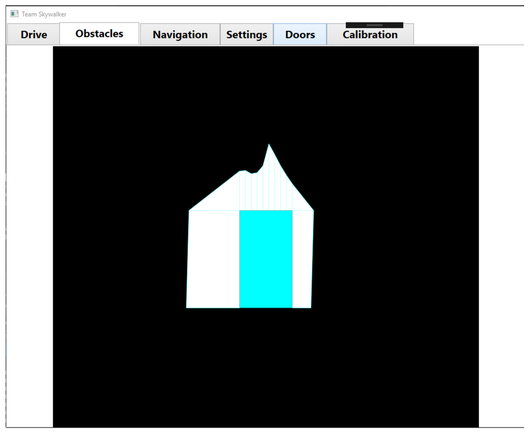
Assistive Wheelchair Technologies for ALS Patients

Sponsor: Team Gleason, Microsoft & WSU Intelligent Robot Learning Lab
Mentors: Dr. Sakire Arslan Ay, Dr. Matthew Taylor, Jon Campbell
Team Eris: Junhao "Freddie" Zhang, Aidan Lancaster,
Justin Hubbard, Maxwell Shoop, Patrick Guo

Kinect and Sonar Depth Sensing

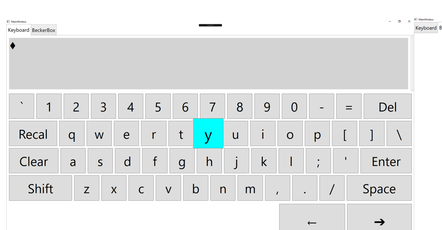
- Provide information about the distance of surrounding obstacles to provide accurate environment representation to the user
- Use of sonar sensors and depth-frames from Microsoft Kinect
- Top-down user interface display shows known depths around chair perimeter
- User is given prompts for correcting course in current path to avoid collision based on perceived obstacles
- UDP broadcast of kinect and sonar depth data for receiving data about the environment

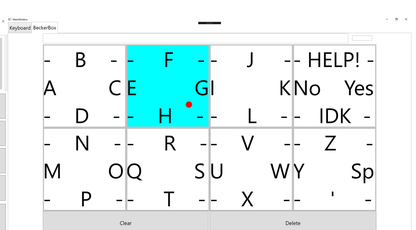


Becker Box and QWERTY Keyboard

The becker box keyboard provides 8 boxes and each has four alphabet letters and user can input the demanded letter by looking at its location. First, user looks for the becker box which contains the demanded letter in it, and after the user gazed at the becker box with the demanded alphabet letter, the backward code behind will select the becker box based on the Coordinates to select the demanded becker box. If the becker box contains four alphabet letters, each will be located on the UP/DOWN/LEFT/RIGHT sides of the rectangle-shaped becker box and user select the demanded letter by looking at the certain side of the becker box with the demanded letter on it. If the becker box contains five letters, then the fifth letter is located at the center of the becker box and user select the fifth letter by gazing at the center of the box.

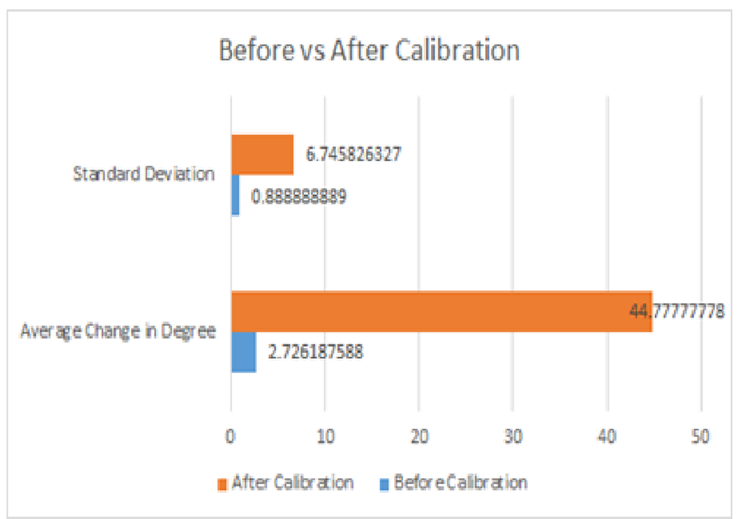
For the QWERTY keyboard, the user stares at a key for a particular threshold of time, then that key gets inputted after the timer expires. (Very straightforward)





Motor Calibration

- Due to mechanical inconsistencies in the motors, the way the motor's power drains during use, unevenly distributed weight in the chair, and other factors the wheelchair originally failed to move straight
- Moving straight for five seconds the chair turned 44.78 degrees to the right
- Calibration began with gathering of data from the onboard compass
- Telling it to move forward for a given time we can end with an end value showing the change in degrees
- Used this to test for delta: degrees off from expected turn
- Top level C# code communicates with an Arduino Mega which communicates with the motors
- In the motor C# class, which handles that communication, we were able to modify values sent to the Arduino which resulted in a reduction in the number of degrees turned
- Essentially, the motor class passes an X and a Y vector to the Arduino. When moving straight the Y vector will be 1, and the X vector will be 0. Our test increments the X vector based off of a delta degrees value gathered.
- By sending a slight amount of power to a motor, the chair turns a small amount in a direction, and thus mitigate the natural drift of the chair.
- In summary, the calibration test causes the chair to move forward a certain amount, and determines how many degrees it turned in a specific direction
- Running the calibration test on a completely uncalibrated system several (two or three) times results in the chair moving effectively straight
- Data was collected from a test regarding the chair's turning consistency
- This test turns the chair a variety of seconds, both left and right and stores all the data
- End result is data of how many degrees the chair turns, for either direction, at a variety of intervals



Eye-Tracking Test Data

Time it takes to type "Hello World" on two different keyboards (in seconds)
Keyboards used:
-QWERTY Keyboard
-8-box BeckerBox Keyboard

User	QWERTY - Good Calibration	QWERTY - Bad Calibration	BeckerBox - Good Calibration	BeckerBox - Bad Calibration
Patrick Guo	8.70	43.43	20.57	23.57
Alex Kerr	15.54	23.30	18.65	31.52

Error statistics for typing "The quick brown fox jumped over the lazy dog" for 500ms hold time vs 750ms hold time
Keyboards used:
-QWERTY Keyboard

User	Hold Time(ms)	Number of Deletes pressed	Number of Spelling Errors	Number of Keystrokes	Finish Time
Isaac Stokes	500	3	3	51	00:58.56
	750	9	3	69	02:22.34
Zane Pierce	500	10	2	65	01:15.75
	750	0	0	44	01:03.29

Future Work

- Add additional sensors for improved localization
- Convert system to ROS for more simple robotics augmentations
- Implement real time course correction for obstacle avoidance
- Develop computer vision-based object classification and plotting
- Use calibration data to train a machine learning system to actively correct for motor function

Glossary

Kinect - An intergrated RBG and infrared camera with depth detection functionality created by Microsoft
Eye Gaze - refers to the use of eyeball tracking hardware like Tobii and EyeTribe to determine where user is looking on screen
Becker Box - a system for typing the English alphabet developed for use by individuals limited to eye movement. Alphabet is spit into multiple boxes for easier targeting

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