Design and Implementation of an Autonomous Wheelchair for Physically Challenged People

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Introduction

Background

Many people struggle on a daily basis with the issue of mobility. For most, the struggle of mobility is due to a physical handicap that is prohibiting their movement. Wheelchairs were invented to help provide a remedy for these situations. However, standard wheelchairs still seem to prove ineffective for a large percentage of users. Autonomous wheelchairs for physically challenged people is more effective in providing effortless mobility to improve their lifestyle.

Problem Formulation

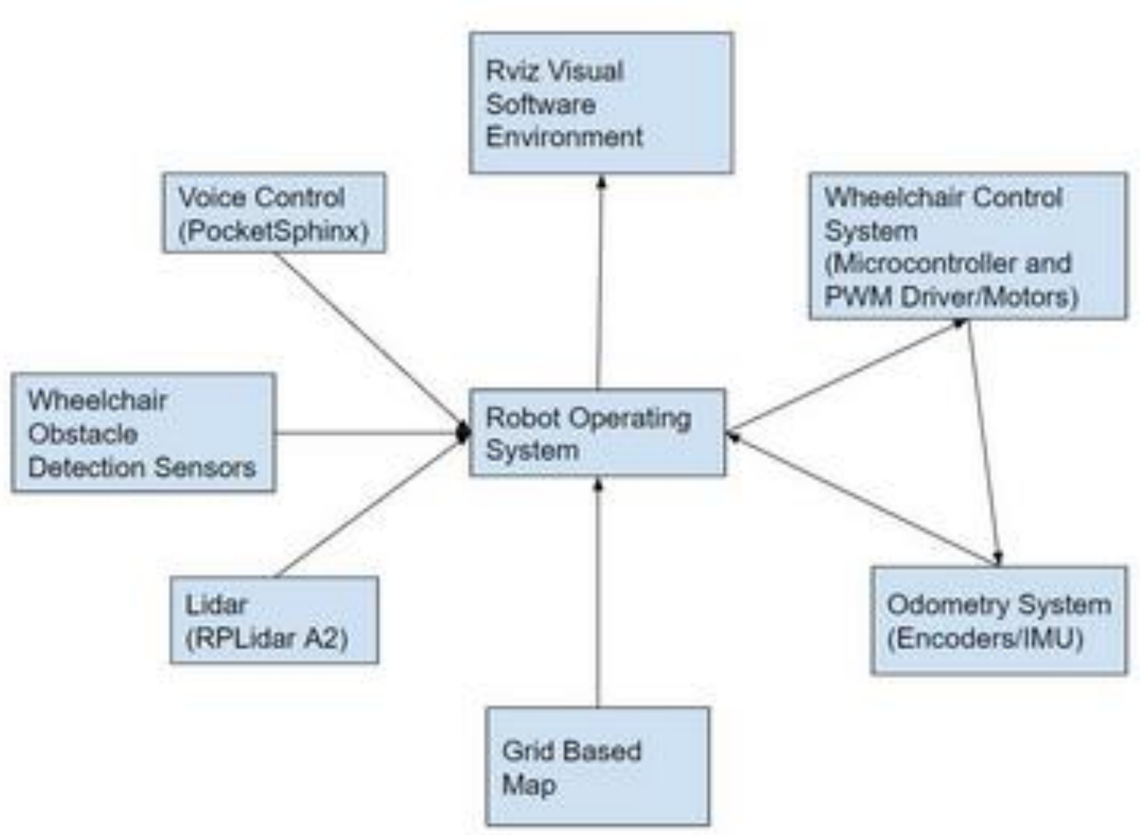
Due to a variety of possible handicaps pertaining to many individuals, many standard wheelchairs just don't prove to be beneficial. Standard wheelchairs only benefit those with the ability to use their arms and vision to help move them along. For those who do not have the luxury of those factors, a autonomous wheelchair must be designed. This issue can be solved using a standard wheelchair and adding the autonomous capability.

Motivation and Approach

This research aims to deliver an automated, safe and convenient solution for assistive technologies/ advanced smart assistance which will enable elderly and handicapped people with locomotive disabilities to travel around alone with no assistance. The command of the person in the form of voice, written information, or hand gesture, is captured by the wheel chair artificial brain and convert it to a control command, which tells the wheelchair where to go. In order for the artificial brain to perform properly, it must know the environment it is operating in and the coordinates of the different possible places the chair is likely to go.

Methods

This project uses Robot Operating Software (ROS) platform, a Lidar Sensor, Sonar Sensors, and an Inertial Measurement Unit (IMU). Two DC motors are used to provide the mobility of the wheelchair.



The Robot Operating System (ROS), is the framework used to write the robot's software. ROS Visualization (RVIZ) is the visualizer used along with ROS for displaying sensor data. It helps in easier representation and analysis of sensor data.

The research project is broken down into three stages, namely:

a) Mapping of the environment
b) Localization of the Wheelchair in the environment
c) Obstacle detection
d) Autonomous Navigation

In this phase of the research, the human voice will be used to provide the locations to go to.

Mapping: Mapping is done using a Lidar Sensor, it generates a visual representation that shows all features, obstacles, and objects in the environment

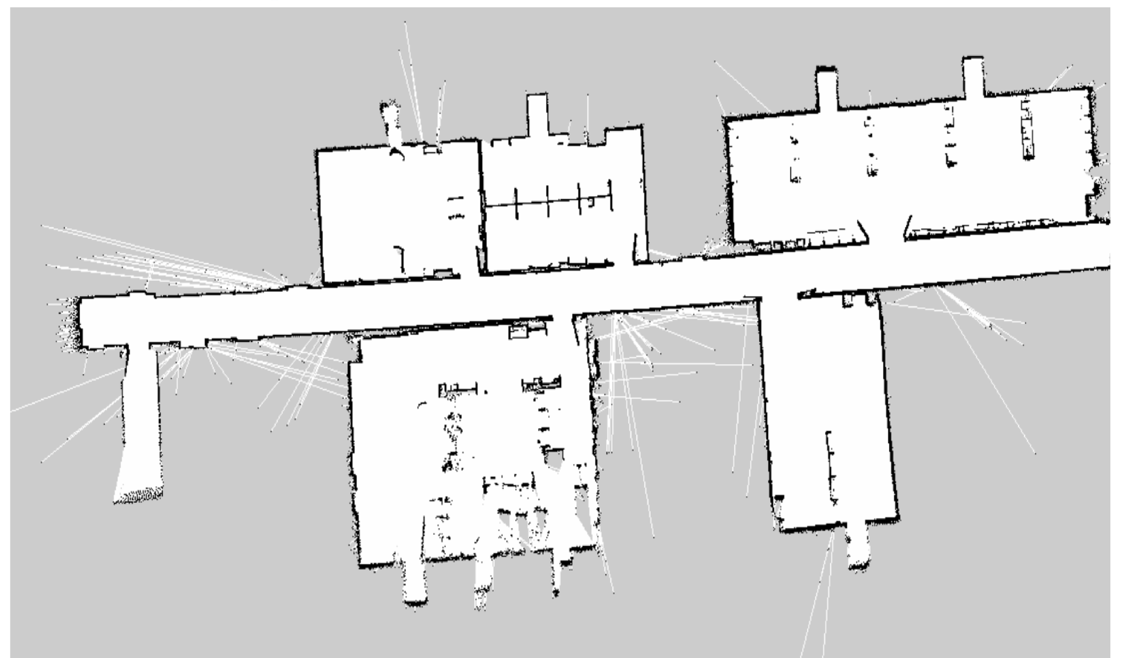
Localization: The Adaptive Monte Carlo Localization algorithm is used to estimate the pose of the robot in its environment against a known map of the environment.

Obstacle Detection: Sensor readings from the Ultrasonic/Lidar Sensors are used to build an obstacle map

Autonomous Navigation: A path planning algorithm is used to determine an acceptable path for the wheelchair to follow to its destination while avoiding obstacles.

Results

1) Mapping



2) AMCL

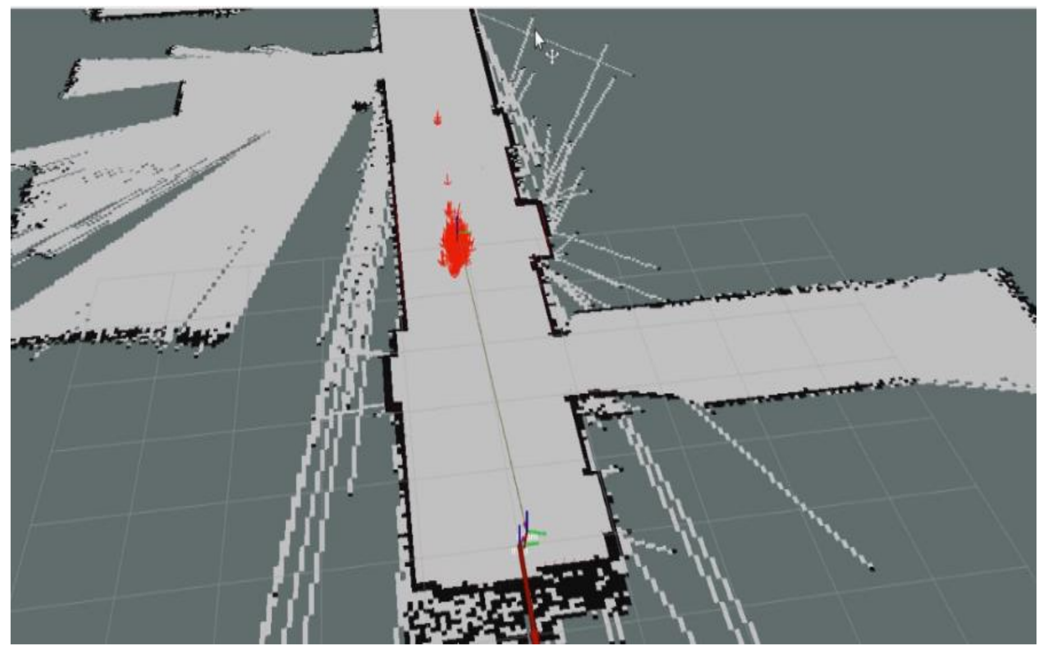
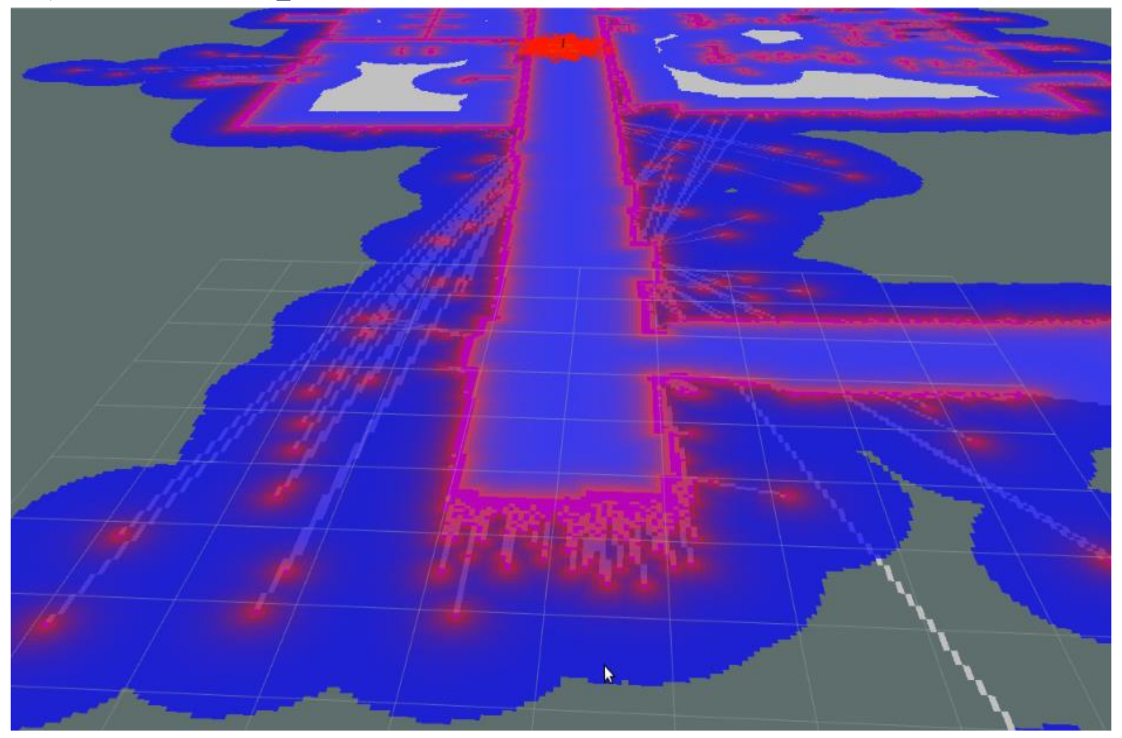


Figure 1: Map of the fourth floor of Brown Hall created with a LIDAR Sensor and Hector Mapping Algorithm. **Figure 2:** Localization of the wheel chair using the AMCL algorithm in the Map created.

3) Cost Map



4) Path Planning

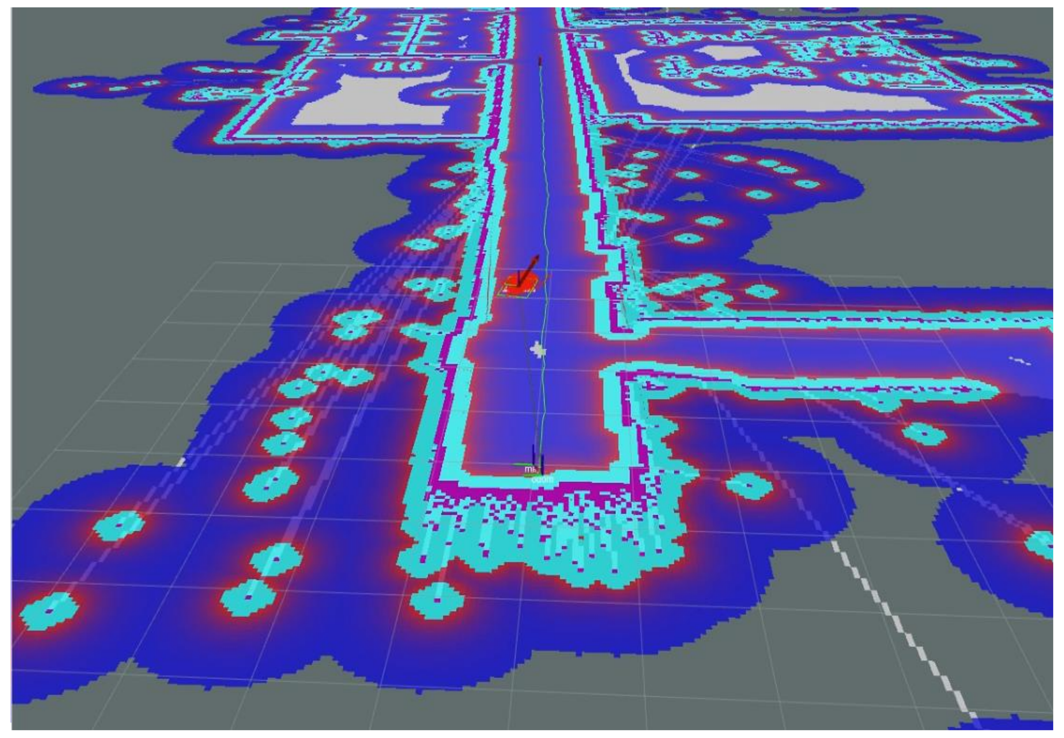


Figure 3: Cost map generated by Lidar and Ultrasonic Sensors, the map generated is used for obstacle detection. **Figure 4:** The green line indicates the path to be used by the wheelchair to get to its destination, and the red particles with the arrow indicates the actual position/path of the wheelchair

Conclusions

The control system that converts a manual wheel chair to a fully autonomous wheel chair was designed and developed in this work.. Preliminary testing was successfully performed. Further testing and tuning is currently underway.

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References

[1] B. F. a. G. F. Steven Alsalamy, "Autonomous Navigation and Mapping using Lidar," San Luis Obispo, California, 2018.
[2] L. H. H. &. M.-M. K. Chen, "Ekf based mobile robot localization.," in 2012 Third International Conference on Emerging Security Technologies, 2012
[3] l. a. T. D. K. R. C. N. D. H. Kevin Townsend, "Adafruit BNO055 Absolute Orientation Sensor," Bosch, [Online]. Available: https://learn.adafruit.com/adafruit-bno055-absolute-orientation-sensor/overview. [Accessed 07 November 2019].

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