# AUTONOMOUS WHEELCHAIR FOR PATIENT DELIVERY

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CYBERWORKS ROBOTICS

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## Problem Statement

### Hospitals and high traffic areas are challenging to move about in powered wheelchairs

- This wheelchair will eliminate the need for the rider to make precise motion inputs to drive the machine
- We have made steps in developing an autonomous control system for powered wheelchairs to deliver patients with dynamic obstacle avoidance

### System Data Flow

- Data shared among ROS devices through USB
- User selects a destination and orientation in a previously mapped environment
- Robot autonomously navigates to destination with live object avoidance and Graceful Motion

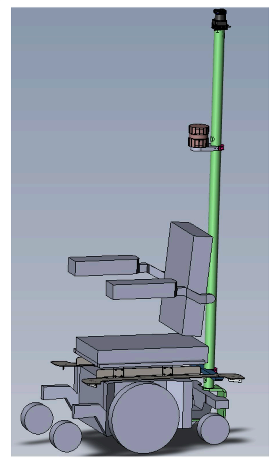
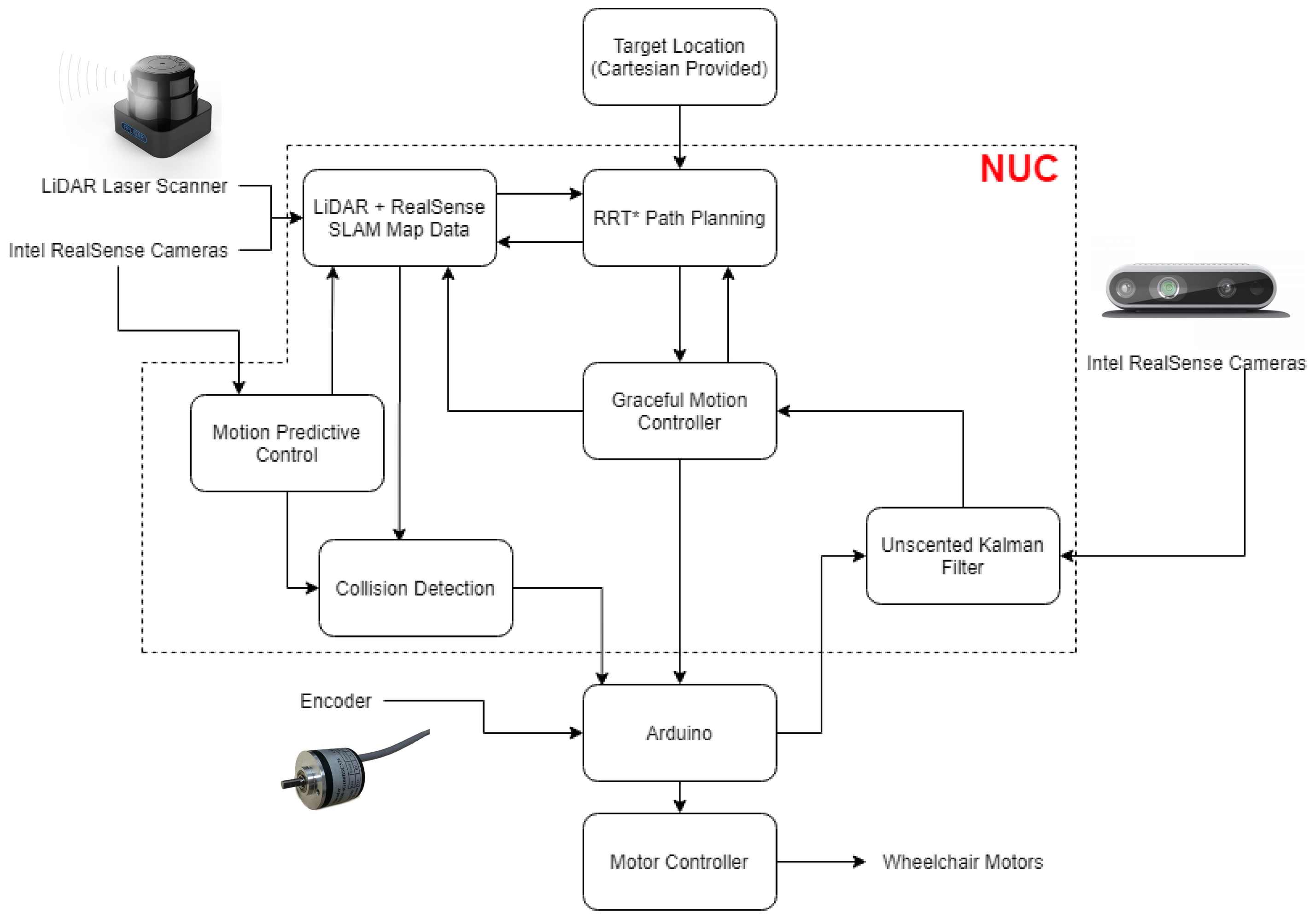


Figure 1: Model of Pride Mobility Edge Wheelchair with Hardware Components

## Hardware and Software Layout




## Simultaneous Localization & Mapping

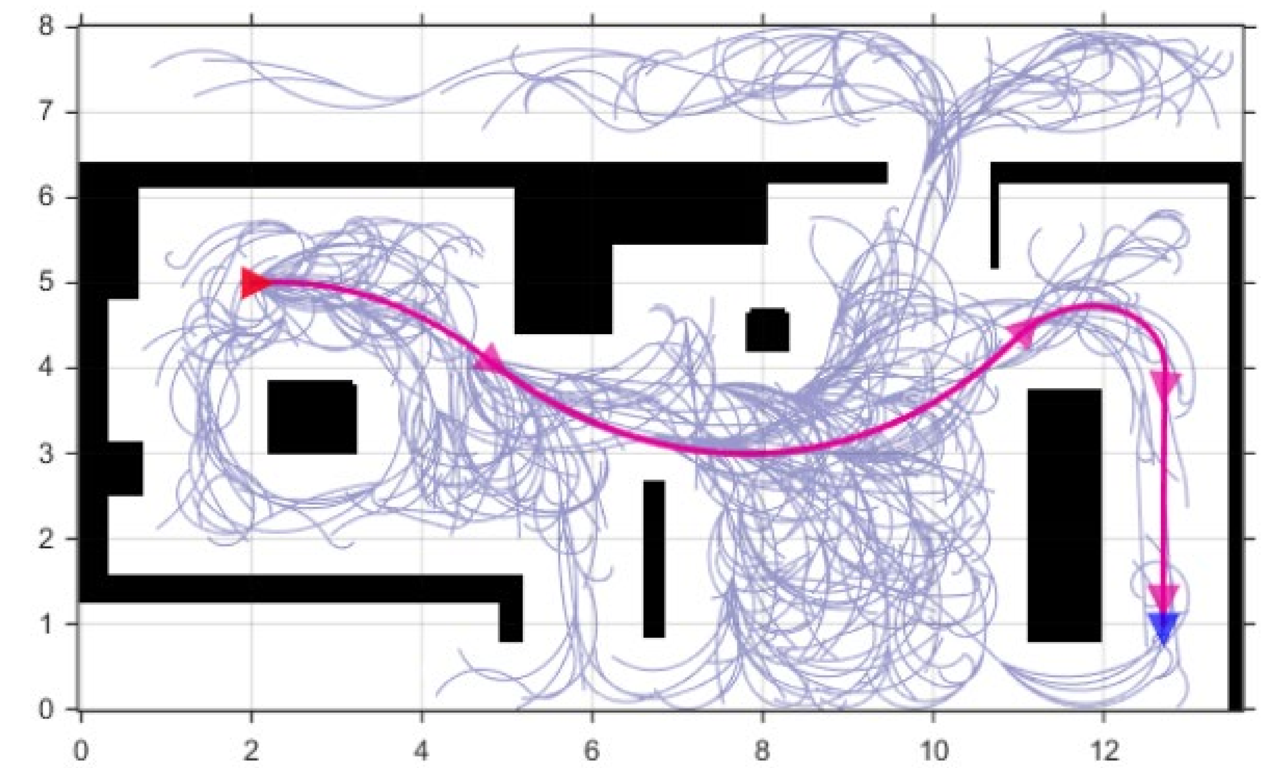
- Provides both recorded and live mapping data for use in Graceful Motion and RRT* Path Planning Algorithms
- LiDAR Laser scanners are computationally and monetarily expensive, but provides more visual and Inertial Measurement Data than simple Depth Cameras

## Graceful Motion

### Providing the user with comfortable movement

- Use ego-polar geocentric coordinates to measure user's velocity, acceleration and jerk
- Implement customizable velocity, acceleration and jerk bounds restricted by two constants in control law
- Updating internal heading and target location orientation for smooth and intuitive steps for possible paths
- Use SLAM data to identify obstacles to generate possible steps available given constraints on control law
- Control law provides comfortable steps that are constructed together in the RRT* Path Planner

## RRT* Path Planning




[1] Figure 2: Visualization of RRT* Path Planning Algorithm showing the minimum path found after building a tree of possible steps the control law provided within the bounds given for the users' comfort. Also included in grey lines is the exploratory steps being trimmed from choices.

### Construction of possible paths

- Initialize starting location, the target location and the control law
- Randomly sample the control law and insert locations if they're obstacle free
- For selecting the parent location, find the nearest with the least "cost" and select the shortest least "costly" path

### Trimming of suboptimal paths

- After a path is added, we check to if it is the optimal path or if there is a more cost-effective path, removing the extra steps and reconnecting the current to the shortest path
- Beneficially, the paths keep the target direction, so the steps need to be contiguous in location and heading to be joined

## Experimental Results

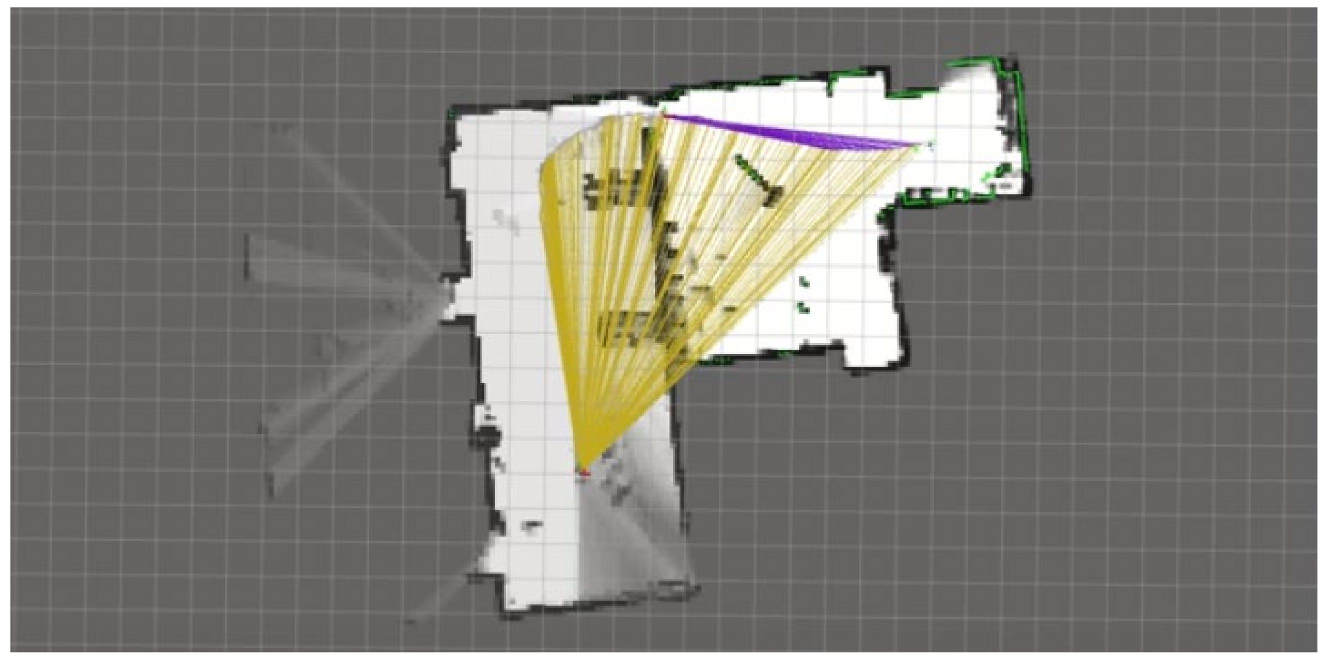


Figure 3: Visualization of SLAM data of testing

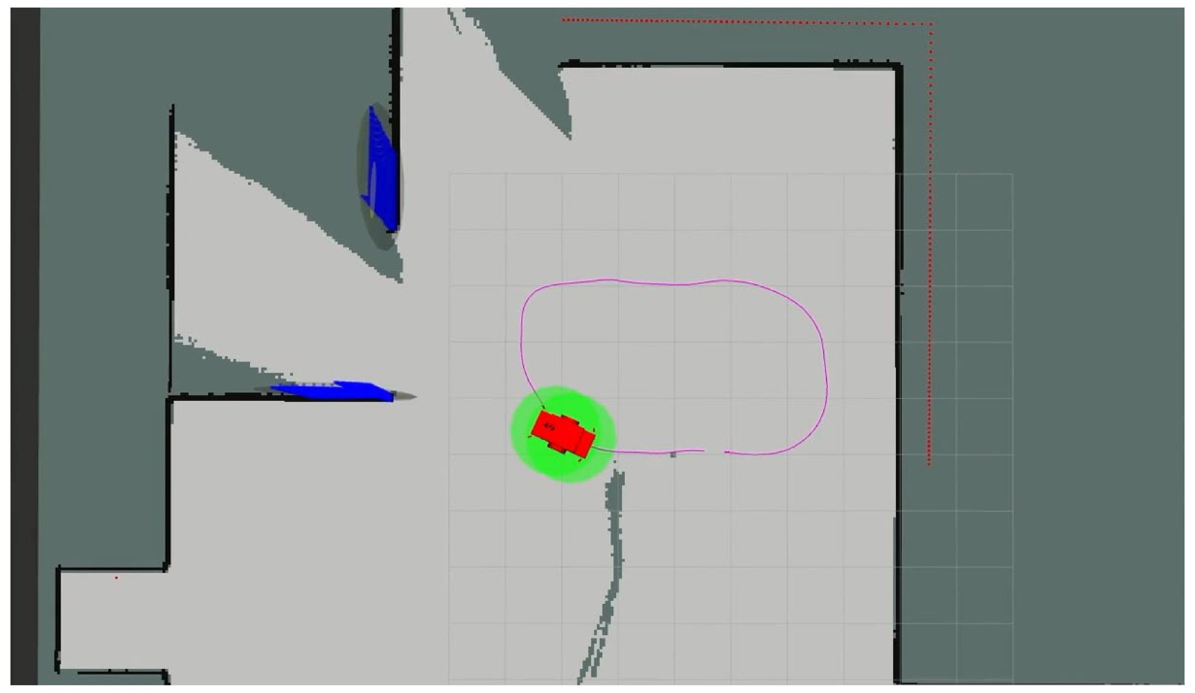


Figure 4: Screenshot of the wheelchair in simulation following a taught path

- Wheelchair safely equipped with an abundance of components run off internal power
- Precise and safe Arduino based motor control
- Simultaneous Localization and Mapping (SLAM) achieved with LiDAR and RealSense cameras combined
- Teach and Repeat algorithm prepped for simulation, installing and improving

## Future Work, References, and Acknowledgments

- Improve on Point Cloud Clustering in Graceful Motion Controller
- Implement RRT* Path Planning
- Fully incorporate SLAM and Graceful Motion with current CyberWorks stack
- Secure and build a stable design

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[1] Park, Jong Jin. "Graceful Navigation for Mobile Robots in Dynamic and Uncertain Environments." *University of Michigan*, University of Michigan, 2016, pp. 1–99.

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