WPI

Indoor Navigation and Manipulation using a Segway RMP Platform

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SEGWAY
Simply moving

AIM
WPI Automation and Interventional Medicine Laboratory

Goal

- Implement an indoor, multi-floored mobile manipulation platform in an assistive manner using an RMP200.
  - Accomplish this by:
    - Research existing technologies
    - Update the platform
    - Multi-floor navigation with semi-known map
    - Build and integrate an arm

Literature Review

- Examined other successful mobile manipulation platforms
- Looked for common characteristics between platforms

Care-O-bot

PR2

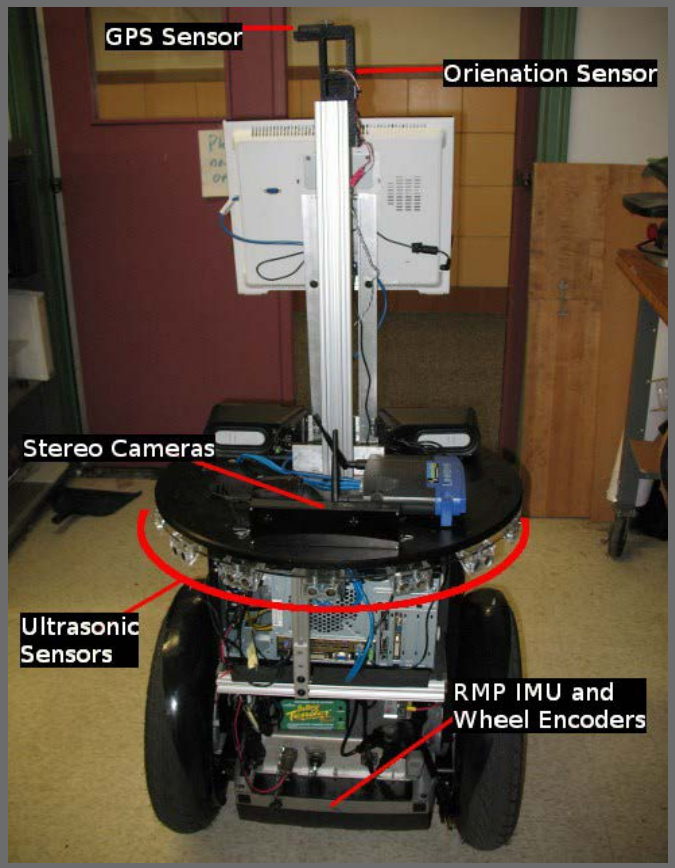
KUKA youBot

Rollin' Justin

Previous MQP

Power distribution

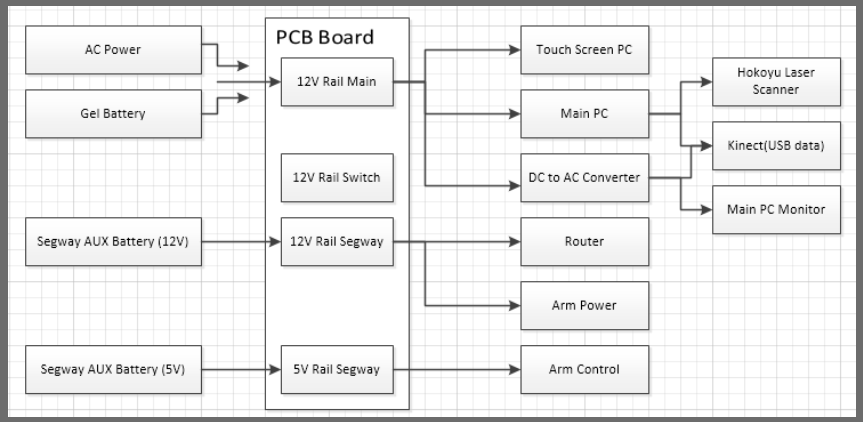
Back of Segway



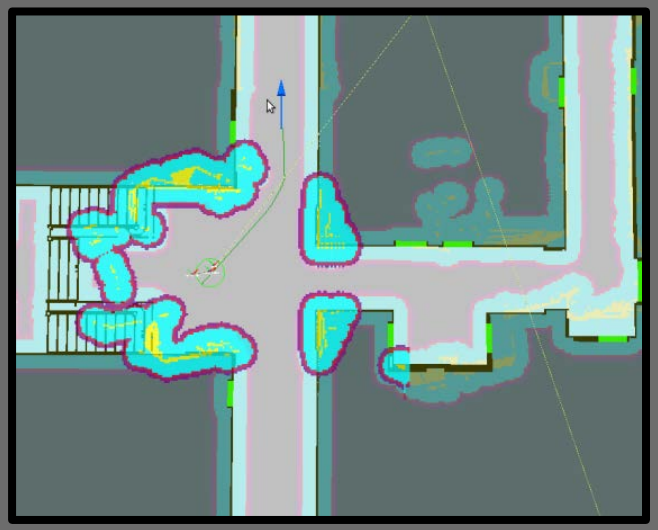
Previous MQP Robot

Previous MQP Robot Guide

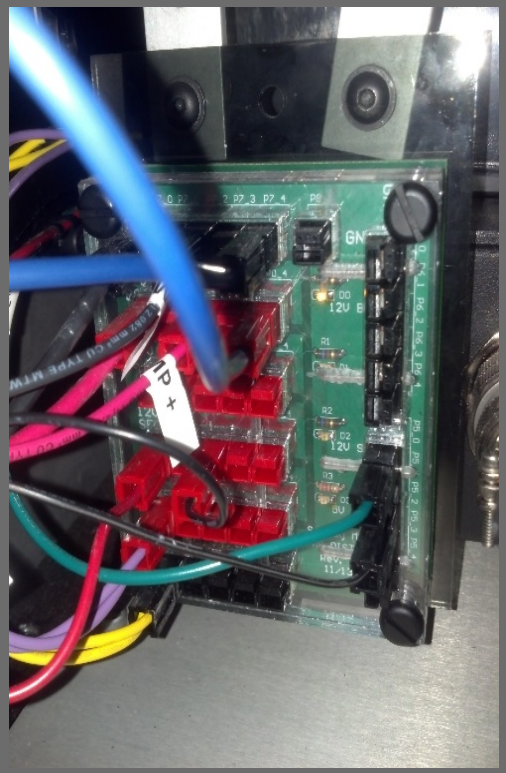
Base Platform Overview



Final Electrical Schematic



Map with all nodes running



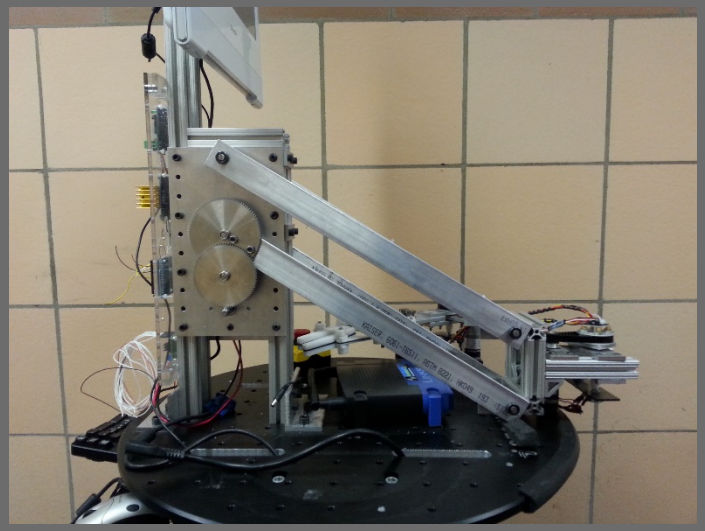
Power Distribution PCB

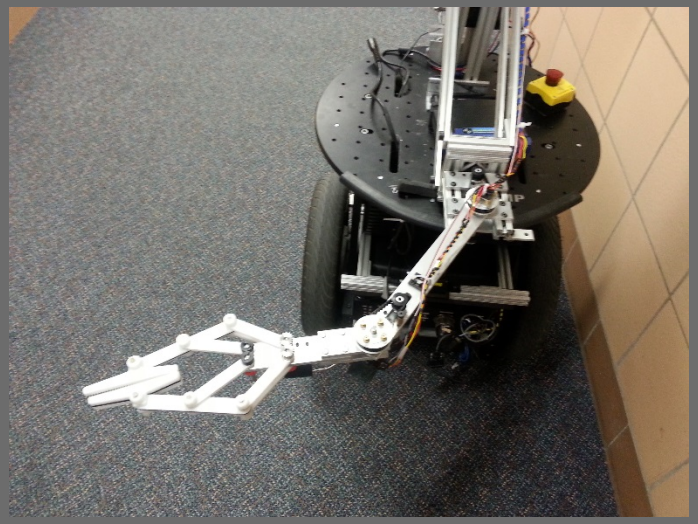
Final Robot Layout

Robot Arm

Arm design goals:

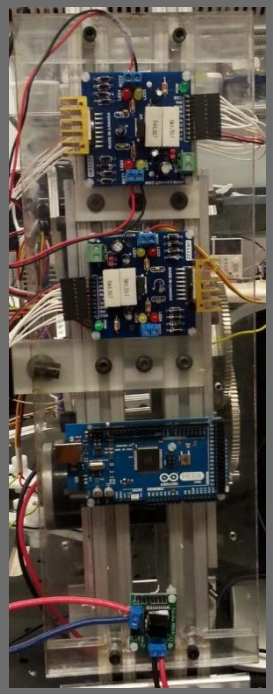
- 5lb max object weight
- object size of 0.5-3in diameter
- Retrieve obj. from height of 30 - 60in (30in above robot top)
- Be able to hit a square 1 inch target (elevator button)
- 2 foot extension from front of robot

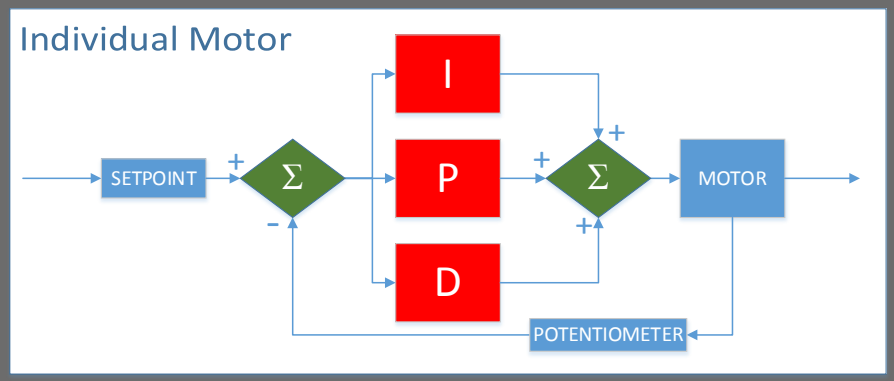




Arm Control

- Arduino Mega 2560
- Two motor driver boards (Pololu/Sparkfun)
- Serial Communication over USB
- PID Control structure
- Teleoperated keyboard manipulation

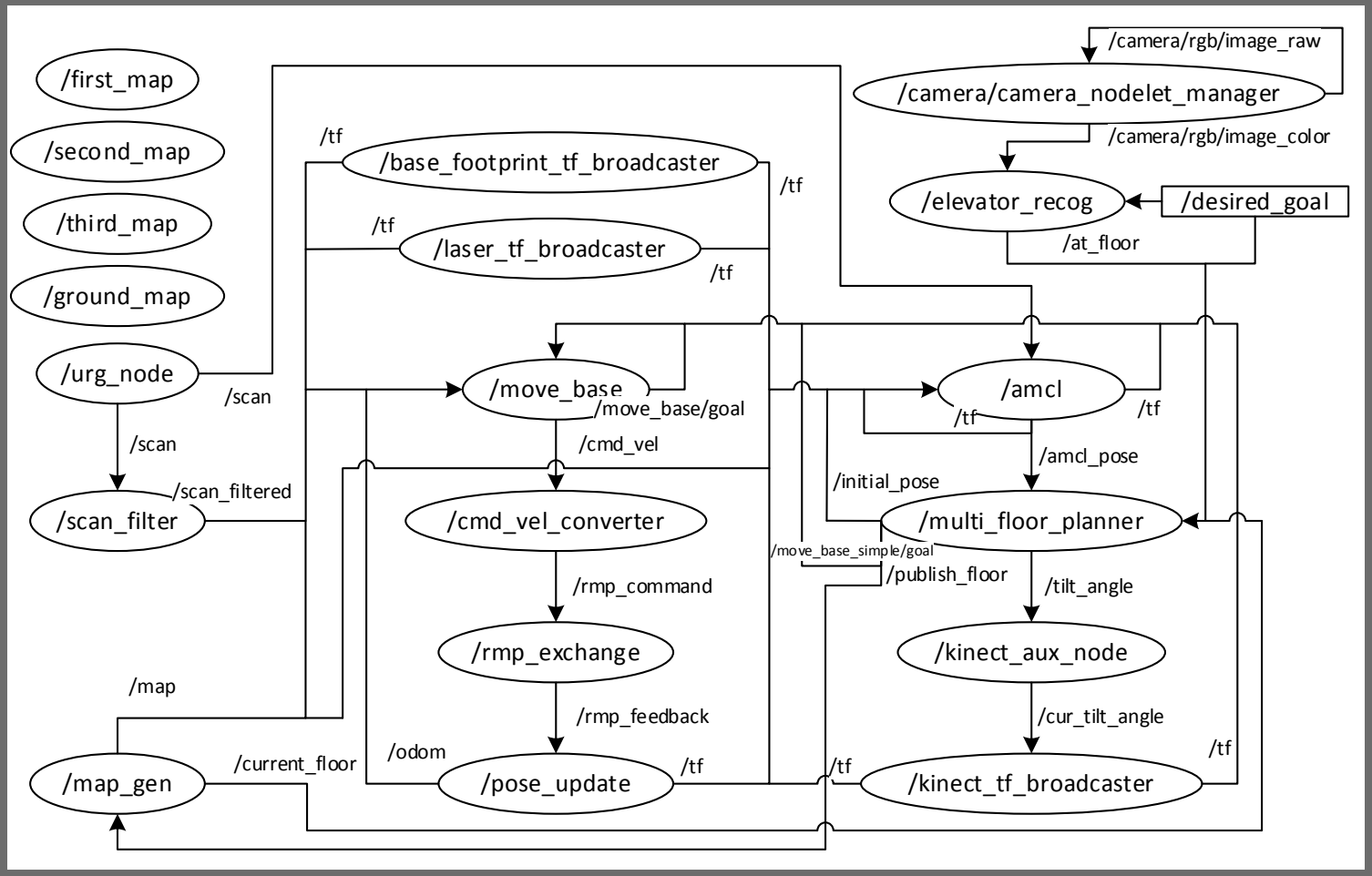




Denavit–Hartenberg Table:

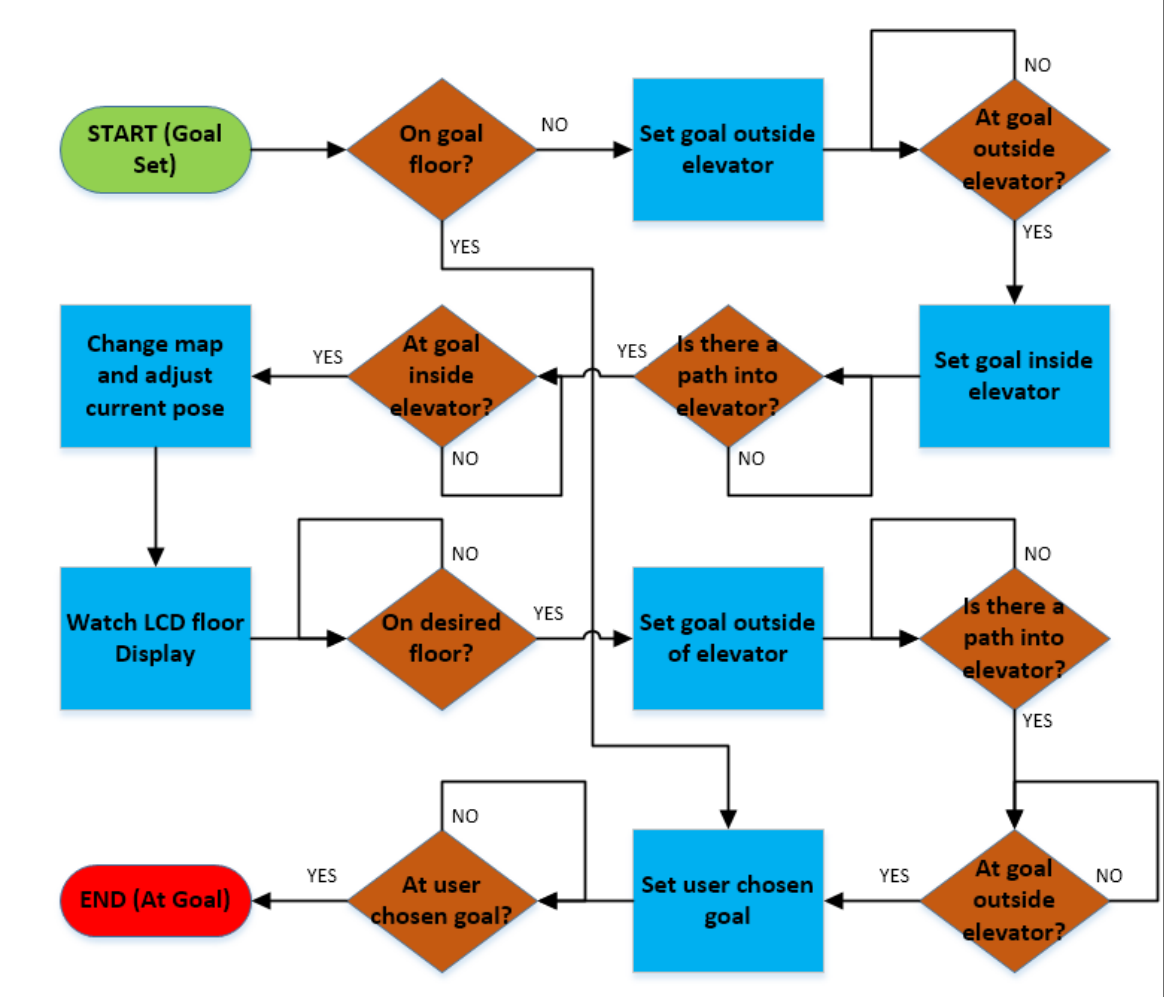
Link #	θ	d	a	α
0	θ^*_L	$\sin(\theta^*_L)$	$\cos(\theta^*_L)$	90
1	θ^*_1	0	a_1	0
2	θ^*_2	0	a_2	0

Navigation



ROS Node Schematic

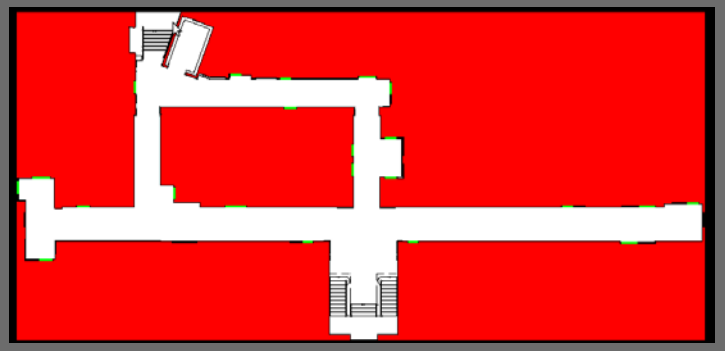
Navigation



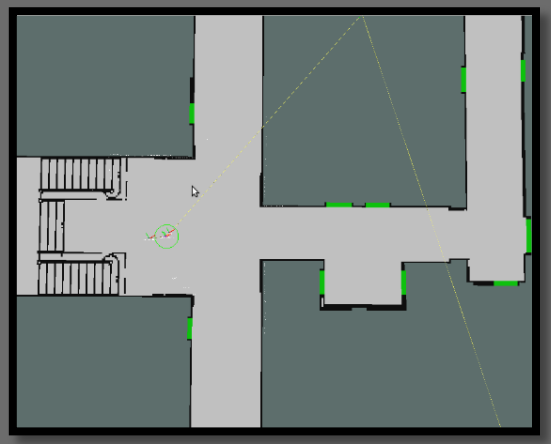
Multi-Floor Planner

Navigation

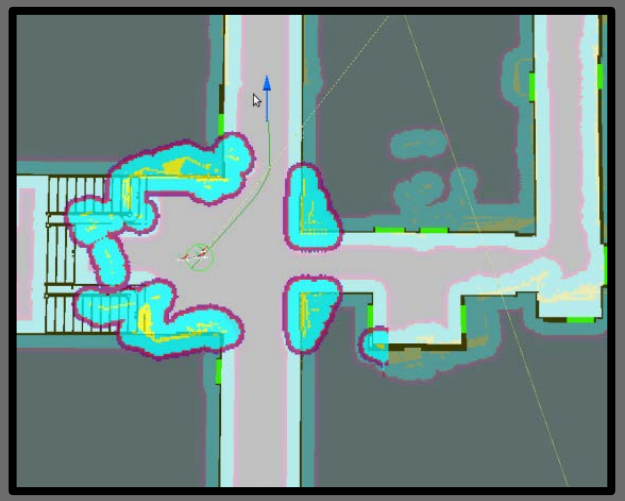
Original Floor Plan



Modified Floor Plan



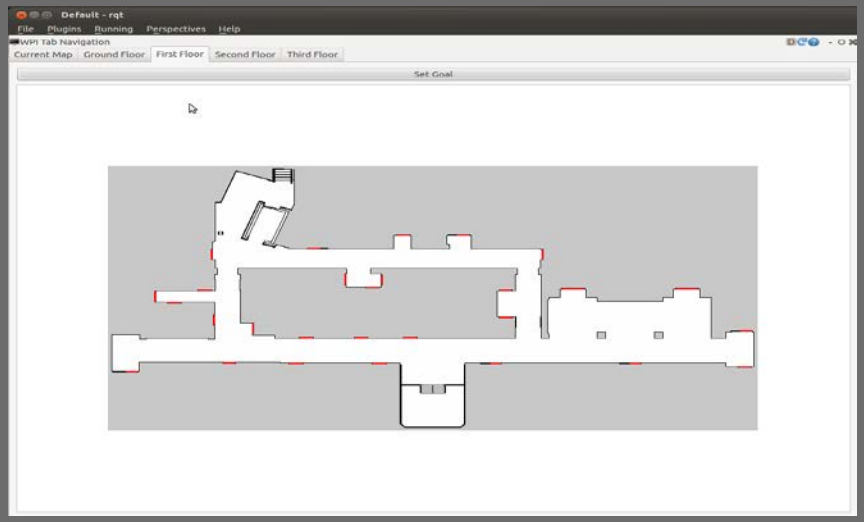
Map as seen by Map Node



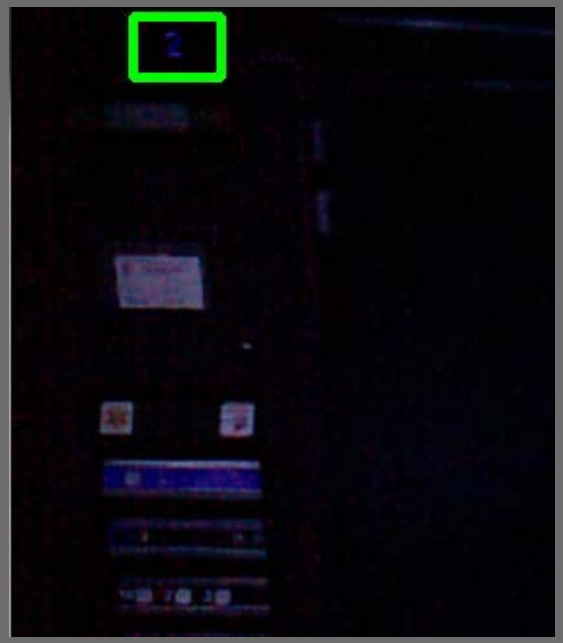
Map with all nodes running

Navigation

Mutli Floor Navigation GUI (Set Pose)

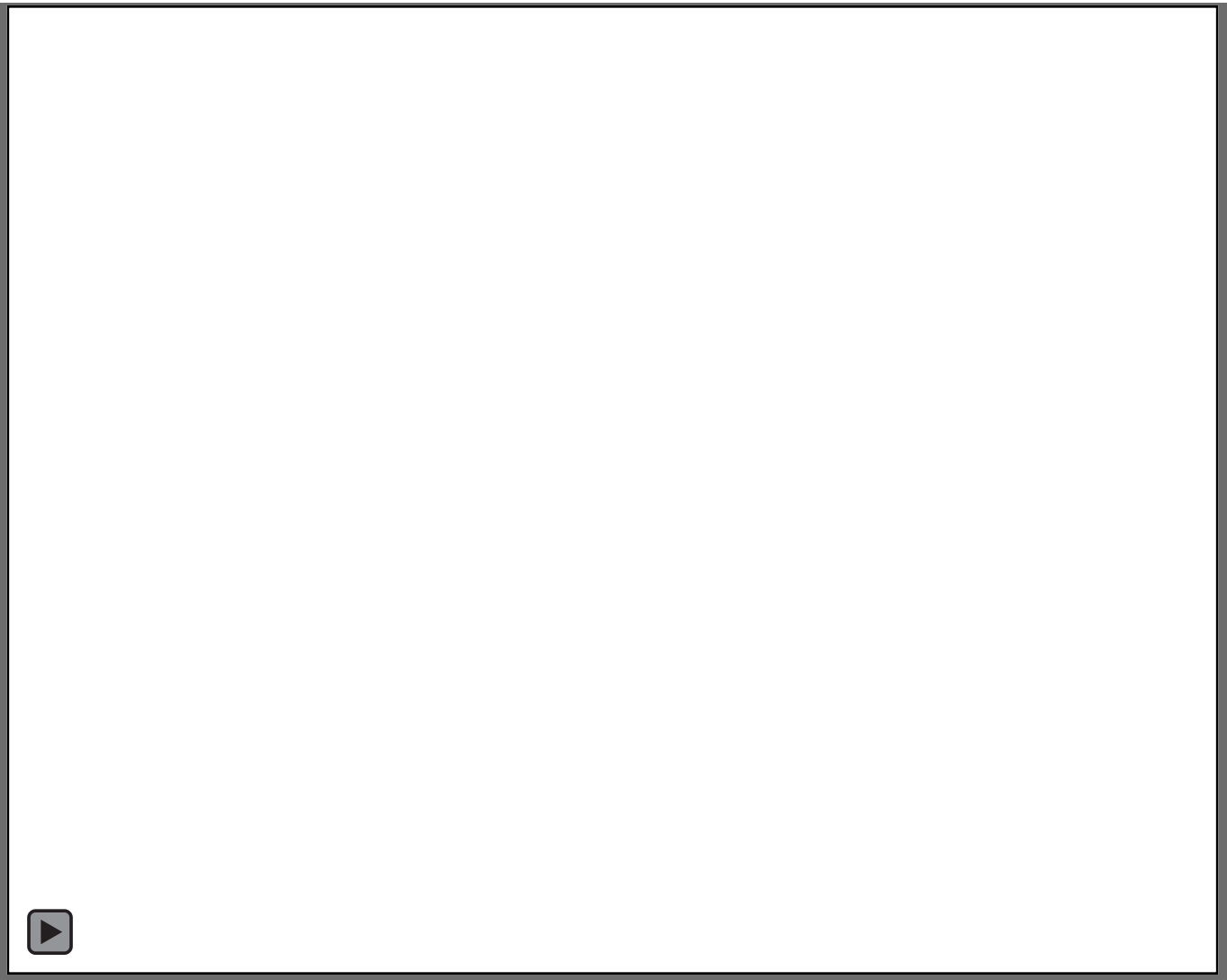


Mutli Floor Navigation GUI (Set Goal)



Kinect Floor Recognition

Video



Results

- Modular research platform for mobile manipulation.
- Multi-floor navigation, with the assistance of a person.
- Computer could not reliably handle the processing load of navigation.
- Template matching was used to determine elevator's current floor.
- Telepresence capabilities through standard video chat.
- Delivered ROS packages to Segway Inc.
- Mechanical arm was designed and built.

Short-Term Recommendations

- More processing power
- Distribute processing over wired Ethernet or faster Wi-Fi connection
- Multi-Threaded interface with Segway RMP
- Full implementation of the arm
- Redesign of the gripper
- Align maps based on the elevator location

Long-Term Recommendations

- Implement autonomous object retrieval and other assistive applications
- Remember objects
- Voice control to make it more accessible to varying degrees of disabilities
- More versatile manipulation capabilities
- Able to learn floor plans

Acknowledgements

- **Chris Crimmins and Segway** for the donation and continued support of the Segway RMP.

- **Professor Gregory Fischer** for being an advisor and donating AIM Lab space and resources to our project.

- **Joe St. Germain** for his continued support and advice, and for lending the LIDAR sensor to our project.

Thank You!

Questions?