

Automated Acoustic Measurements in the Anechoic Chamber with a Mobile Robot

Fall 2018
EEE 500
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Overview

- ❖ Project Motivation and Purpose
- ❖ Robot Hardware
- ❖ Control and Debug Software
- ❖ Image Processing in the Anechoic Chamber
- ❖ Mapping Software and Viewing Measurements

Motivation and Purpose

- ❖ Characterize loudspeaker in three dimensions
- ❖ Previous attempt used large robotic manipulator (below)
- ❖ Make something small, cheap, scalable to other spaces



[1] Zbrowski et. al.

Robot Design

- ❖ Mobile robot - Three wheel drive (omnidirectional)
- ❖ Hardware - VEX robotics omnidirectional robot,
Arduino, Raspberry Pi, 3D printed sensor-robot mounts
- ❖ Software - ROS, Python, C++

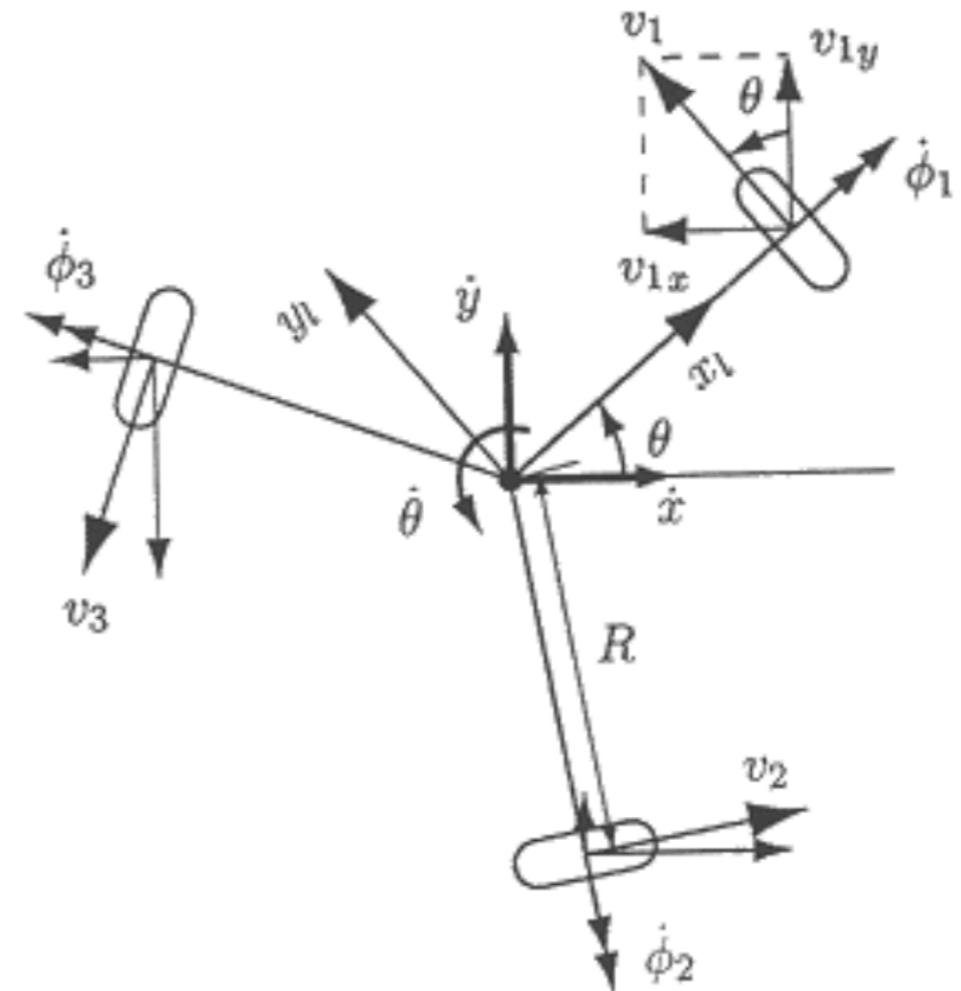
Robot Design

Bill of Materials	Source	Price(\$)
Omnidirectional Robot Chassis	Robotshop (Vex)	121
Arduino Due	Robotshop	40
R-Pi	Robotshop	40 (x2)
12V NiMH Batteries	Robotshop	30
NiMH wall charger	Robotshop	30
3500mAh USB battery	Amazon	25
12V Stepper Motor	Amazon	12 per 5
9V Battery	Amazon	4
USB Cameras	Amazon	50 per 2
Servo Motor	Amazon	5
LM298N	Robotshop	8 (x2)
Microphone	Amazon	15
Plastic	Amazon (Village Plastics PLA)	40 per kg
		468

Robot Design

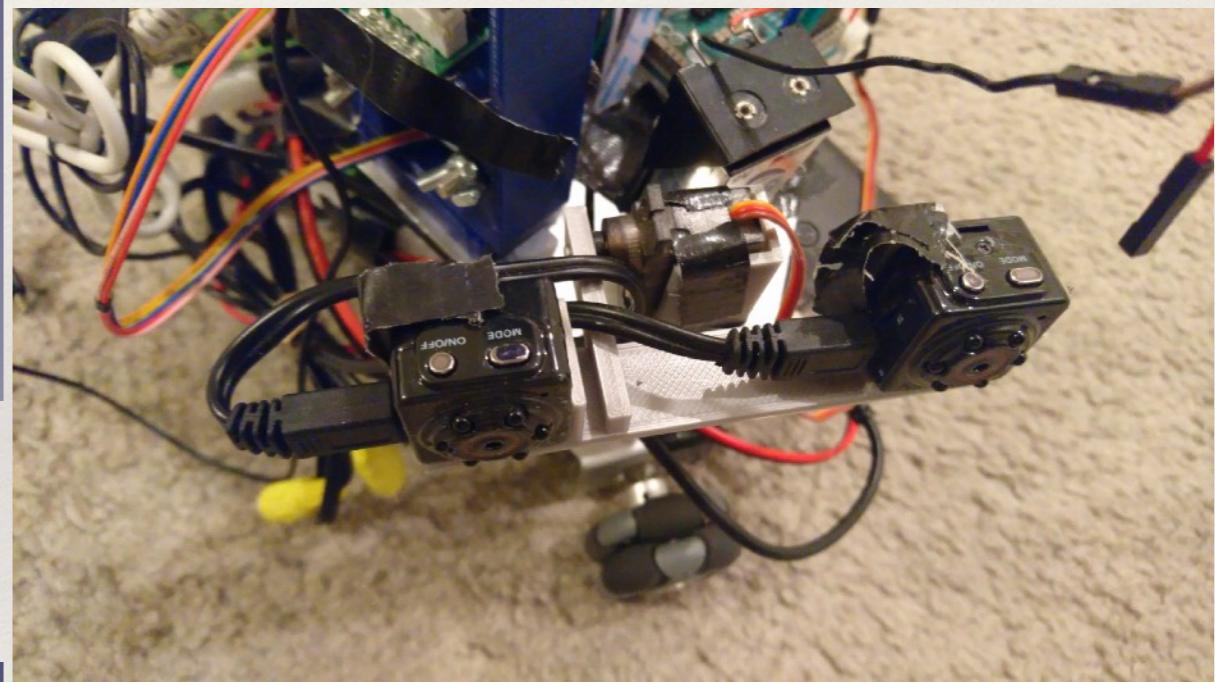
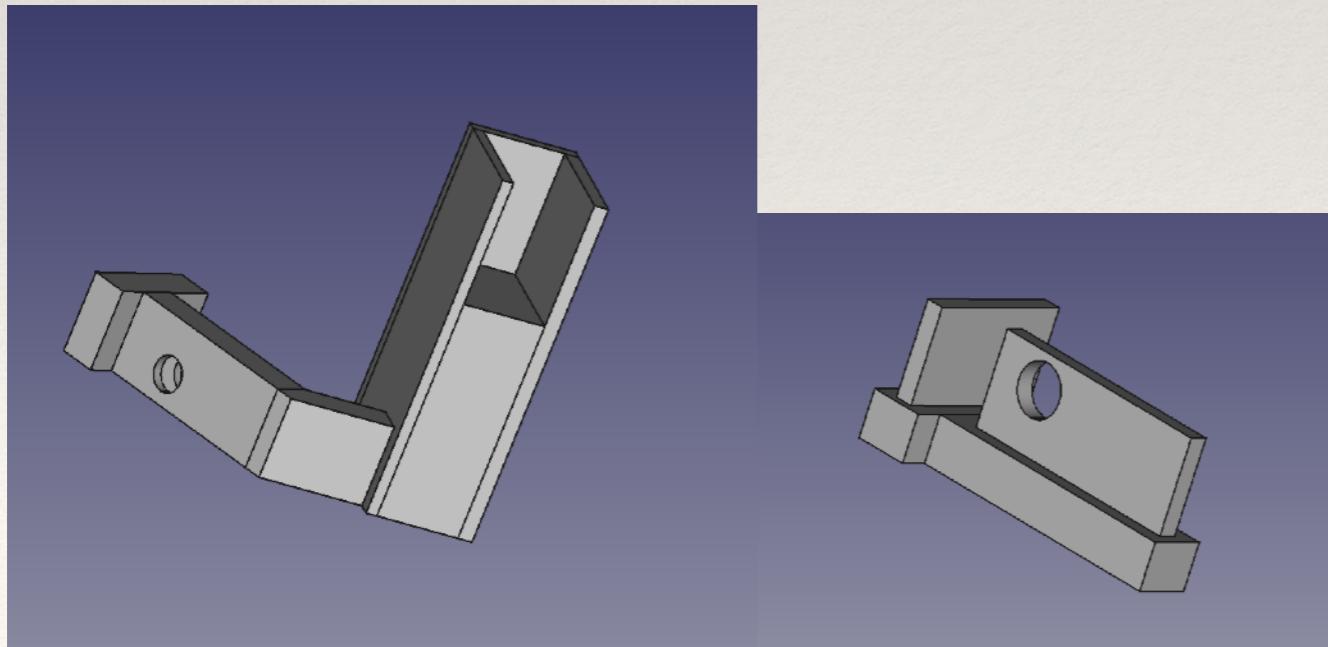
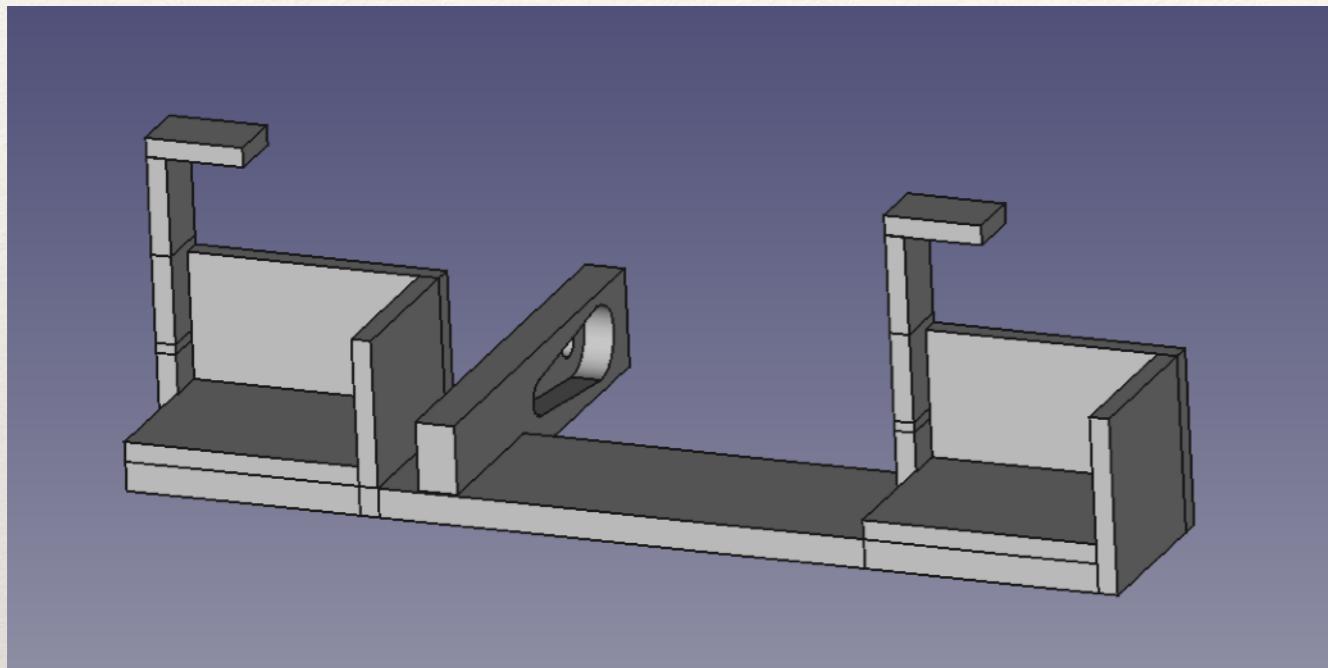
$$\begin{aligned}\dot{\phi}_1 &= (-\sin(\theta)\cos(\theta)\dot{x}_L + \cos^2(\theta)\dot{y}_L + R\dot{\theta})/r \\ \dot{\phi}_2 &= (-\sin(\theta + \alpha_2)\cos(\theta)\dot{x}_L + \cos(\theta + \alpha_2)\cos(\theta)\dot{y}_L + R\dot{\theta})/r \\ \dot{\phi}_3 &= (-\sin(\theta + \alpha_3)\cos(\theta)\dot{x}_L + \cos(\theta + \alpha_3)\cos(\theta)\dot{y}_L + R\dot{\theta})/r\end{aligned}$$

Three-Wheel Drive Kinematic Model



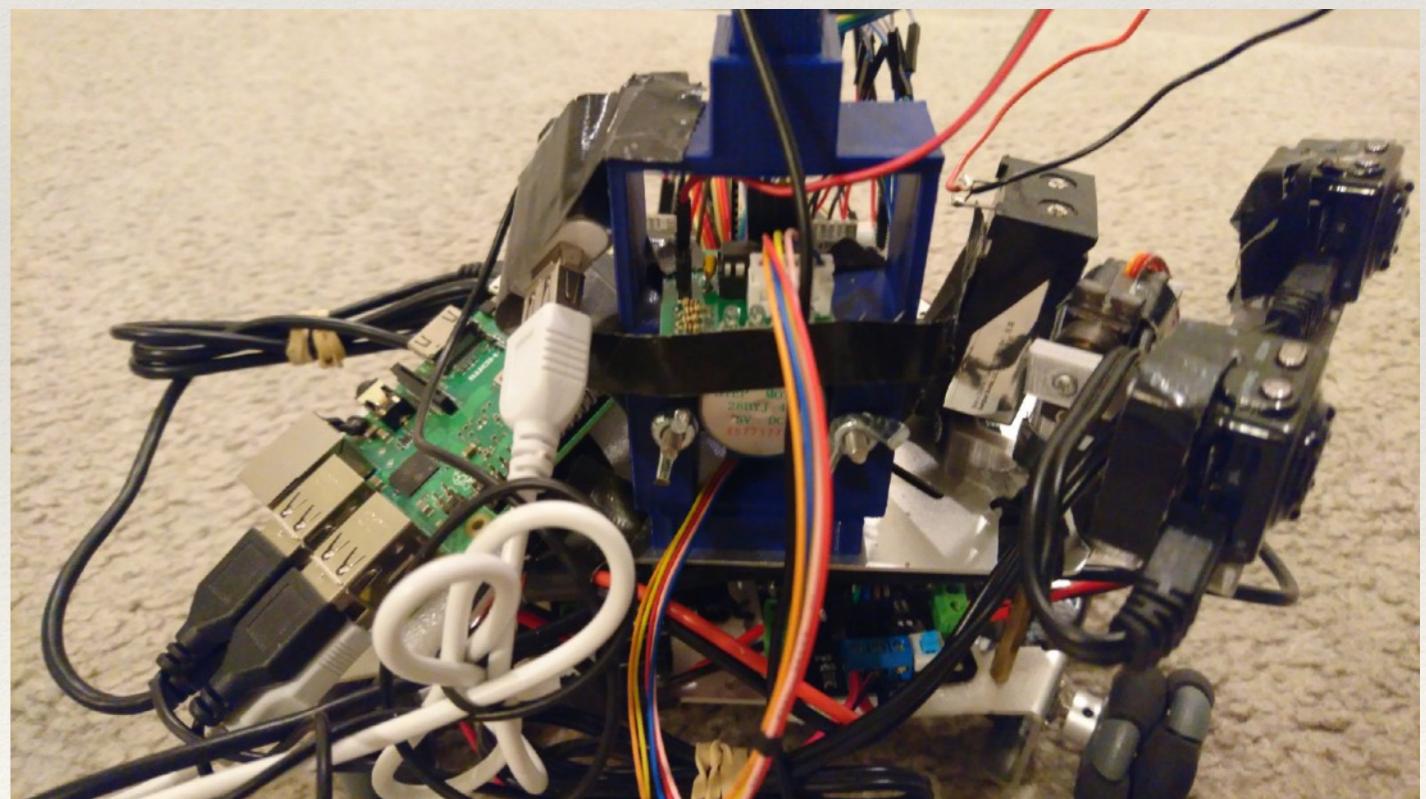
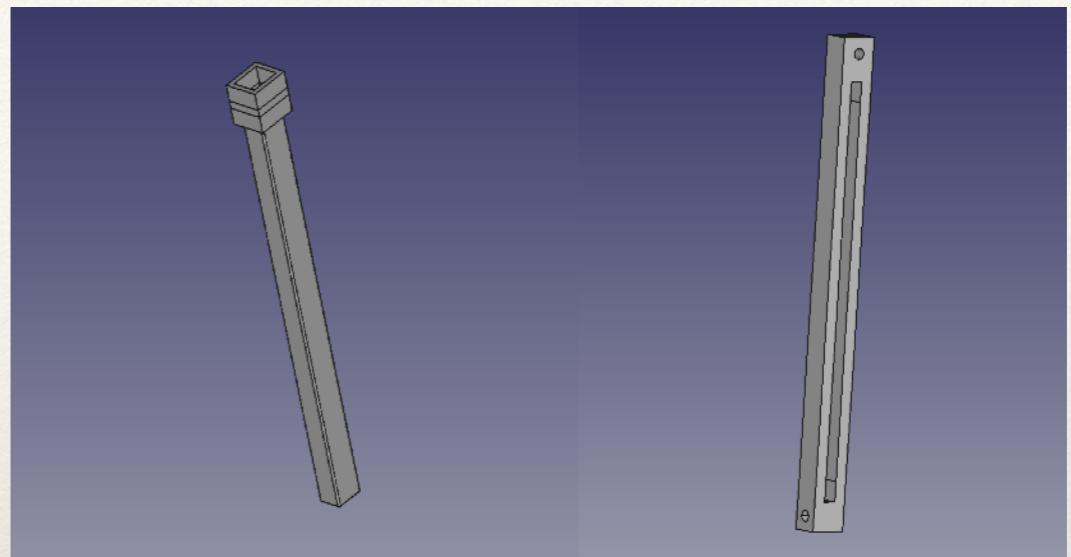
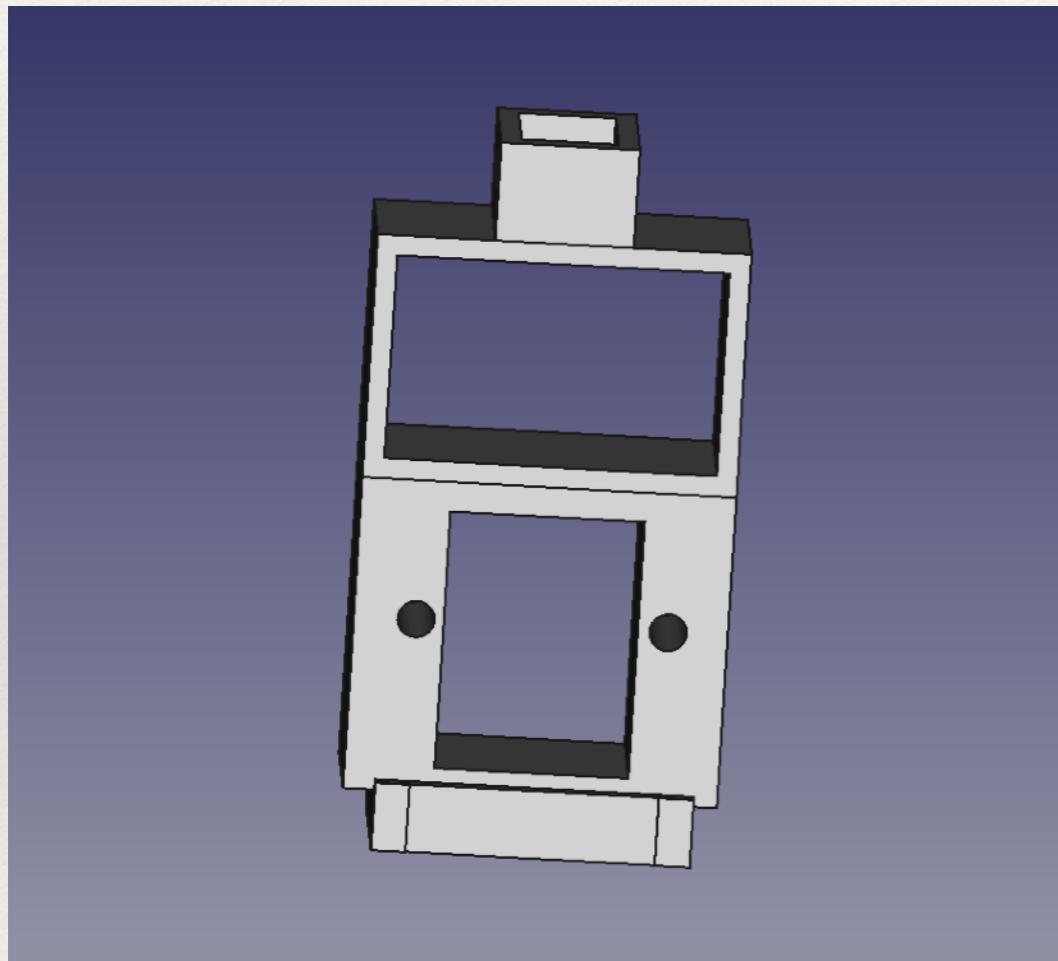
3D Printed Parts

Camera and Servo Mount



3D Printed Parts

Stepper mount and mic extension



Control and Debug Software

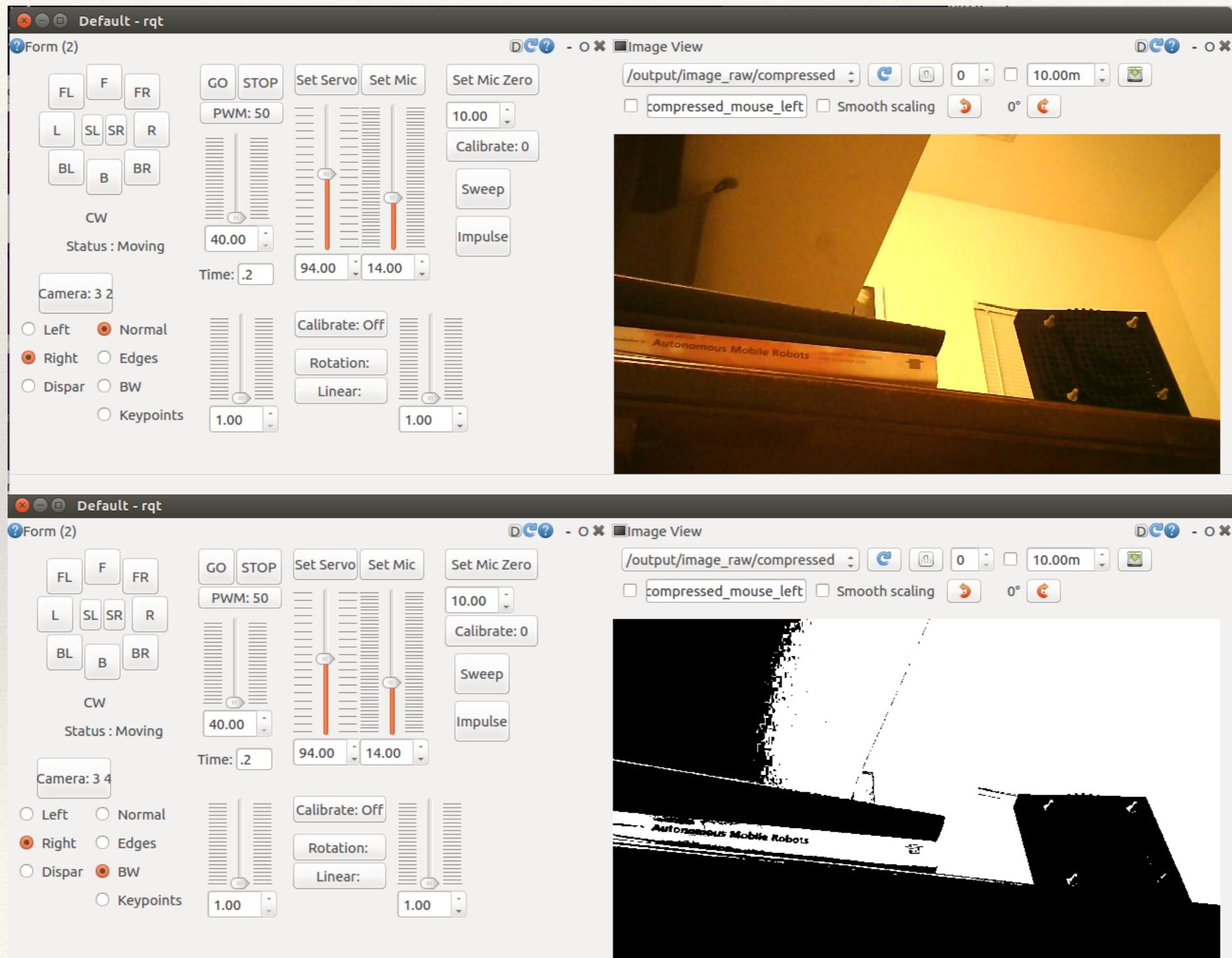


Image Processing

Image for boundary identification

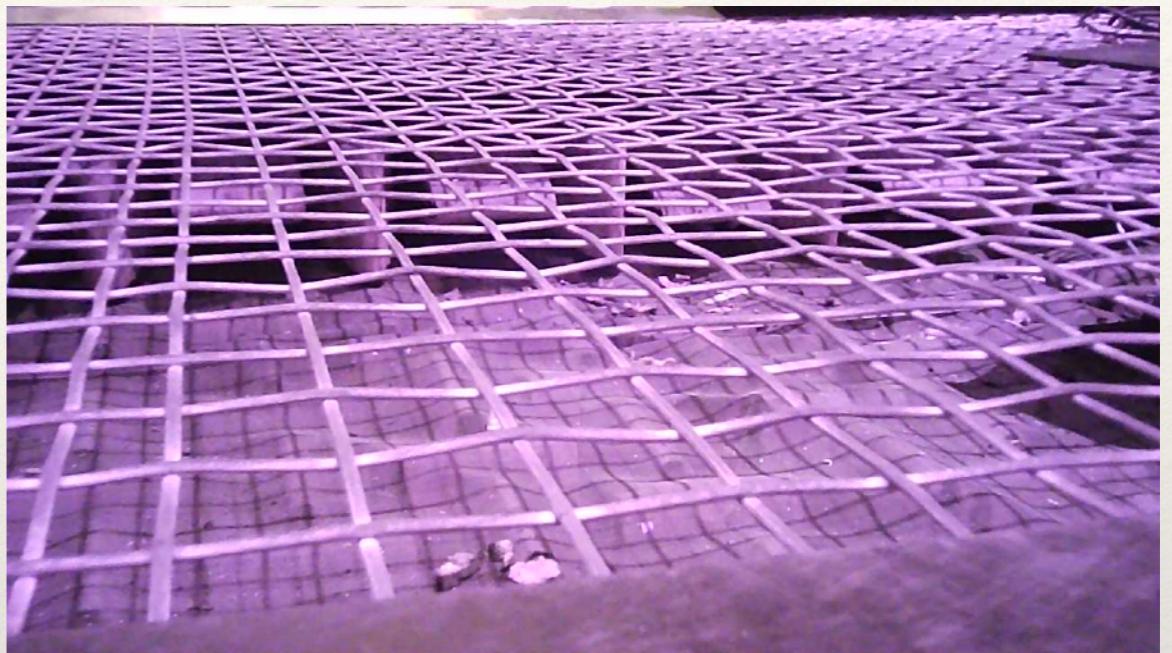


Image after Canny edge detector

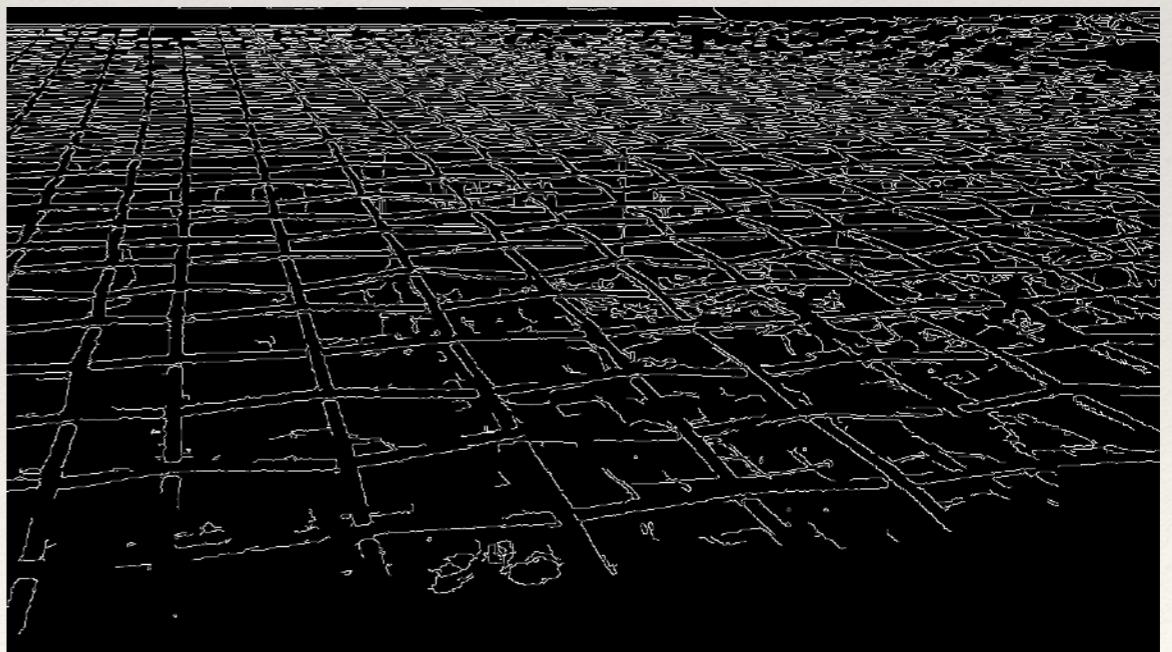
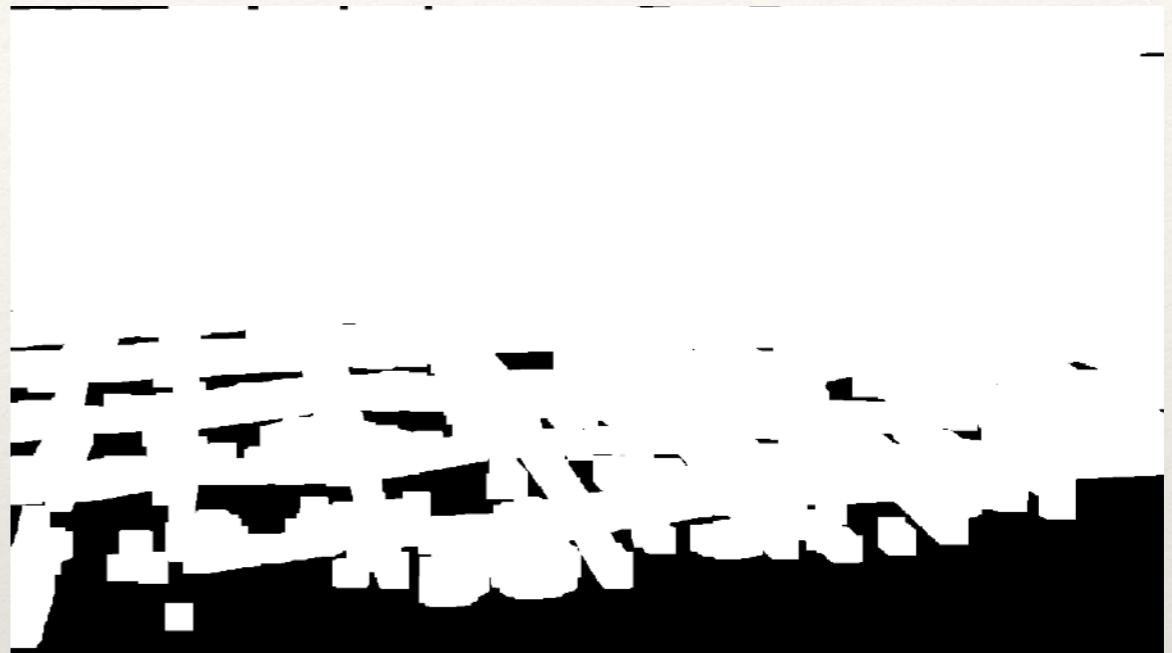


Image Processing

After dilation



After dilation and closing

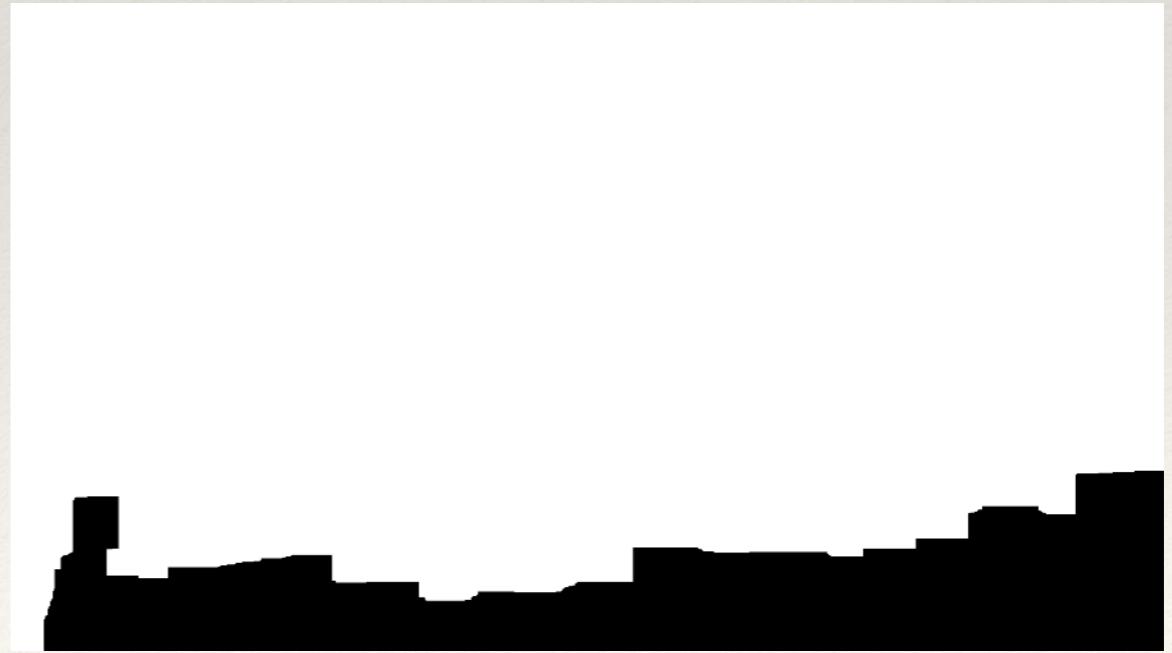
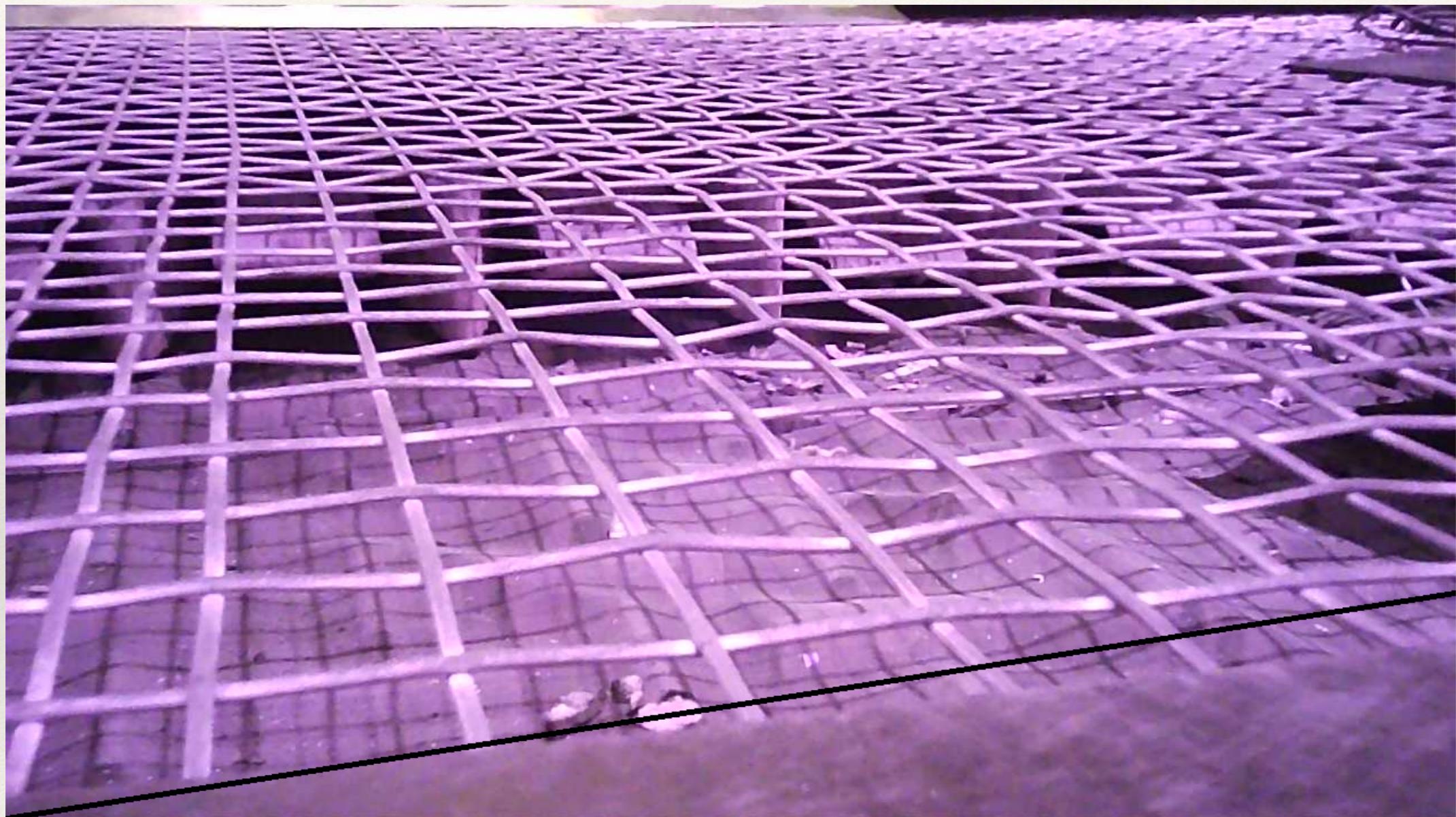


Image Processing

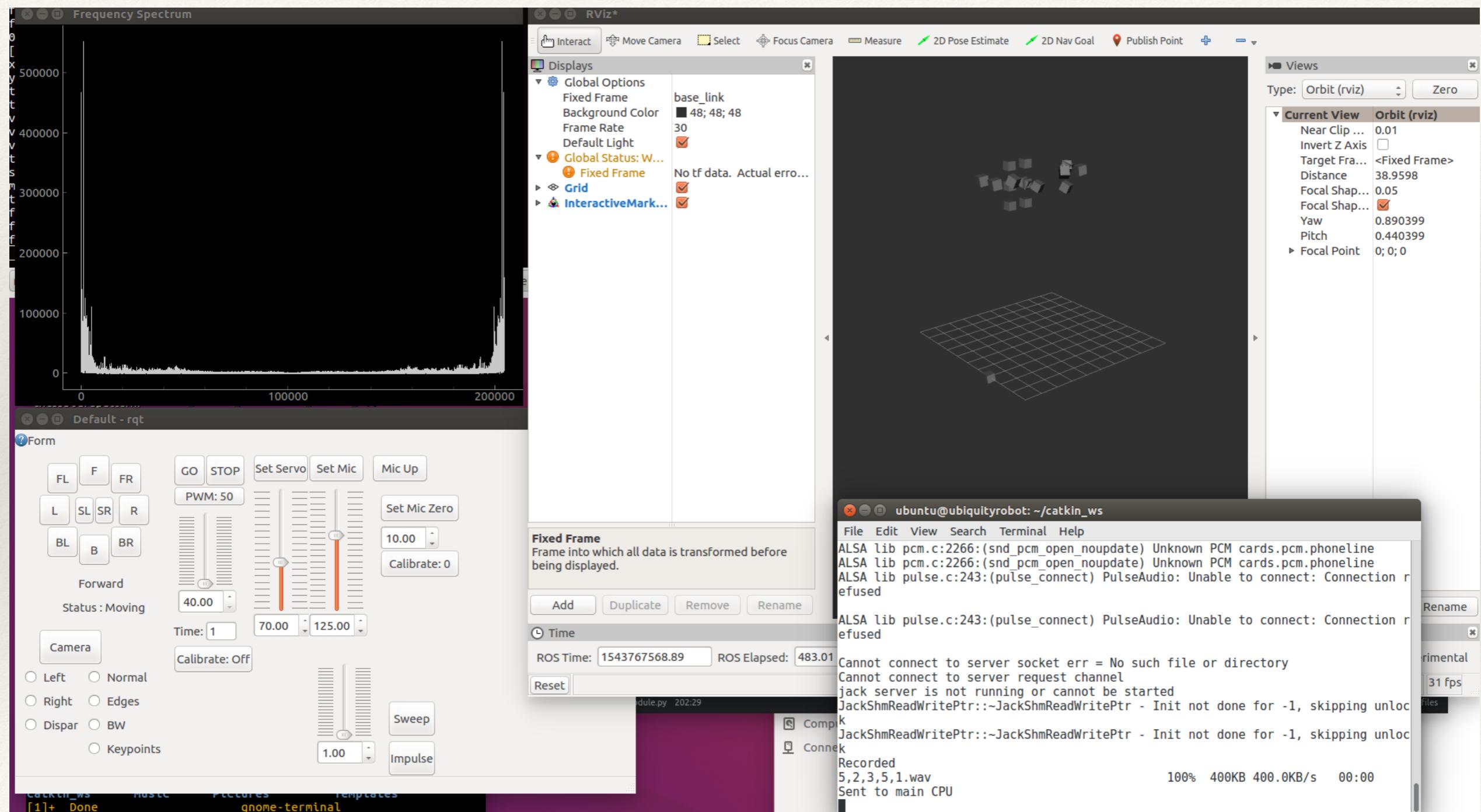


Line approximating boundary between net and tarp

Mapping with ROS

- ❖ ROS package ‘rviz’ for mapping
- ❖ Place boundaries and landmarks (loudspeaker)
- ❖ Create interactive markers for measurements

Mapping and Measurements



Conclusion

- ❖ Issues
 - Sensor inconsistency, open-source pros / cons
- ❖ Proof of concept achieved
 - Affordable, scaleable robotic measurement system
- ❖ Future work
 - Alternative robot designs, camera system

References

- [1] Zbrowski, Mesyk, Giesko, Kamisinski - "SYSTEM FOR AUTOMATED ACOUSTIC MEASUREMENTS IN THE ANECHOIC CHAMBER"

- [2] Baede, T.A. - "Motion control of an omnidirectional mobile robot"