# Mapper

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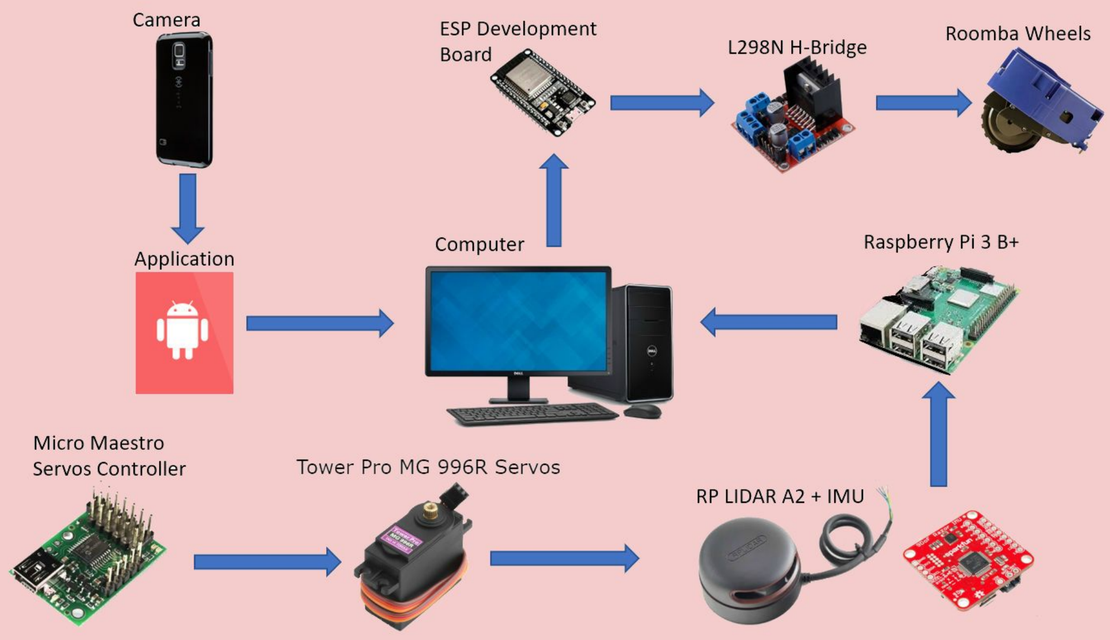
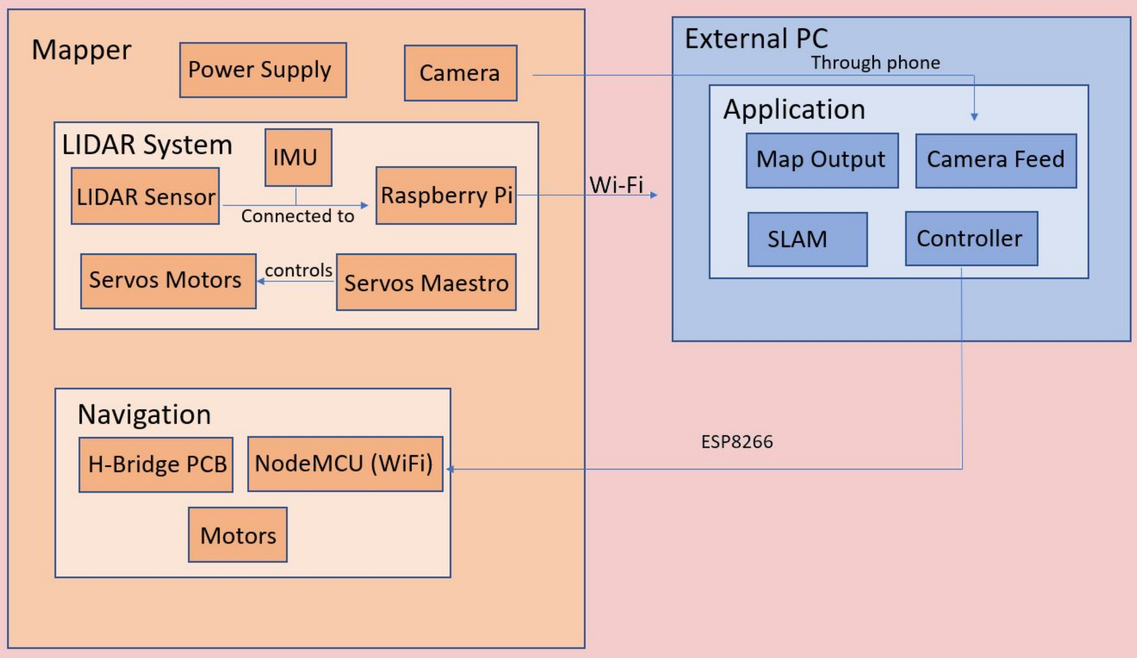
## Abstract

To the average person, buying a house can be seen as a huge milestone. It's a sense of accomplishment that is unlike anything else. But in today's modern real estate, that process can be tedious, long, and often overwhelming. Our project, Mapper, provides users with a more convenient method of viewing houses for sale or rent. By using Simultaneous Localization and Mapping (SLAM) algorithms, our robot will feature the ability to map an entire floor in 3D for users to view, thus reducing the need to travel there in person to get an accurate visualization of their potential home. Using a LIDAR sensor and IMU mounted on a custom robot, Mapper will be able to send data through Wi-Fi to an external PC for the SLAM algorithm processing. The result will be a 3D mesh map of the building viewable on the external PC.

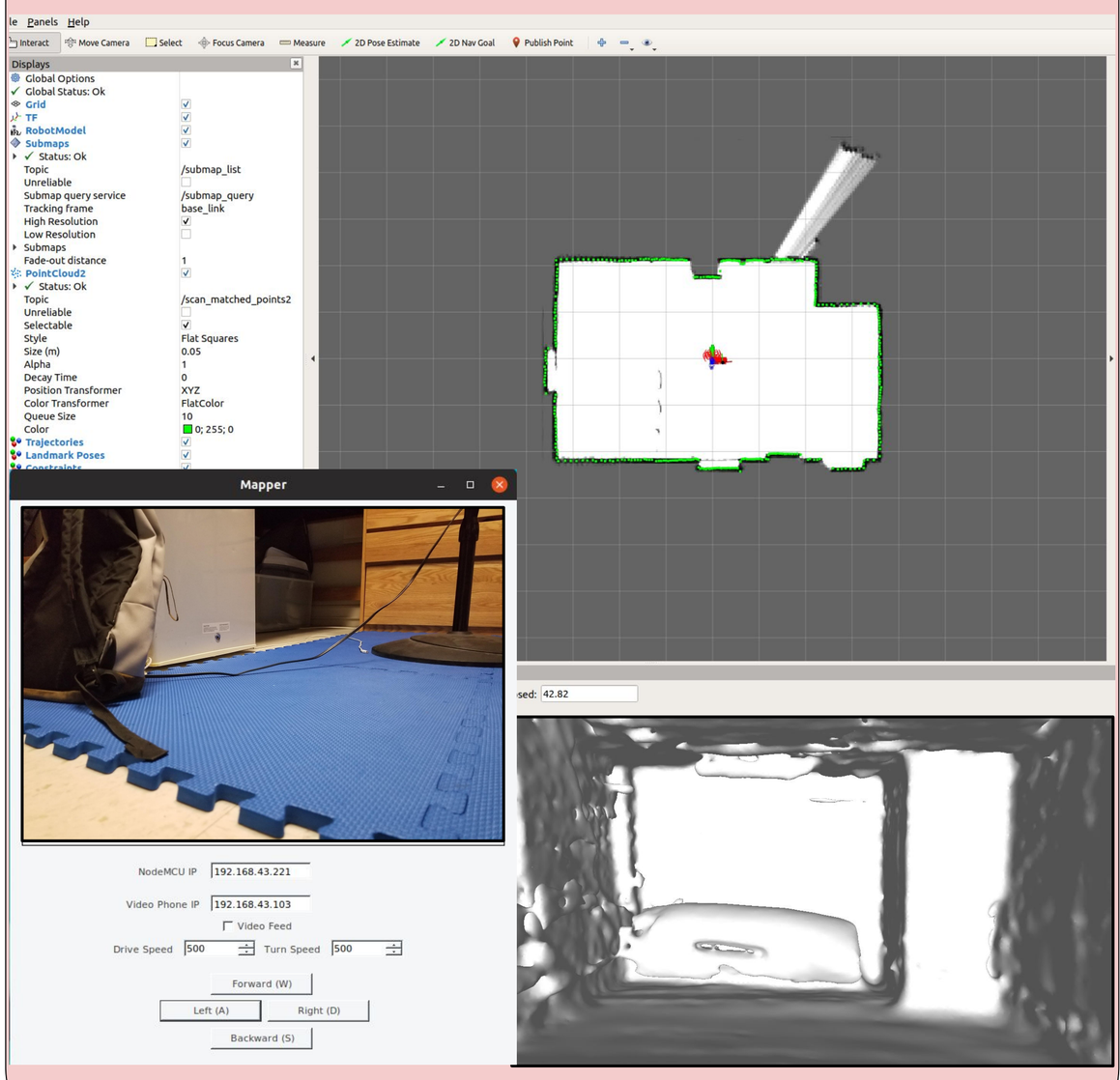
## System Overview




## Block Diagram




## Results




## Specifications

| Requirement | Specification | Actual |
|---|---|---|
| Navigate efficiently | Speed of up to 3 mph | 2.1 mph normal<br>3 mph max |
| Long range sensing | Effective detection range of 15 ft | 5 meters (16.4 feet) |
| Light-weight design | Approximately 12 pounds | < 10 pounds |
| Sufficient Battery Life | Approximately 2 hours of battery life | Approximately 3 hours 26 minutes |
| 3D SLAM | LIDAR servos tilt system of 35 degrees | 45 degrees |
| Robust | Durable enough to withstand minor collisions | Durable enough to withstand minor collisions |
| User-Friendly | PC application for navigation commands and map display | Applications include: Mapper camera, map display, navigation control, speed control |

## Acknowledgement

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**Prof. Aura Ganz** for being our advisor and guiding us through technical and non-technical aspects of our project
**Shira Epstein** for providing thoughtful insight regarding SLAM and possible problems to look out for
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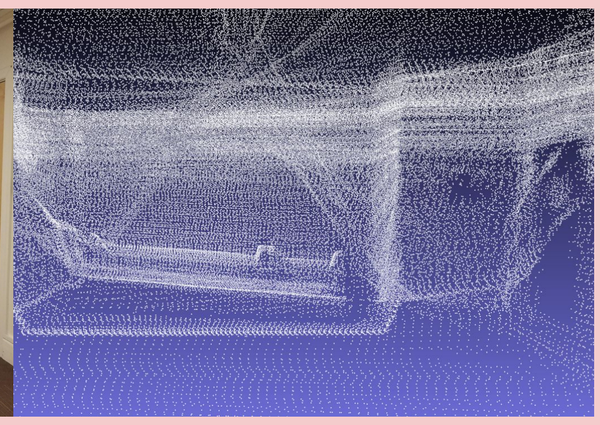
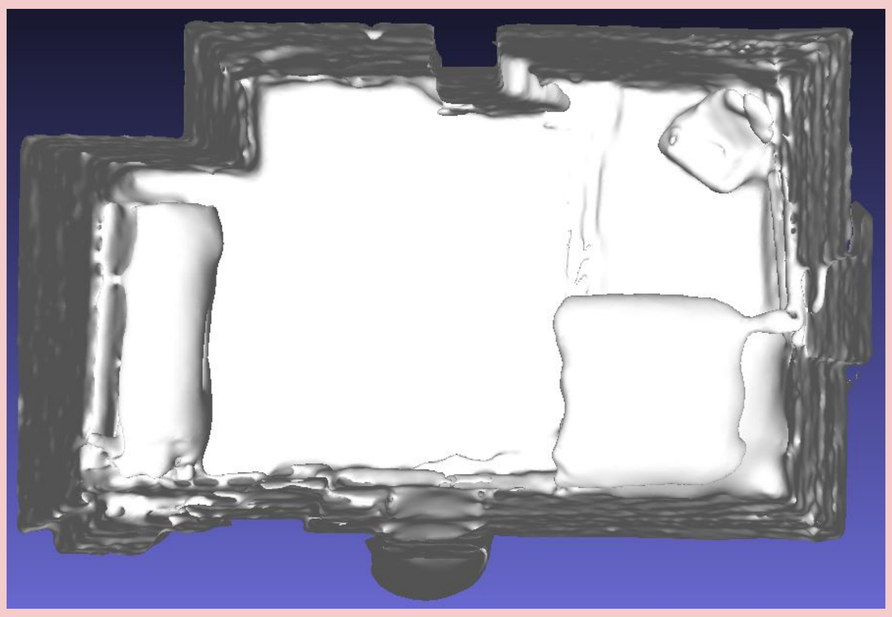
**Dr. Chengbo Ai** for his advice regarding LIDAR systems
**Francis Caron** for ordering the parts we needed and getting them to us as quickly as possible

# Example Scan

Original Room (Lewis Classroom)



Generated Point Cloud

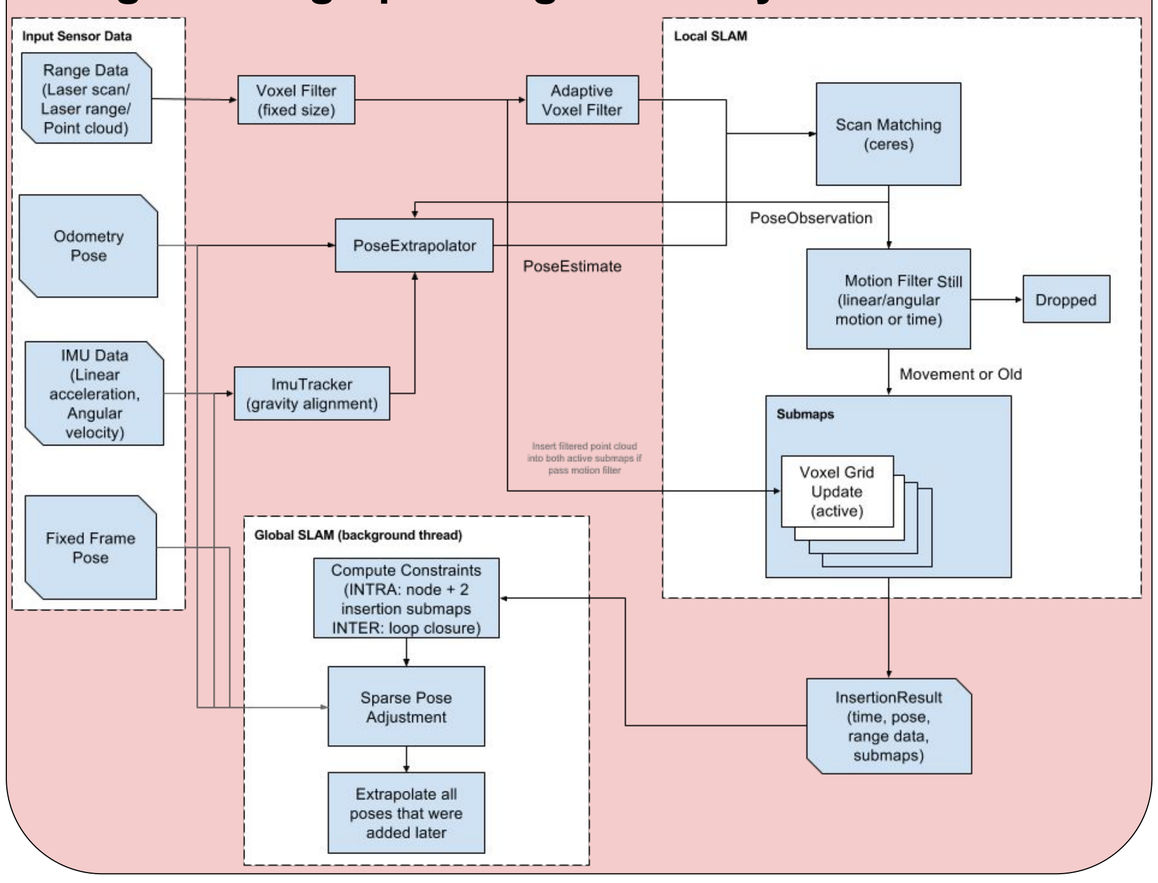


Generated Mesh
(top-down view)

# Simultaneous Localization and Mapping (SLAM)

- SLAM - using sensor data to estimate the pose of the robot and the map of the environment at the same time
- Google Cartographer's SLAM algorithm used to generate our 2D and 3D maps

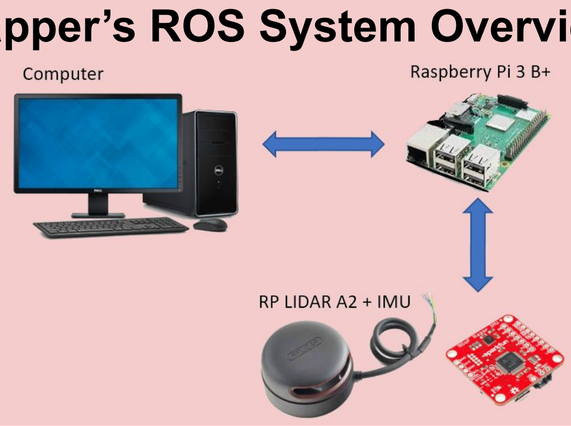
**Google Cartographer High Level System Overview**



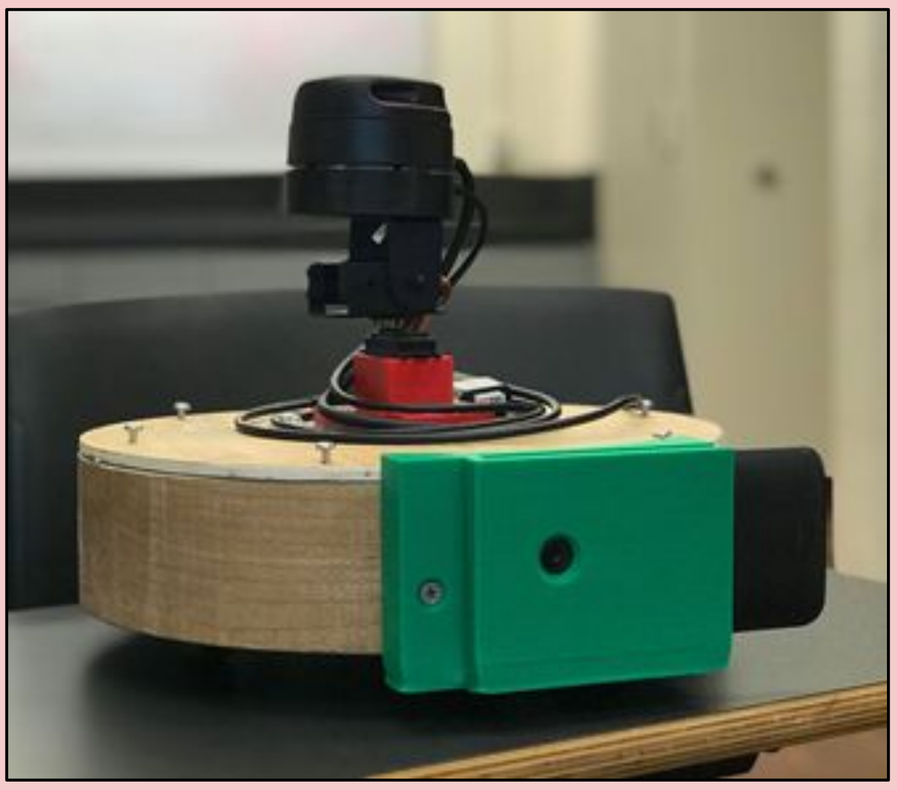

# Robot Operating System (ROS)

- ROS - set of software libraries and tools to help in building robot applications
- LIDAR and IMU integrated into ROS to be compatible with Cartographer ROS package
- Raspberry Pi running Ubuntu Server with ROS
- taking advantage of ROS' distributed computing environment to remotely launch sensors and publish sensor data over Wi-Fi

**Mapper's ROS System Overview**




# Robot

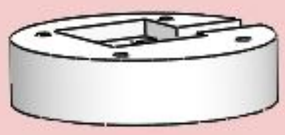


- 11 inches in diameter
- 2.75 inches in height
- L-shaped cutouts to house Roomba motors
- Rectangular cutouts to house circuitry, batteries and wiring.
- Lid included for mounting

# LIDAR System

The LIDAR system is comprised of the pan & tilt system, LIDAR mount, LIDAR, and IMU.

Assembled LIDAR System



LIDAR Mount

**LIDAR**

Rotates at 600 RPM, providing us with constant distance measurements to be utilized in the SLAM algorithm.

**IMU**

Utilizes an accelerometer and gyroscope to determine the orientation of the LIDAR. This allows us to record three dimensional measurements.

**LIDAR Mount**

Connects our sensors to the pan & tilt system. The center of the mount is hollow to allow our IMU to fit snugly beneath the LIDAR.

**Pan & Tilt System**

Manipulates our sensor system to allow for angled measurements. The system rotates 360° and provides a maximum tilt of 45° in both directions.

# Cost

## Development

| Part | Price ($) |
|---|---|
| RPLidar A2 | 319.95 |
| IMU | 34.95 |
| Chassis | 26.50 |
| Servos controller | 19.95 |
| NodeMCU | 8.39 |
| PCB | 5.51 |
| Raspberry Pi | 38.10 |
| MicroSD | 11.99 |
| Connector/wires/pins | 5.59 |
| Wheel motors | 0 (M5) |
| Servos | 0 (M5) |
| Batteries | 10.80 |
| Camera (Phone) | 0 (Owned) |
| Total | 481.73 |

## Production

| Part | Price ($) |
|---|---|
| RPLidar A2 | 319.95 |
| IMU | 30.56 |
| Chassis | 13.25 |
| Servos controller | 12.49 |
| NodeMCU | 6.50 |
| PCB | 2.18 |
| Raspberry Pi | 35.00 |
| MicroSD | 5.66 |
| Connector/wires/pins | 3.78 |
| Wheel motors | 59.98 |
| Servos | 13.80 |
| Batteries | 3.29 |
| Camera Module | 22.51 |
| Total | 528.95 |