Advanced Rollator Automation Utilizing Robot Operating System

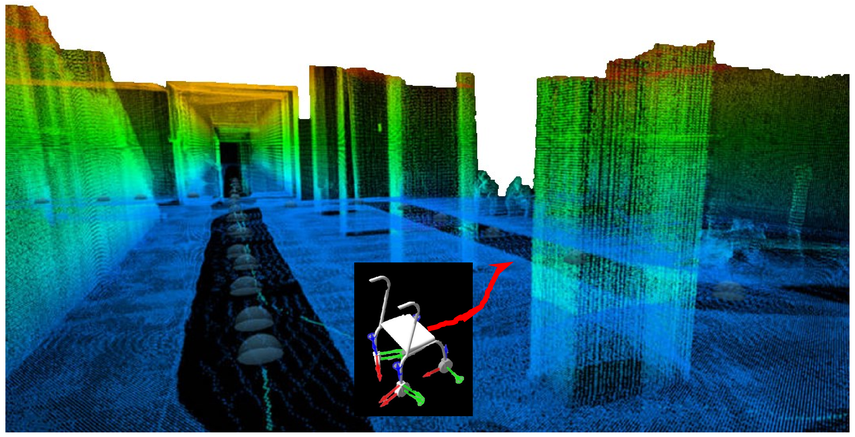
Introduction

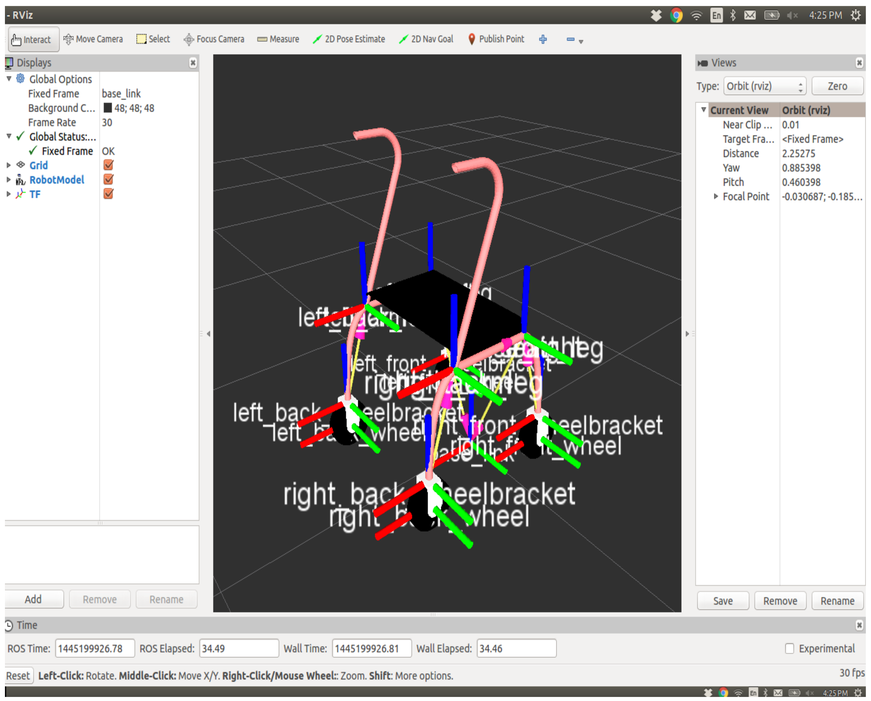
Mobility issues make up 7.2% of the approximately 3 million Canadians that are identified with disabilities.[1] Loss of mobility has been shown to cause cognitive and psychosocial issues.[2] There are many causes of mobility loss such as spinal cord injuries, trauma, poliomyelitis, multiple sclerosis, and the effects of ageing.[3] Mobility is going to become a larger concern with the elderly population size growing from 14.1% of the total population in 2011 to over 20% in the next 10 -15 years.[4] There are many degrees of mobility loss with a variety of and ever increasing number of options for assistive devices to help increase mobility. The main assistive device our group is working on is four wheeled walkers (walkers). Our research objective is to improve walker design to aid in utility of the devices and enhance the safety of the users. We are doing this by automated devices to help make motion decisions. This requires a complete picture of the environment to allow decisions to be safely and effectively executed.

Objectives

Our primary objectives are to better understand user interactions with the walkers, reduce falls, and increase users safety and standard of living. We have modified a walker with a Kinect, encoders, and brakes that is running a custom code built in Matlab that allows the walker to do basic simultaneous localizing and mapping (SLAM) with basic collision avoidance. Instead of future developing custom code to do more advanced features we are going to leverage an already developed platform, the robot operating system (ROS). To over come some other issues we have had in testing we are building a walker from he bottom up with the following traits:

- Kinematic and dynamic model of mobility devices with and without human interaction considered in ROS working environment and simulation environment.
- Develop standards for model development following ROS best practices that allow for customization and variation in designs.
- Develop piecewise interfaces for working with control strategies for navigation, obstacle avoidance, user input, local and global control.
- Simple ROS package for real-time research based data collection and analysis.
- Develop streamlined sensor to mobility device model, work flows for deployment in ROS across a wide variety of platforms.
- Focus integration on low cost, high value sensors/controls such as Kinect, raspberry pi, Arduino and smart phones.
- SLAM with Kinect V2.0





Robot Operating System

Robot Operating System (ROS) is an open source framework for robot systems and sensors to communicate and interact with each other. ROS has a wide selection of tools and nodes developed that allow for a wide array of functionality.

The communication structure of ROS has two types of messages publish/subscribe and services. In this system each ROS node has the ability to publish messages of standard types. To receive the information the nodes can subscribe to message types. These message come as the node creates them or at rates set by the parameters. There are also procedure calls that set up services to allow messages to be sent at fixed rates. The setting for the system are also stored in a distributed global key-value store that allows for straight forward modification of configuration for different tasks. The communication system also has the capability to store and play back message data. This enables operation to be played back and analyzed.[5] Beyond the communications structure the ROS has libraries on geometry and descriptive language for working with robots, diagnostics tools, pose estimation, navigation, mapping and localizing. All of these features have applications that will help us develop a standard walker framework.

[8]

Real-Time Appearance - Based Mapping and Localizing

The real-time appearance-based mapping (RTAB) software is used for real time simultaneous mapping and/or localization(SLAM). This software can be used standalone or can be used integrated into ROS. For our application I will look at the ROS integrated version. RTAB utilizes a wide variety of distance sensors and 3D cameras to create a point cloud. The point cloud is a file type that is a list of millions of x,y,z coordinates that represent a real three dimensional space. To create the model the software uses a bag-of-words model in a Bayesian loop closure detection to build the map piecewise. To look at the map the program takes a picture and finds features in that picture. Each feature is defined as a "word" in the bag-of-words model. After a move RTAB takes another picture and finds the same "words". It then aligns the models based on these models and when it finds that a group of pictures match it closes the loop and saves it as part of the overall map. This way it can keep making loops. When it finds something new it adds it to the model and when if finds something existing it then localizes the position of the camera to report the position of the robot.[6]

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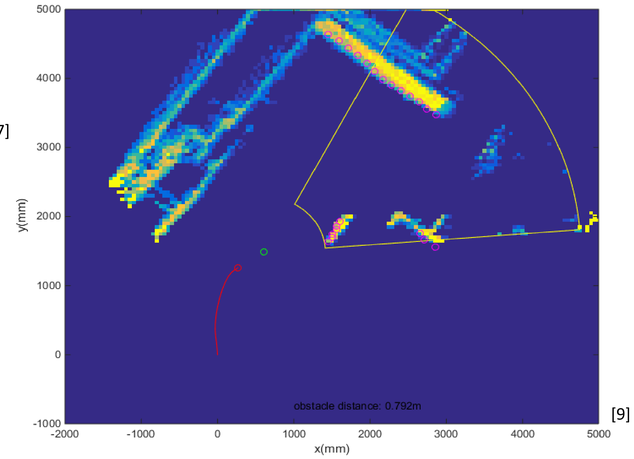

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