

Midway Design Review

Mappa Signa
December 9th, 2019



Introduction



Nicholas Dirschel
(CSE)



Ethan Hart
(CSE)



Samuel Jager
(CSE)



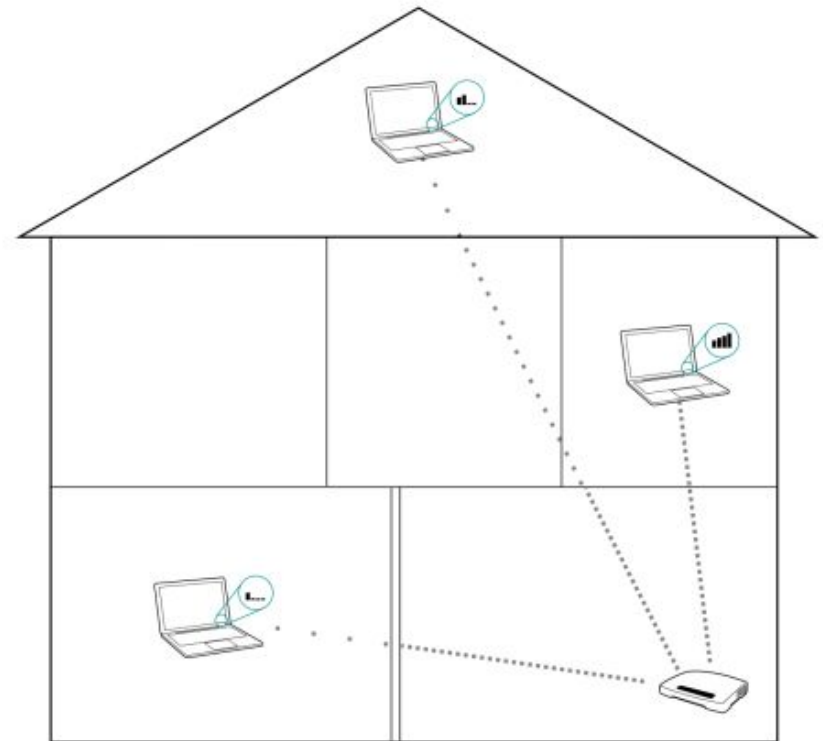
Heather Thompson
(CSE)



Team Advisor:
Prof. Jackson

Problem Statement

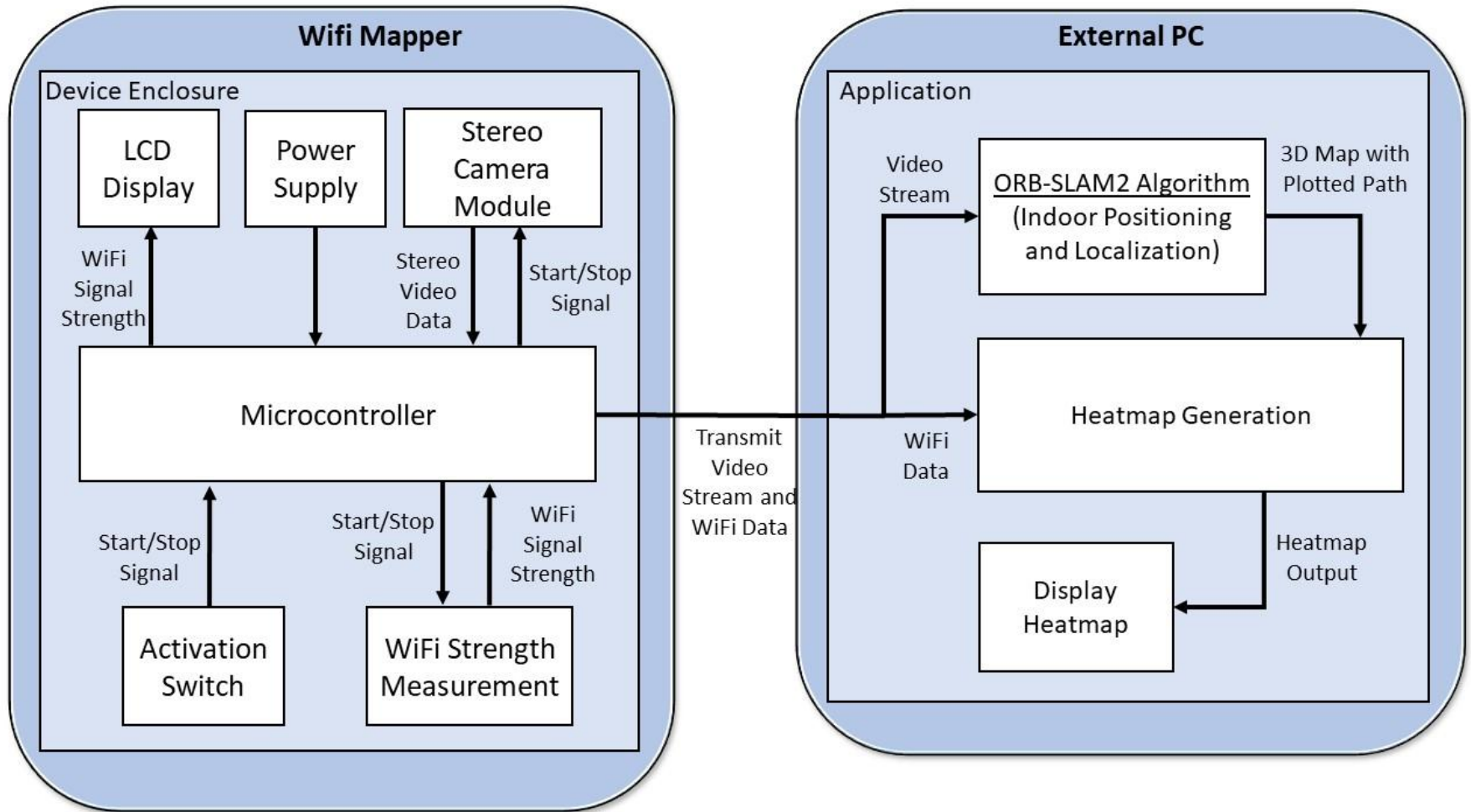
- WiFi signal is inconsistent throughout homes and offices
- Most homes have a single access point
- Houses are filled with walls and furniture that block WiFi signals
- Current solutions require copious manual input of data



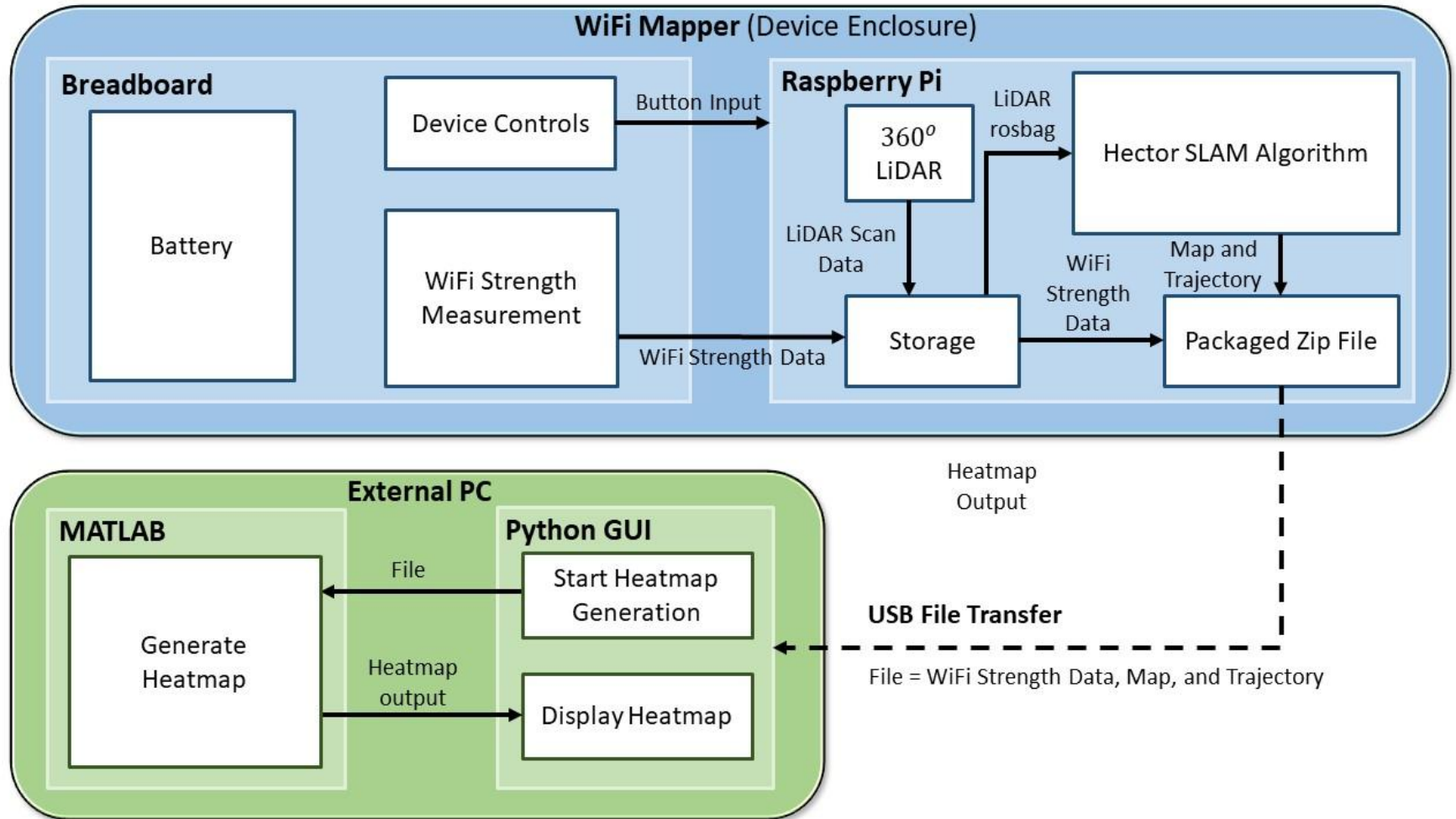
System Specifications

- 1. Battery lasts minimum of 3 hours or long enough to map entire building.**
- 2. Map creation and trajectory estimation without user input of pre-existing map.**
- 3. Suggest optimal signal booster placement based on heatmap results.**
- 4. Turn on and go functionality, no user intervention until data analysis.**

Original Block Diagram (PDR)



Current Block Diagram



Proposed MDR Deliverables

- Create map of environment
- Simultaneously capture WiFi data
- Communicates with external PC via USB to transfer map, trajectory, and wifi measurements
- Combine received data to create heatmap of WiFi signal strength

MDR Deliverable - Progress

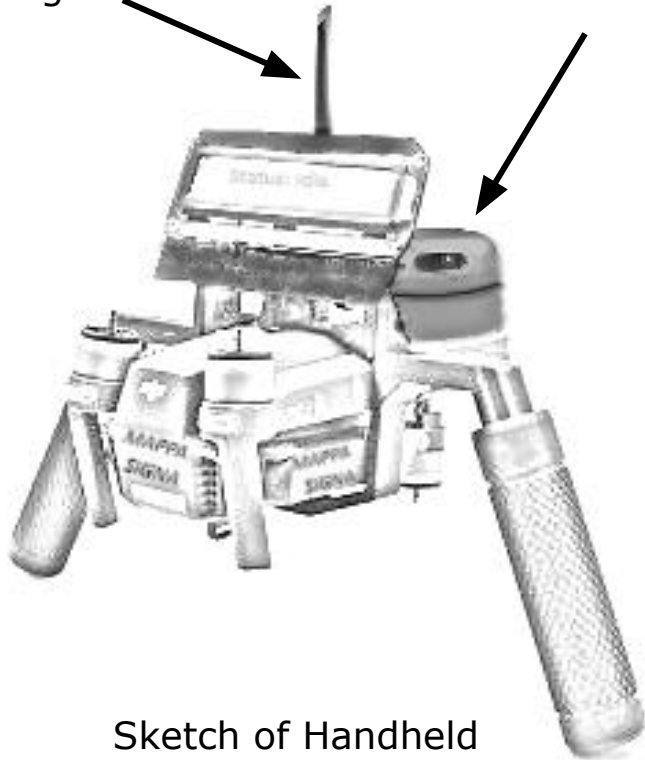
- ✓ Create map of environment using LIDAR & Hector SLAM
- ✓ Simultaneously capture WiFi data
- ✓ Communicates with external PC via USB to transfer map, trajectory, and wifi measurements
- ✓ Combine received data to create heatmap of WiFi signal strength

Concept Design

Measure WiFi Strength

LiDAR scans room

Transfer Map, Trajectory, and WiFi strength data to External PC

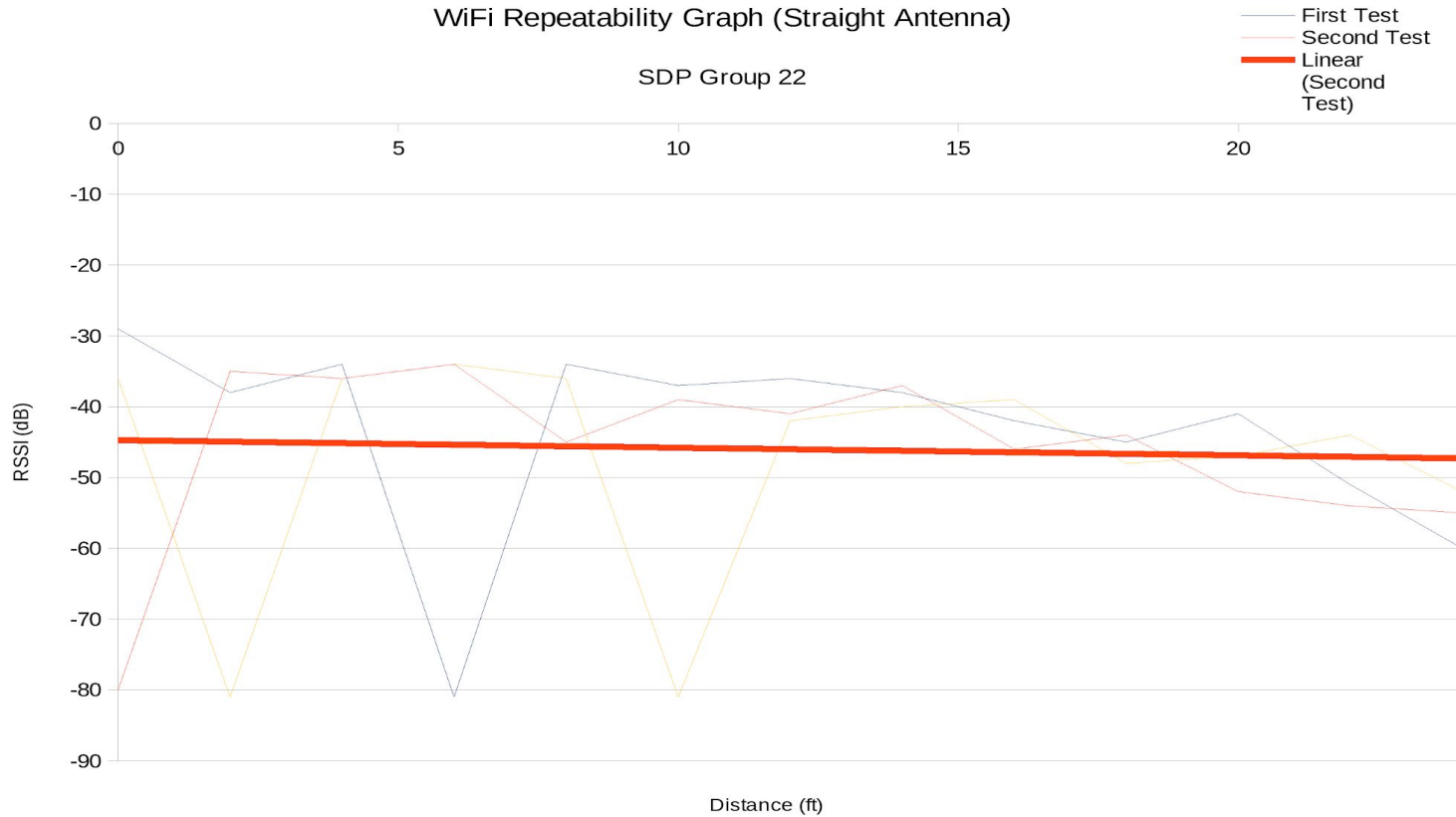


Sketch of Handheld Device Concept Design



External PC Generates Heatmap

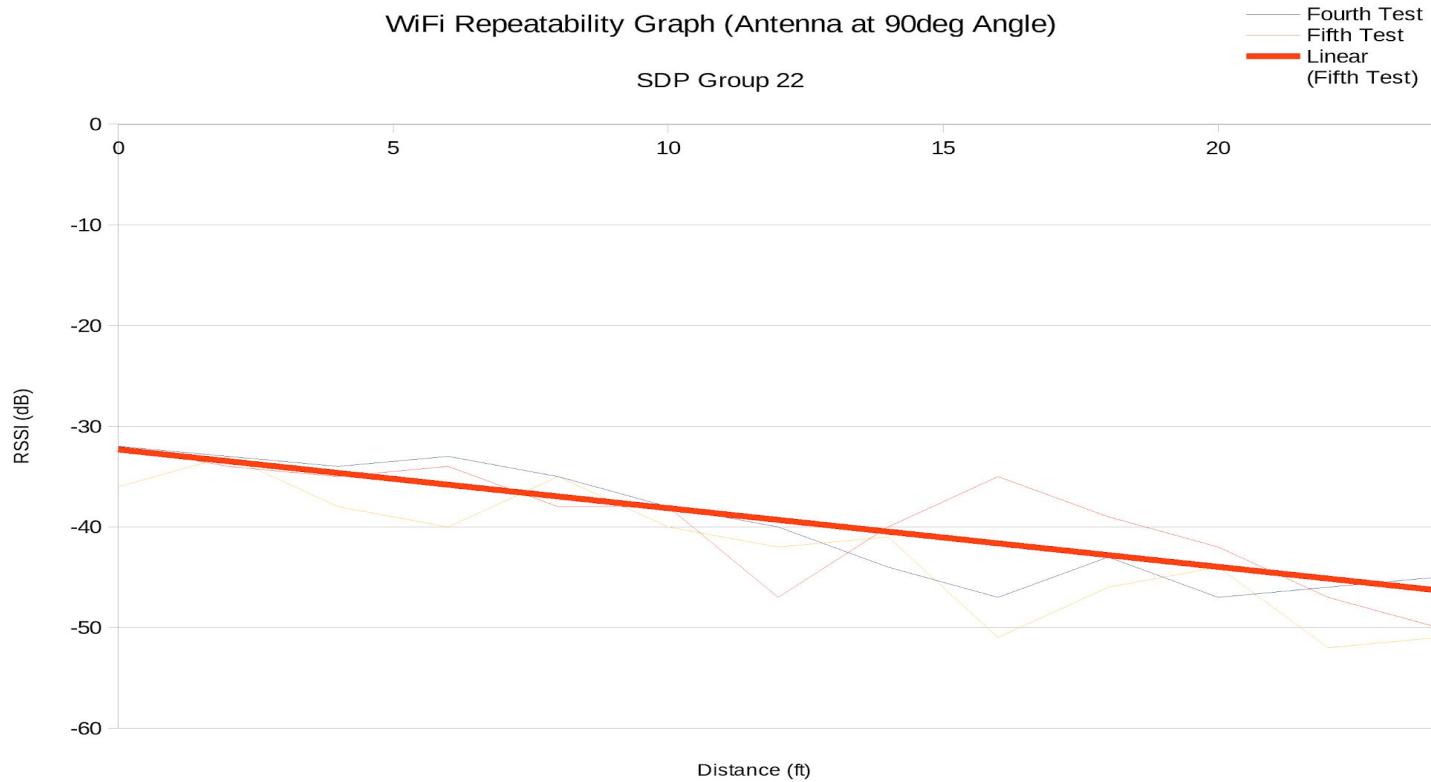
Measuring WiFi Signal Strength



Measuring WiFi Signal Strength

WiFi Repeatability Graph (Antenna at 90deg Angle)

SDP Group 22



360° LiDAR: RPLIDAR A2M8

- Specs:
 - Range: 0.15 - 12m
 - Distance Accuracy: $\sim 1\%$
- Open Source Package: `rplidar_ros`
 - Read raw scan data from LIDAR
 - Record scan data for playback at later time



Hector SLAM using LiDAR

- Simultaneous localization and mapping
- Can perform using:
 - real-time LIDAR scans
 - simulated-time LIDAR scan recordings

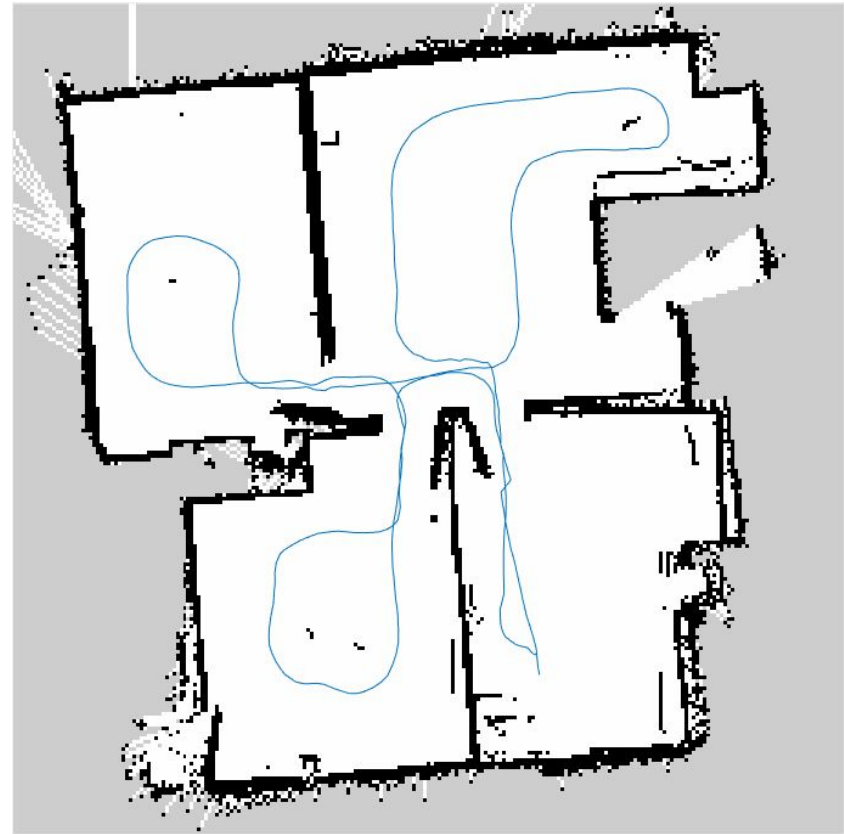
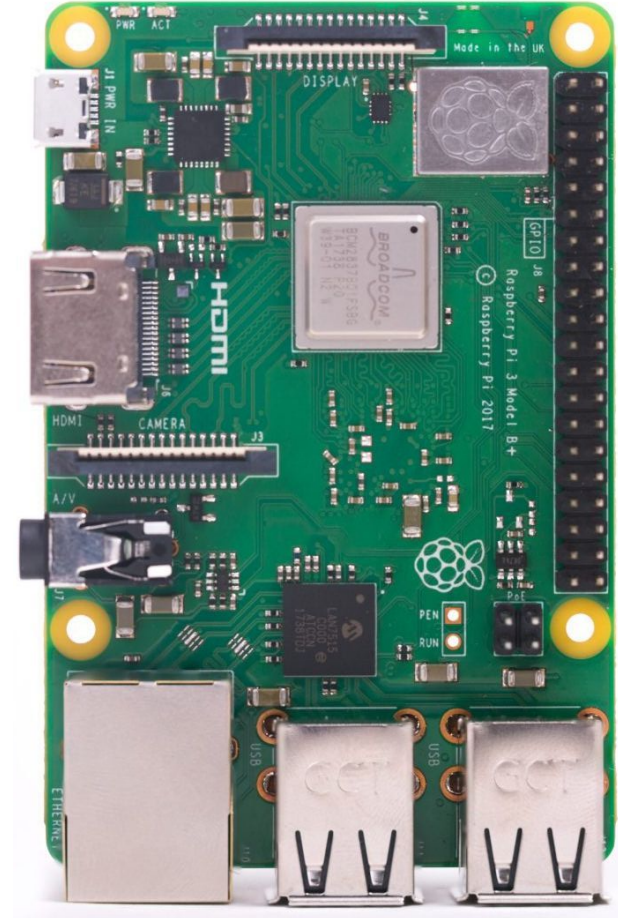


Fig. 5: Hector SLAM Map and Trajectory results from Cliffside apartment.

Microcontroller: Raspberry Pi 3

- Purpose:
 - Simultaneously record WiFi strength and LiDAR scan data
 - Perform Hector SLAM
 - Transfer map, trajectory, and wifi strength data to PC.



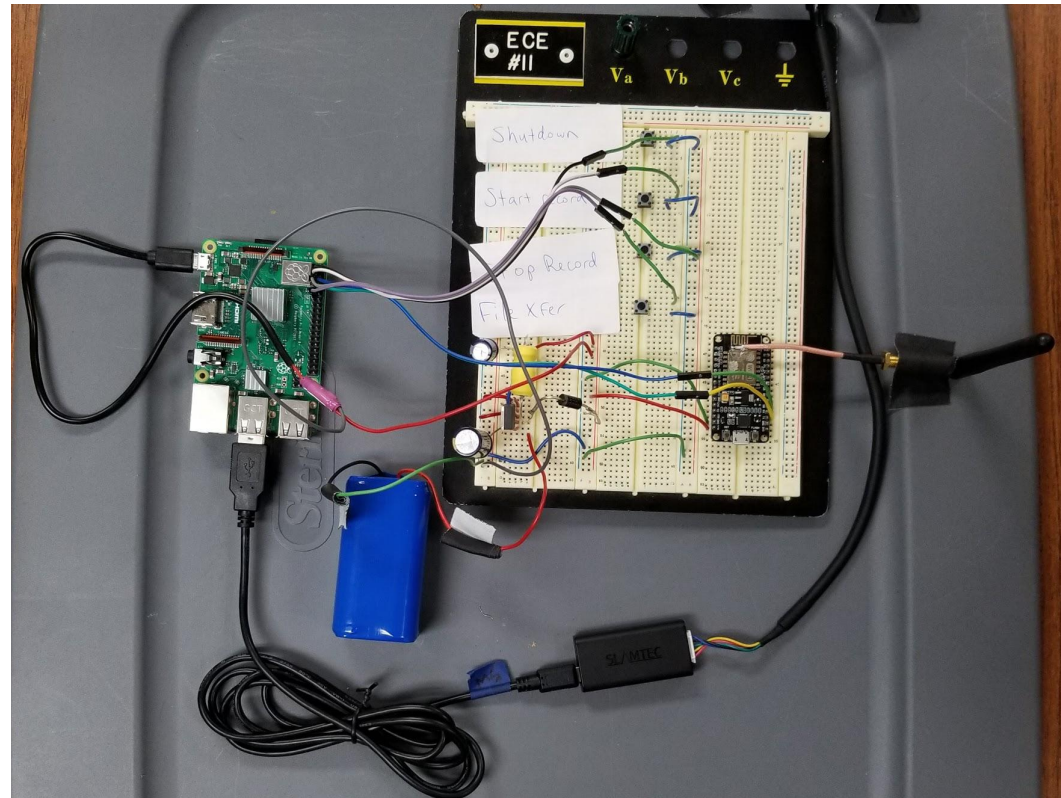
Power

- 7.2V 6500mAh Lithium-Ion battery powers:
 - Raspberry Pi 3
 - LiDAR Scanner
 - NodeMCU Amica WiFi
- Total system power usage between 1200-1900 mA
 - 3-4 hours of battery life
- Buck regulator used to step down voltage from 7.2V to 5V



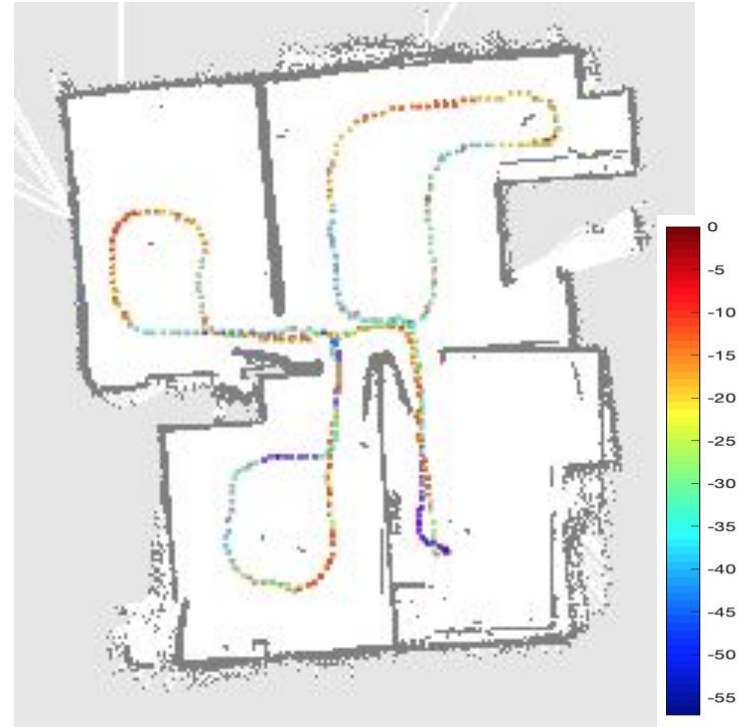
Significant Hardware Component

- Data transfer from WiFi device to Raspberry Pi
- Regulate power for each component
- Display current signal strength



Computer Application on External PC

- Generate Heatmap
 - Combine SLAM trajectory with WiFi signal strength data
- Signal Booster Suggestion
 - suggest signal booster placement based on weak points of heatmap



Parts Used

- Raspberry Pi Compute Module 3 - ~\$40
- RPLiDAR A2M8 - \$319
- WiFi Breakout Board - \$25
- Activation Switch - \$1
- Lithium ion battery - \$60
- Step-down regulator - \$6
- External PC - \$0

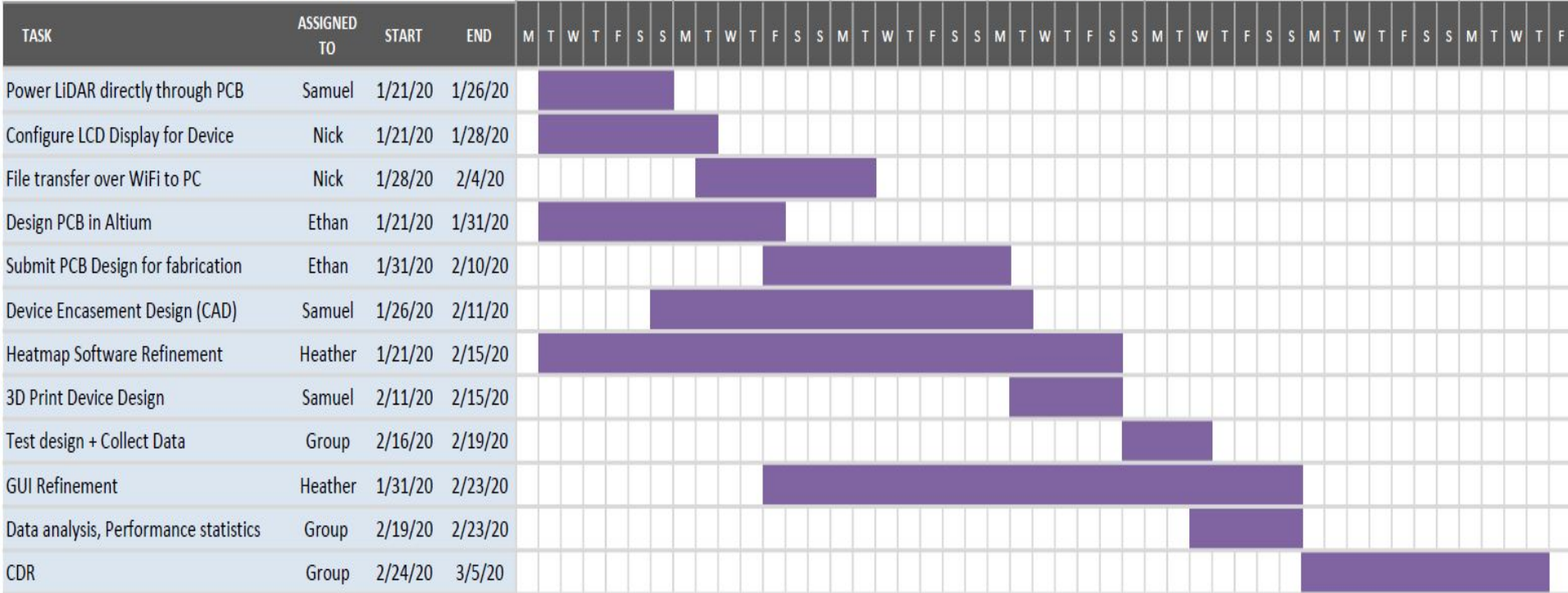
Team Roles + Responsibilities

- Nick Dirschel (CSE)
 - WiFi Data Processing
 - GPIO Pin Configuration
- Ethan Hart (CSE)
 - PCB Development
 - Power Management
- Samuel Jager (CSE)
 - LIDAR Data Processing + SLAM Implementation
 - Process automation
- Heather Thompson (CSE)
 - Heatmap Generation (Matlab)
 - Application Development: Signal Booster Placement

Gantt Chart

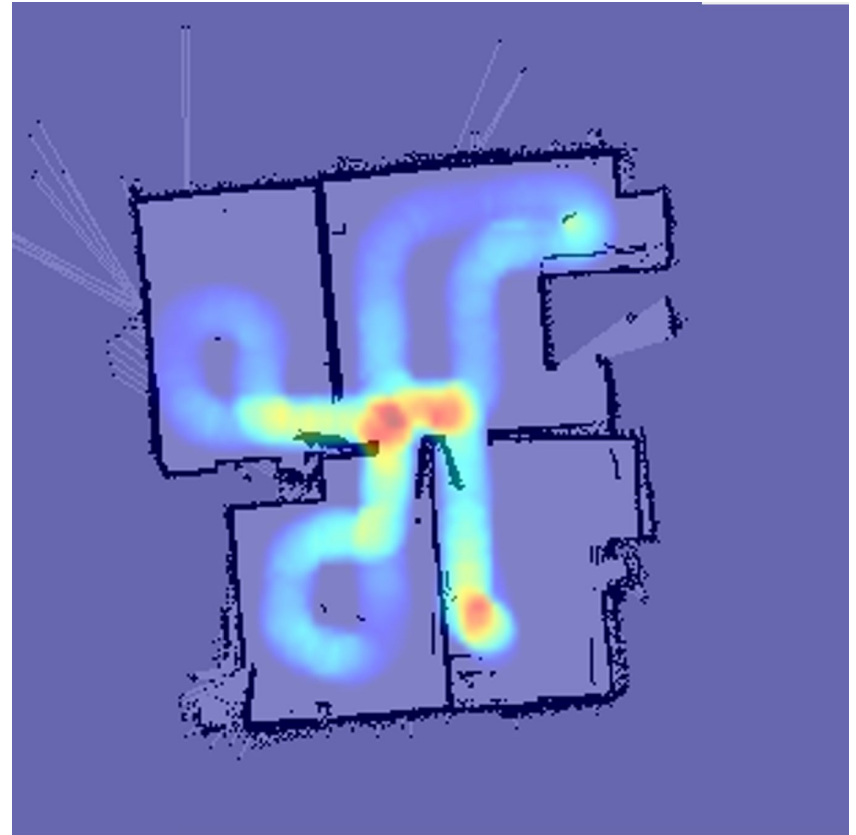
Mappa Signa

Nick Dirschel, Ethan Hart, Samuel Jager, Heather Thompson



Proposed CDR Deliverables

- Convert power and device controls to PCB
- Create device enclosure for easier use
- Incorporate LCD display to show status of device
- Automate file transfer from device to external PC over WiFi

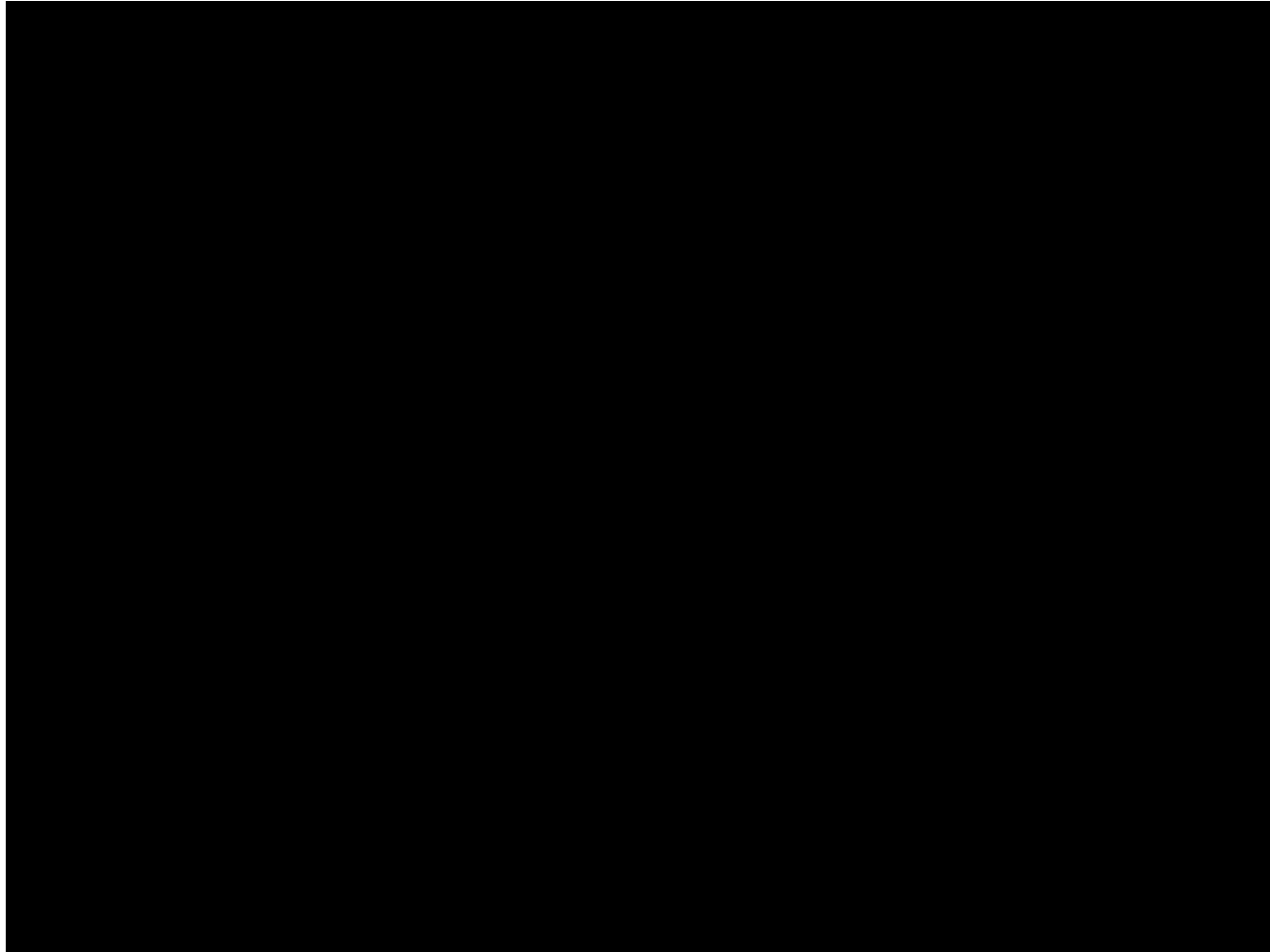


FPR and Demo Day

- Final Product
 - Device encapsulated in comfortable form factor
- Demonstration of Mappa Signa
 - Create 2D map of current room
 - Generates heatmap from newly acquired data
 - Recommends best places on map to place a signal booster based on heatmap and amount of boosters user requests

DEMO

Video Demo



Questions?