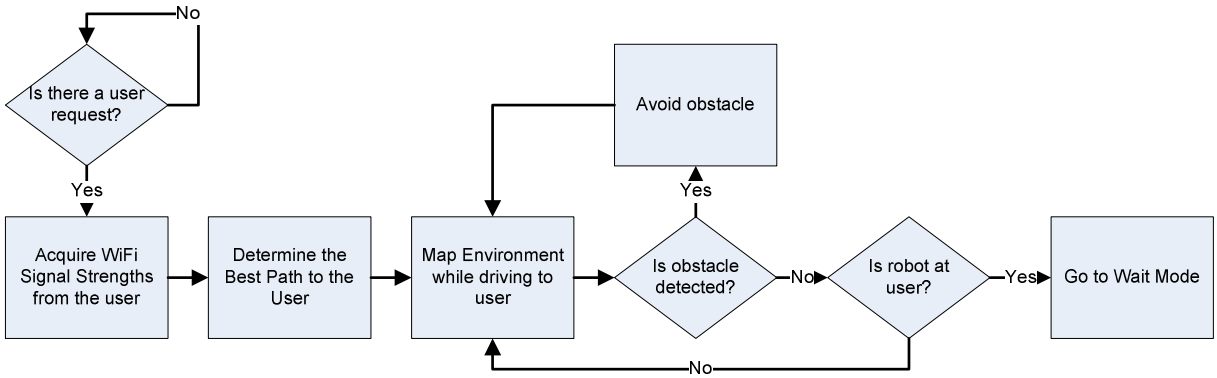

Figure 2 – Robot Normal Operation

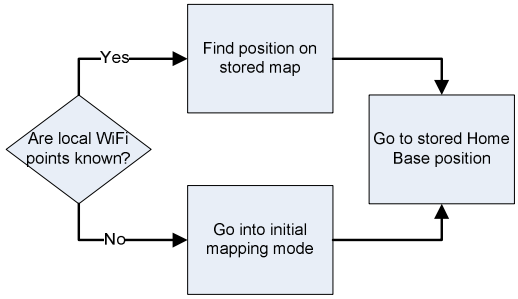

Figure 3 – Robot Startup Operation

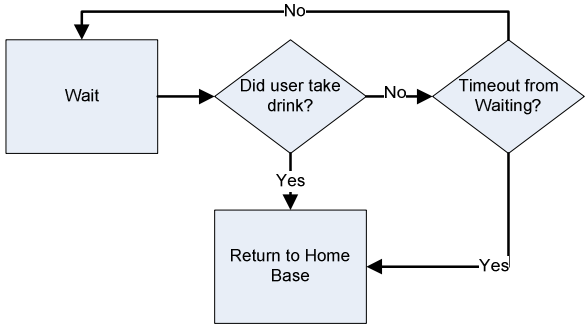

Figure 4 – Wait Mode Operation

Software Subsystem Descriptions

WiFi Signal Strength Acquisition Software

This software will be used by the robot and user interface to determine the position of each using a minimum of three WiFi signals. The received signal strength indications (RSSI) of each signal will identify the unique location of the user and robots. Each RSSI will be associated with a MAC address which is unique to each WiFi point. Problems include noisy RSSI values which can be averaged into a useable value.

Robotic Obstacle Avoidance Software

This software will be used by the robot to assist in navigation around the environment. It will use fuzzy logic and control algorithms with data acquired from the sonar sensors on the Pioneer to detect obstacles and navigate safely around them. Possible problems can occur from poor sensor readings. This can be solved by averaging sensor readings, throwing away extremes, and moving the robot slowly.

Localization and Mapping Software

Using the RSSI and the sonar sensors the robot will map its environment to determine its location in reference to the user. The map will be used by the best path algorithm software. Possible problems will be wheel slippage and map skewing. Different filtering techniques will be researched to overcome these issues.

Best Path Algorithm Software

We will research different algorithms to determine the best path from the robot's position to the user. Possible solutions include the bug algorithm, potential field path planning, and fixed cell decomposition [1].

Additional Functionality

Webpage

Users can access a webpage that will display the map with dynamic robot position, WiFi strengths, and possibly allow the user to tell the robot to go to a certain point on the map. Additional features of this website will also be explored.

Dynamic User Locating

User can move with laptop in local environment and robot will continue to navigate towards the user. This will require constant updating of user's position.

References

[1] Nourbakhsh, Illah R., and Roland Siegwart. Introduction to Autonomous Mobile Robots (Intelligent Robotics and Autonomous Agents.) London: The MIT Press, 2004.

Pictures Used

http://www.activrobots.com/press/PatrolDX.jpg
http://www1.istockphoto.com/file_thumbview_approve/3215941/2/istockphoto_3215941-laptop.jpg
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