Semi-Autonomous Wheelchair (SAW)

Sponsors: Microsoft and WSU Intelligent Robot Learning Laboratory

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Abstract

The purpose of this project is to create a system that integrates with existing wheelchair hardware to assist in the daily lives of people who have debilitating diseases such as ALS. This project provides an accessible interface into a wheelchair that assists them in driving safely if they can, and drives for them if they cannot.

Background

It is difficult for people with physical disabilities such as ALS to live a normal life. In many cases, they are only able to move their eyes. Our goal was to create a hardware/software system to interface with their existing wheelchair in order to help them live easier.

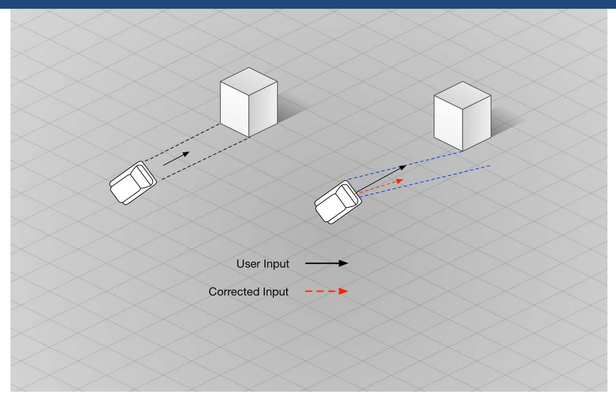
Requirements

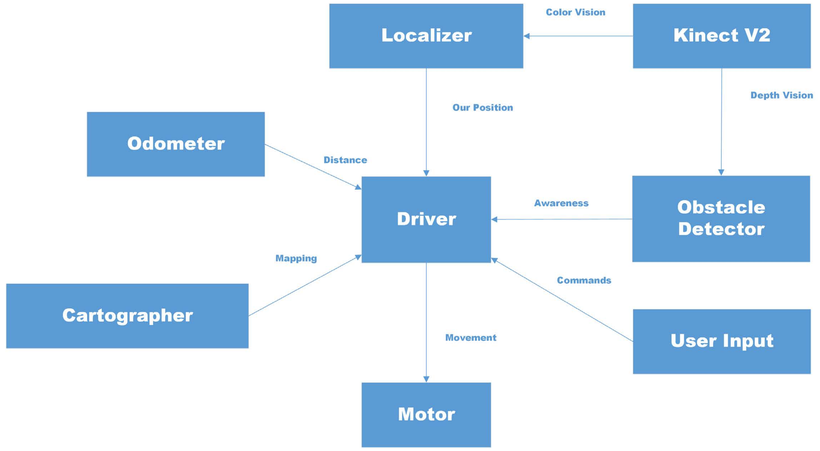
- Fully accessible by users with limited motor control
- Keep the user safe during travel
- Autonomously navigate known environment
- Works on top of existing wheelchair hardware

Objectives

- Obstacle avoiding
- Self-Navigating
- Modular
- Can be driven by eye movements
- User friendly

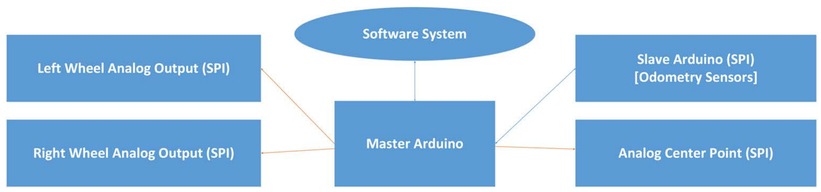
Obstacle Avoidance





Software Solution

- Driver
  - Mediates other components
  - Decides how the chair moves
- Obstacle Detector
  - Utilizes Microsoft Kinect V2 Depth Stream
  - Identifies obstacles in the environment
- Cartographer
  - Maintains map of the area
  - Given a destination, generates a path using A*
- Motor
  - Sends movement commands to wheelchair
- Odometer
  - Records distance traveled and wheelchair orientation
- Localizer
  - Identifies features using Kinect color stream
  - Used to correct our known position
- User Input
  - Gets directional input from the keyboard, Xbox 360 controller, or EyeTribe retina tracker



Hardware Solution

- Omni+ Wheelchair Communication
- Arduino serial commands from software system
- Analog interface to maximize control over speed and direction
- SPI communication to slave Arduino for extra sensors

Features

- Avoids obstacles without removing control from the user
- Can localize itself in a map by detecting features in its view
- Controllable by retina-based input
- Modular software interfaces make the solution easily extensible
- Plug & Play on Omni-based hardware
- Can autonomously navigate a known environment
- Simple and expressive user interface

Future Projects

- Update the Navigation module to incorporate SLAM
- Create a companion app so the patient's caretaker can monitor and control the chair
- Create an Open Source Wheelchair platform to build off of
- Expand feature recognition to identify generic environments

Impact

Our solution is a proof-of-concept to fill the void left by current wheelchairs that do not take advantage of recent technology. We have demonstrated that more sophisticated, comfortable, and user-friendly solutions can be provided using simple software and existing hardware. Hopefully this will encourage the creation of a market-ready product that will bring the safety and convenience of autonomous and semi-autonomous navigation to those who need it most.

Glossary

- ALS - Amyotrophic Lateral Sclerosis
- A* - Efficient path finding algorithm
- EyeTribe - Affordable Eye Tracking device
- SLAM - Simultaneous Localization and Mapping
- SPI - Serial Peripheral Interface
- Omni+ - Abstracts wheelchair driving for interface devices

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Team Skywalker