CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

36530

Project Title

A Map-Building, Self-Driving, Voice-Controlled Service Robot for the Visually Impaired

Abstract

Objectives/Goals

The objective of this project was to build a robot that can guide the visually impaired in an indoor environment. Design goals of the robot include the ability to create a map of its environment, localize itself in the map, plan a route to a specified destination, and drive there while avoiding any obstacles along the way. The robot should be directed using voice commands, respond with synthesized speech.

Methods/Materials

The robot was built using an iRobot Create Educational chassis and 3D printed custom parts, and equipped with a LIDAR rangefinder, 3D camera and inertial measurement unit. The onboard computer is an Intel NUC mini-PC running Robot Operating System (ROS) on Ubuntu Linux. Each layer of the ROS navigation stack was customized for accuracy and dynamic behavior. Data filters were developed for sensor integration. An executive process was written for robot control and voice/speech interaction. Development was done on an iMac running Ubuntu Linux and communicating with the NUC over Wi-Fi.

Results

Our robot could successfully create a map of an indoor environment, determine its position in the map, plan a path to a destination and drive to it while navigating around temporary obstacles. It accepted voice commands and responded with context-aware spoken answers. The map was accurate to within 0.3m for every 10m of linear distance. Self-driving was accurate to within 0.5m from the center of the robot to the actual destination. Voice command processing recognized key phrases 82% of the time, and rejected non-test phrases with 96% accuracy.

Conclusions/Discussion

We achieved our goal of building a robot that can guide visually-impaired persons in an indoor environment. Mapping and localization accuracy were excellent and voice/speech interaction was adequate for the task. While purpose-built guide robots have been reported in the literature, they tend to be large, expensive unitaskers. Our robot can be built inexpensively using commercial parts. With a powerful, general-purpose PC on board, it is a versatile, modular and upgradeable platform for future applications such as health monitoring and social interaction for the visually impaired.

Summary Statement

We built a robot that can autonomously guide a visually impaired person in an environment by first creating a map of an environment and then using voice commands to drive to a specified destination in the map while avoiding obstacles.

Help Received

We designed, built and programmed our prototype and final design ourselves. After the completion of our prototype, we met with Professor Stefano Carpin of UC Merced, who advised us to consider developing on ROS running on a more powerful onboard computer.