# DEVELOPMENT OF MULTI-MODAL CONTROL INTERFACES FOR A SEMI-AUTONOMOUS WHEELCHAIR

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## ABSTRACT

The purpose of the project is to assist different levels of disabilities to apply multiple control technologies to the semi-autonomous wheelchair to. A semi-autonomous wheelchair developed by Robotics and Intelligent Vehicles Research Laboratory (RIVeR Lab) is able to perform assistive control to avoid obstacles and cliffs and to follow walls. With a joystick control adapter, the basic joystick of the wheelchair can take commands directly from computers. In addition to joystick mechanical adapter control, human-machine interaction and control methods such as voice and electromyography (EMG) are deployed, with the aim of enabling people with different levels and types of disabilities to control the wheelchair. These non-physical motion based user control interfaces allow people with limited mobility to control the wheelchair with a desired accuracy.

## Project Overview

## Changes From Previous Project

- Back Rack replaced Headrest Mount, allows for better placement of Kinect and LIDAR
- Improved Sensor Casings allow for sensors to be removed from casing
- Reduced number of sensors
- More eco-friendly material being used
- Reduced number of sensor boars in use
- Sensor Board Casing for protection of the boards
- Motor Controller Casing protects the motor controller, provides easy access to ports, and allows for heat dissipation

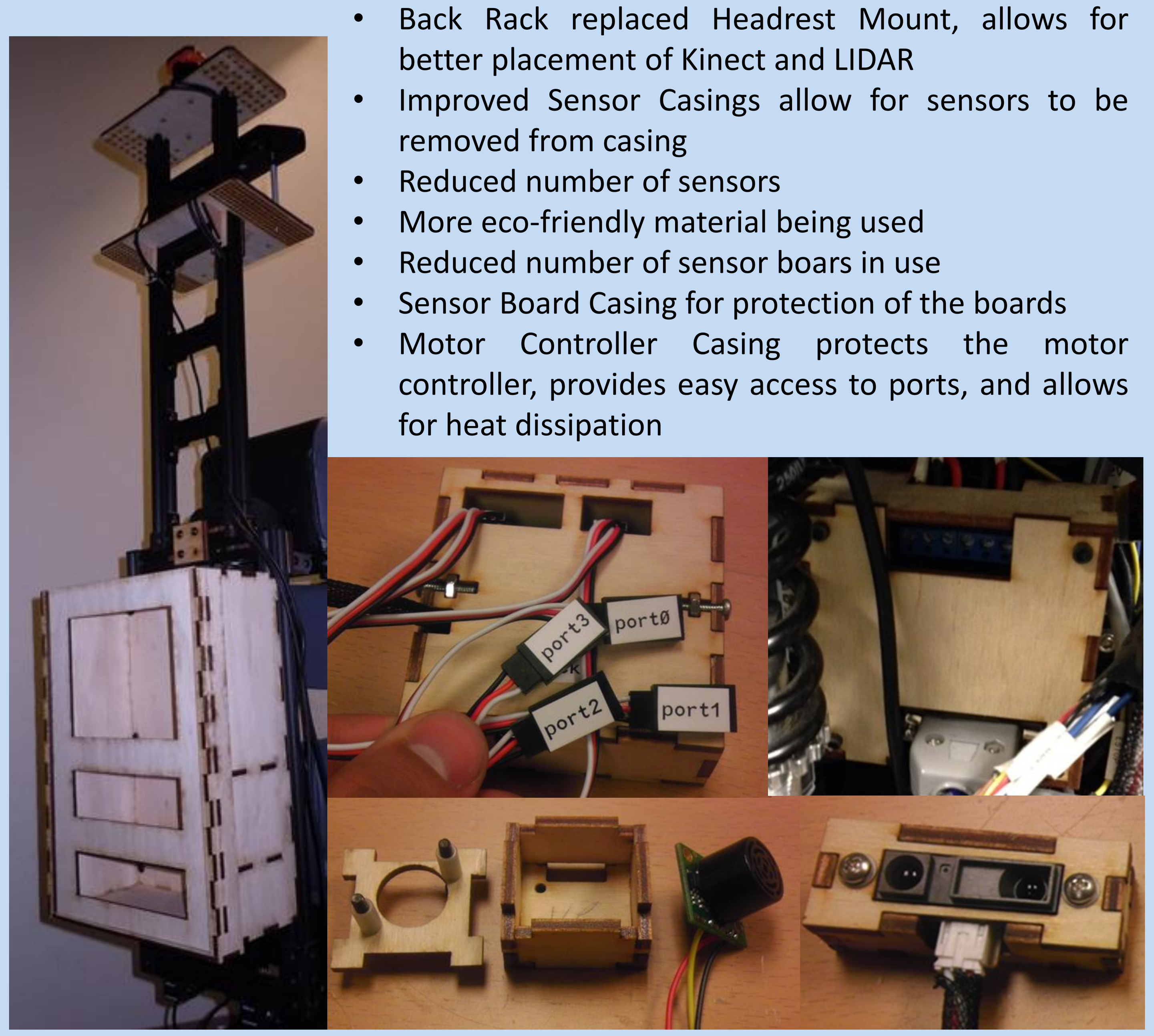


Figure 1: Left -Back Rack mounting system with LIDAR and Kinect mounted
Middle -Top: Sensor board casing, Bottom: Ultrasonic sensor and casing disassembled
Right -Top: Motor controller casing mounted on wheelchair, Bottom: IR sensor in casing

## Joystick Control Interface

Figure 2: Assembled and mounted Joystick Control Interface

- Able to control the position of the Joystick
- Allows for control of the wheelchair without modifying any components, non invasive technology allows for greater modularity
- Uses ROS Serial package and Arduino ROS Library to integrate with the ROS environment

## Voice Control Interface

- The voice control system allows user to control the motion and velocity of the wheelchair.
- The voice control system allows user to control the wheelchair to go to a predefined goal location, User will be able to cancel the goal while on the move.
- The voice control system sends voice feedback to the user a valid command was received . Or ask the user to repeat if the command was unrecognizable.
- Some other types of voice feedback are provided to demonstrate other possible interactions between the user and the voice control system.

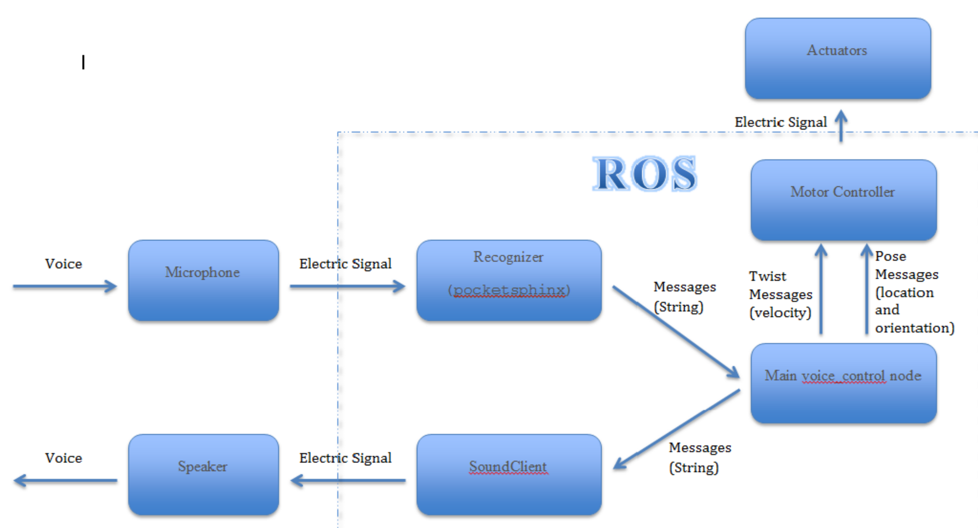


Figure 3: Voice control system diagram

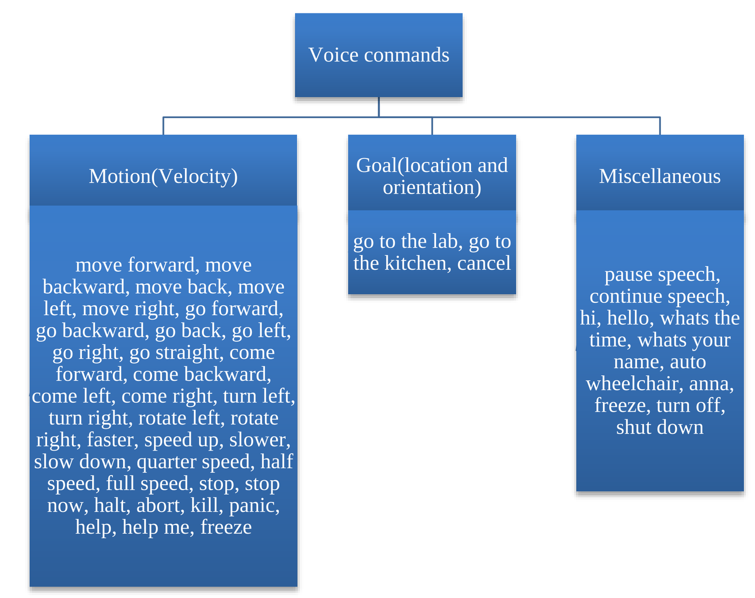


Figure 4: Available voice commands

## EMG Control Interface

Figure 5: Communication among Emotiv headset, computer, and wheelchair

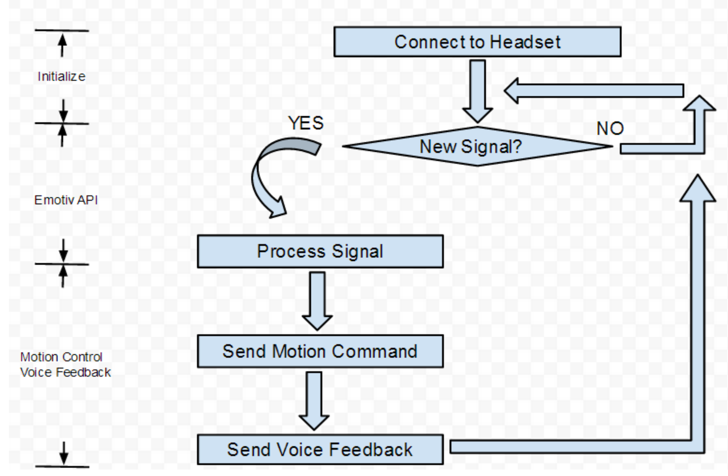


Figure 6: EMG control system diagram

- The EPOC Emotiv headset communicates with the wheelchair through the computer as shown in Figure 5.
- Emotiv API processes the EMG signal and sends the motion commands to motor driver and the voice feedback of the wheelchair.
- Experiment of expression control reaches 70% accuracy, providing a reliable control interface

## Multiple Interfaces Architecture

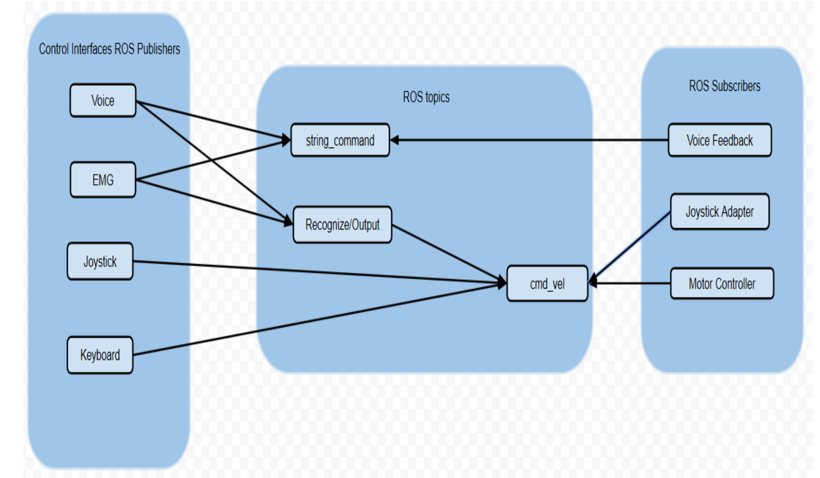

Figure 7: Software architecture

- Robot Operating System (ROS) architecture.
- Multiple user interface nodes can publish to command topics.
- Motor node, voice feedback and joystick adapter subscribe to the topics for new messages from the control interfaces.
- The open software architecture makes it easy to add other user control interfaces into the system.

## Sensor system

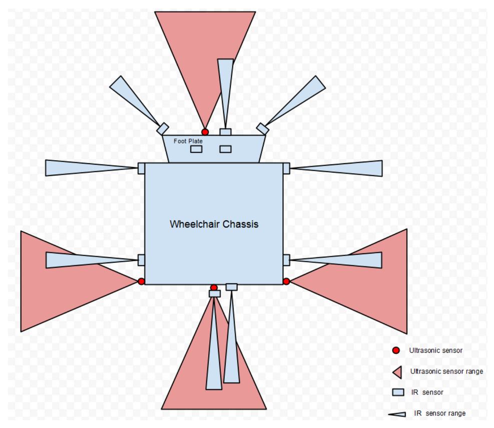

Figure 8: Sensor placement and coverage

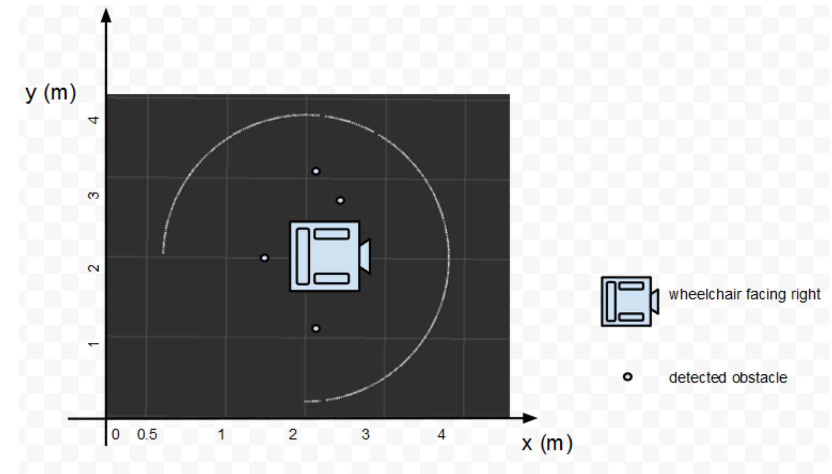


Figure 9: Alternative laser scan

- Figure 7 shows IR and Ultrasonic range sensors' coverage and their layout. Such placement minimizes the possible interferences.
- Figure 8 demonstrates the ability to generate an alternative laser scan.
- The sensor system provides a standard data structure interface for other ROS package.

## Results

- Sensors system is able to generate an alternative laser scan as a standard ROS data type interface.
- Voice control interface allows user to drive, as well as to interact with the wheelchair through voice commands.
- EMG control interfaces is implemented and tested with 70% accuracy.
- Joystick adapter is ready and requires further testing on the reliability of the ROS serial package
- Casings are ready and some have been deployed on the wheelchair
- Back Rack is functional, stable, and components have been mounted to it

## Project Sponsors

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