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.

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 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

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

Future Work, References, and Acknowledgments

- 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.

References