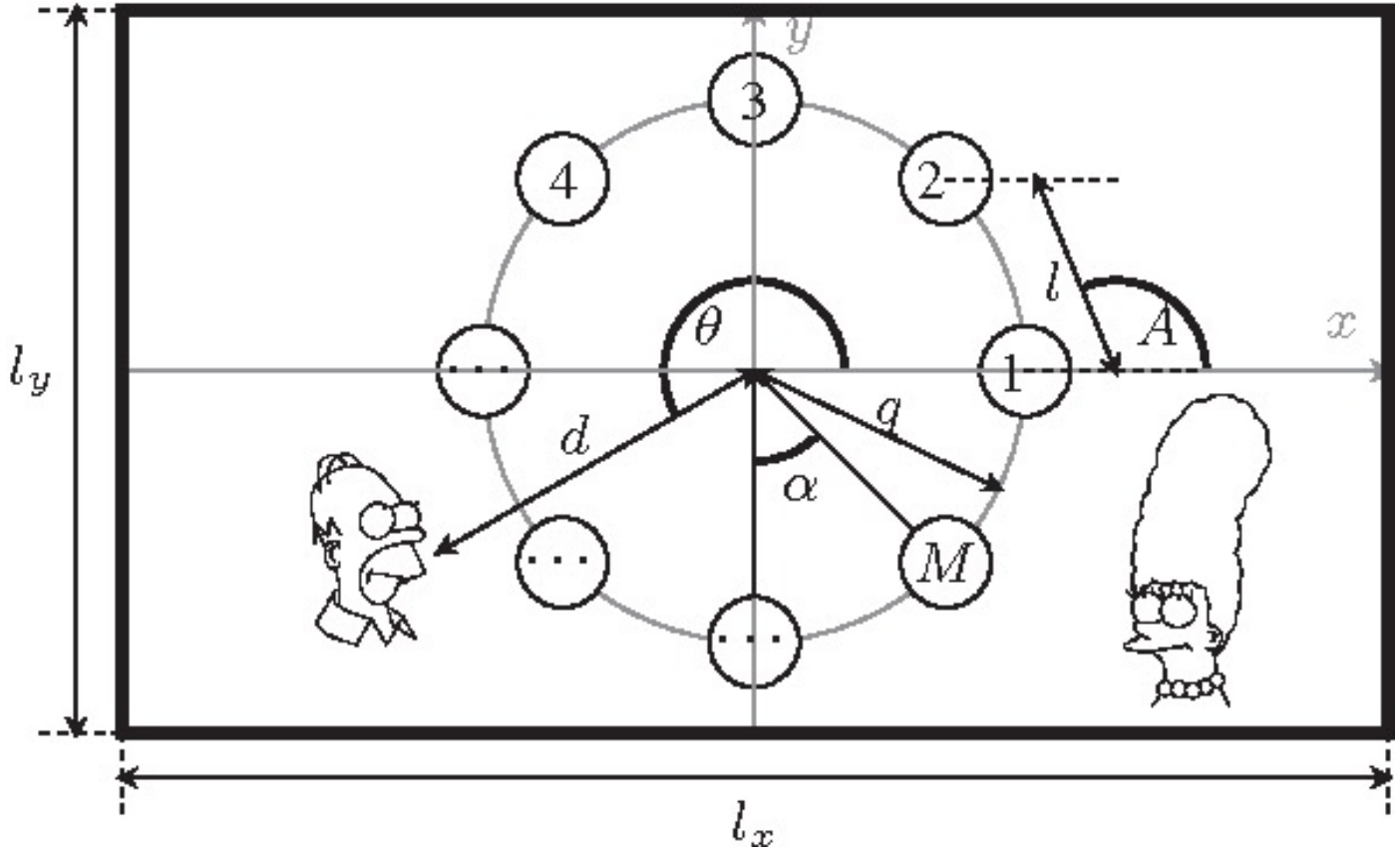
Acoustic Source Localization

By: Tiffany Ho, Ajeetpal Dhillon, Harry Nguyen, Andrew Dulaney, Daniel Scarborough, Sidong Guo

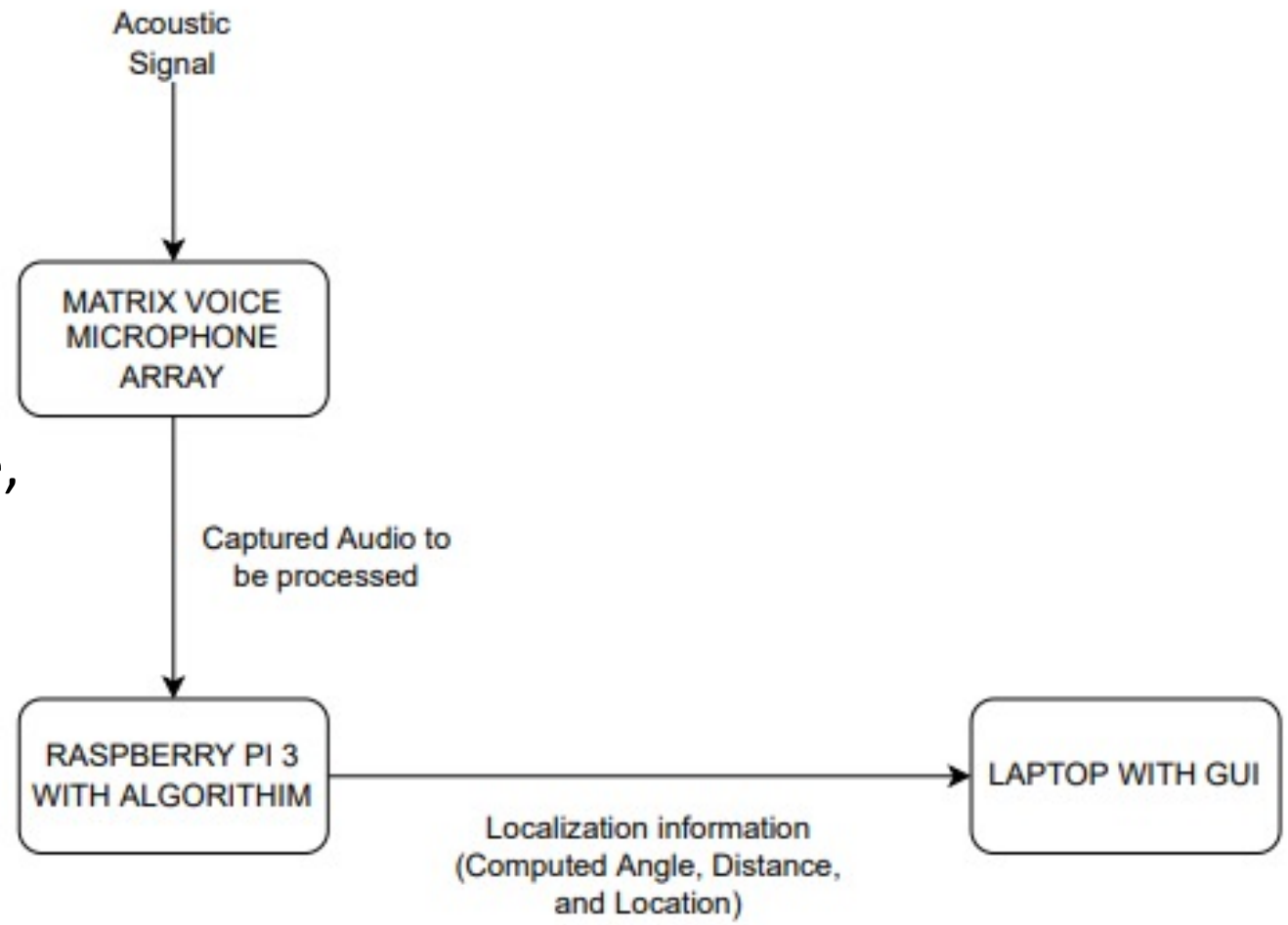


Introduction

- Objective
  - To identify the location of a sound source in a given area.
- Motivation
  - We would like to make an alternated detection method that offer an alternative approach to video detection.
- Background
  - Different Methods
    - Time of arrival
    - Time difference of arrival
    - Receiver signal strength

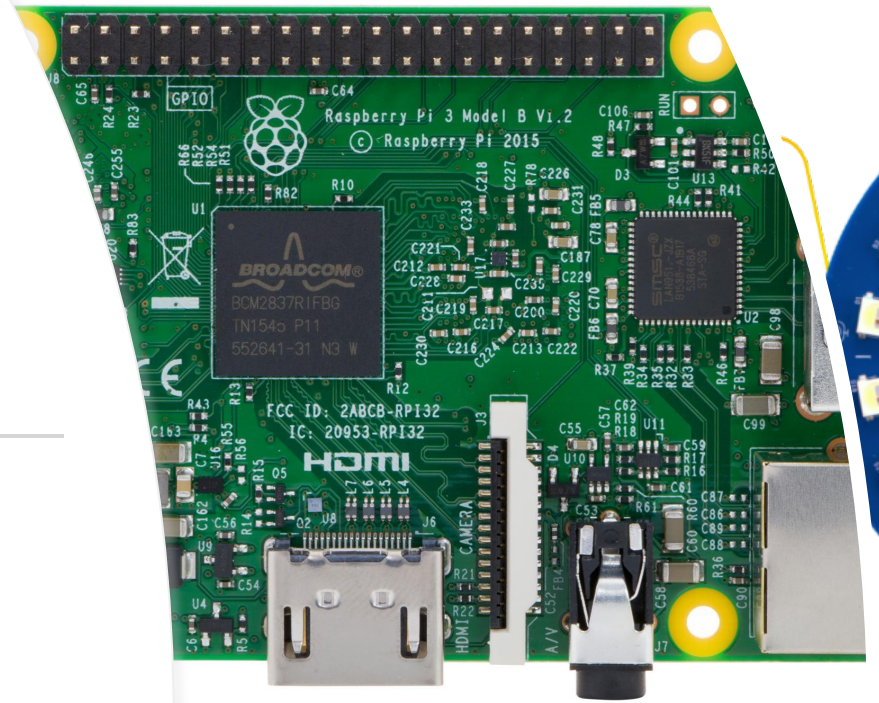
Project Description

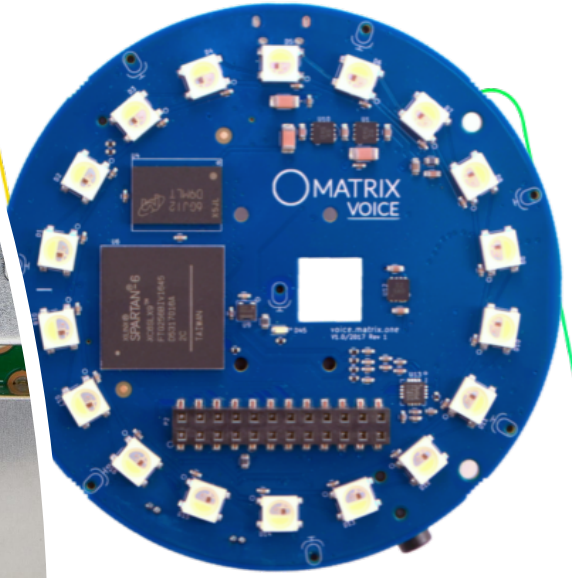
- Localization Software for Acoustic Signals
- Motivation
  - Applications in Emergency Rescue, child and elderly care
- TDOA for Angle
- Signal Strength for Distance

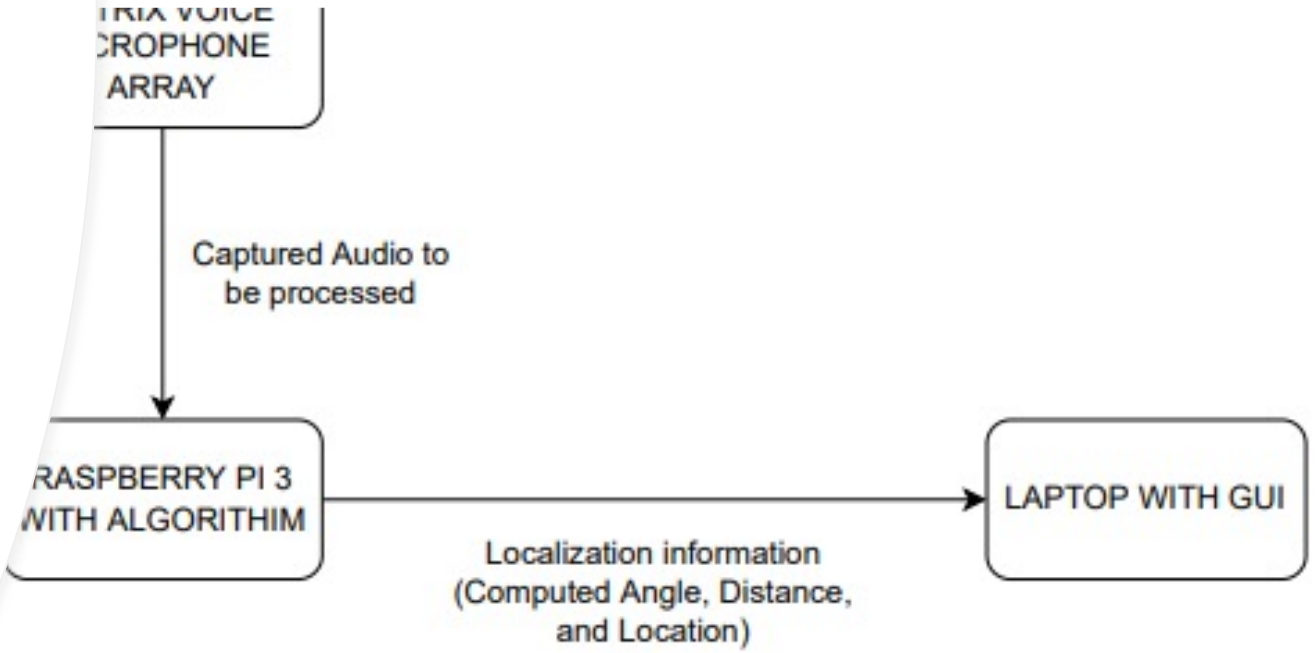


Design Details

- MATRIX VOICE
  - Circular 8 Mic Array
- RASPBERRY PI 3

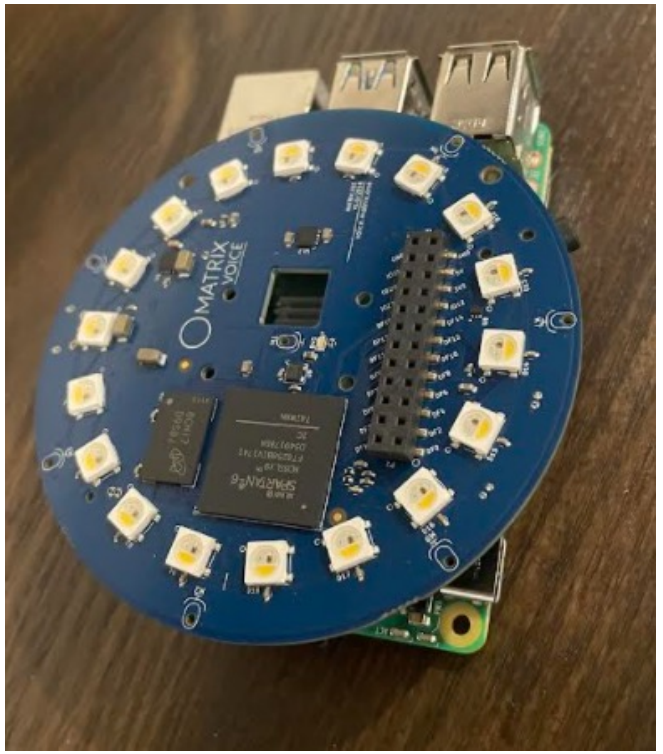






Raspberry Pi and Matrix Setup

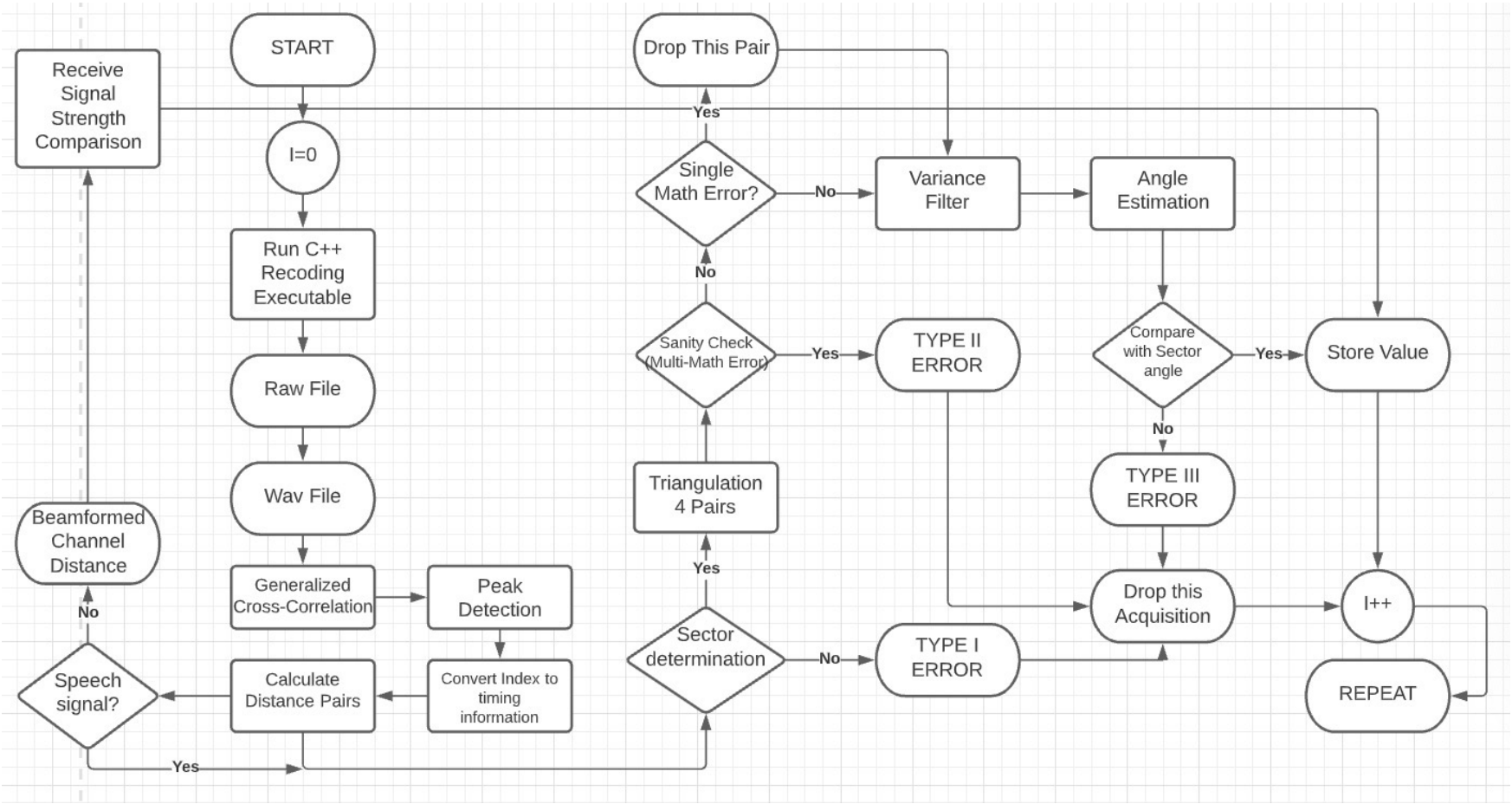
- Two functioning Matrix modules each with a Pi
- Pi's can be 3 or 4
  - Buster OS
  - Matrix HAL Library
- Localization.py
  - Runs recording executable via subprocess
  - Converts .raw files to .wav
  - Begins localization algorithm
- Documentation on Setup



Design Specification

Parameters	Specifications
Audio Specification	8-96 kHz
Bit Depth	Signed 16 bits
Operation Range	20 meters
Cost	Below $200
Angle Accuracy	Average difference within 3 degrees
Distance Accuracy	Average difference within 30 centimeters
Processing Delay	Average processing delay within half second

Software Flowchart

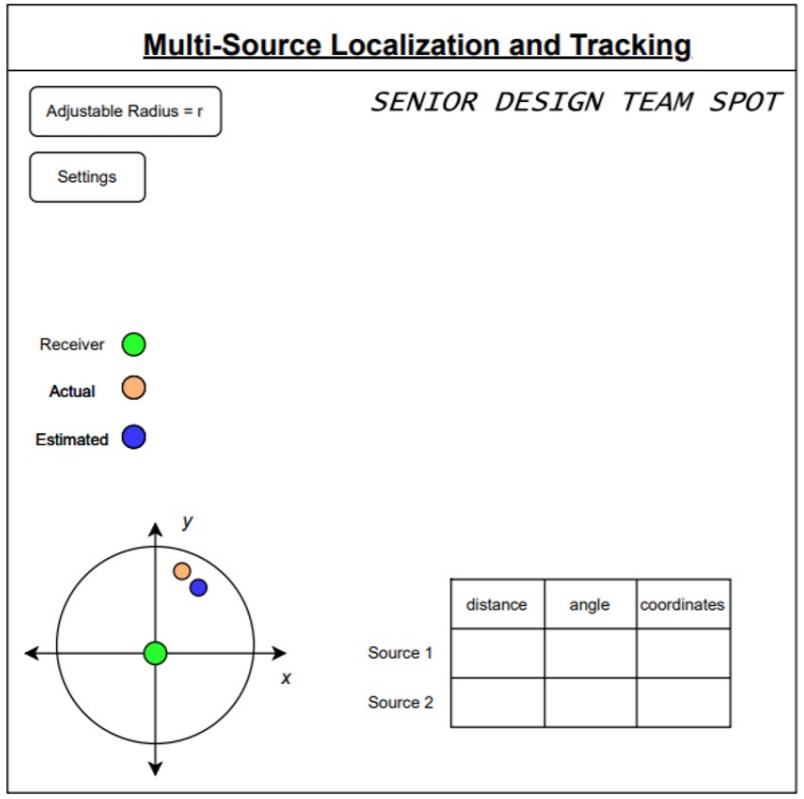


Angle and Distance Calculation

- Use multi-condition if statement that compares 4 sets of microphone distance pairs to determine the sector of the source
- Calculate 4 angle estimation based on triangulation
- Apply sanity check on angle estimates and drop any error estimates, if more than 2 errors are made in 4 angles, drop this acquisition
- Apply variance filter to filter outliers, store the angle value
- Distance calculated based on RSS, store the RSS value
- Ensemble mean averaged over 5 acquisitions in short time period and output the coordinates
- Start again for next set of coordinates

Project Demonstration

- Demo of working project
- Video for back-up
- Will show an overview of GUI
- Will test speech/acoustic signals
- Will show successful tracking algorithm
- GUI will show both actual and expected data



Schedule, Tasks, & Milestones

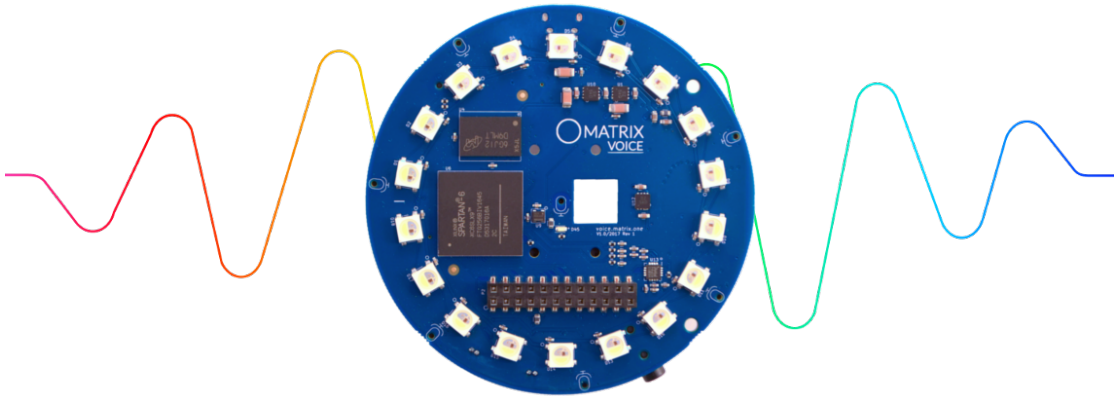
SENIOR DESIGN SCHEDULE	Week	10	11	12	13	14	15	16
Task								
Design Review Presentation								
Update Project Summary								
RSS Test			SIDONG	AJ+SIDONG				
Build GUI (2D PLANE)			Andrew	Andrew				
Build GUI (Display Data)			Harry/Daniel	Harry/Daniel				
Website			Daniel	Daniel				
Build GUI (QoL Features)			Tiffany	Tiffany				
Test GUI				GUI Team	GUI Team			
SINGLE SOURCE TEST			SIDONG					
TRACKING			SIDONG	AJ+SIDONG	AJ+SIDONG			
INTERFACE GUI WITH ALGO				GUI Team	GUI Team			
CAPSTONE DESIGN EXPO			ALL	ALL	ALL	ALL		
FINAL DEMO			ALL	ALL	ALL	ALL		
FINAL REPORT			ALL	ALL	ALL	ALL		
Update Project Summary			ALL	ALL	ALL	ALL		

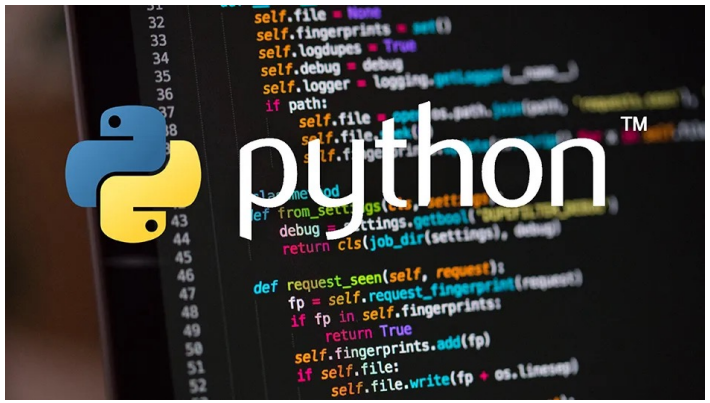
Cost Analysis

- Received the Matrix Voice at the cost of $90
- Collectively, about 20 hours per week for labor and research
  - 10 hours for research
  - 6 hours for algorithm development
  - 4 hours for GUI research and development
- Cost of labor is about $800 to $1,000
  - Used a laxed cost of $40 an hour

Current Status

- Algorithm has been translated from MATLAB to Python
  - Algorithm can be run repeatedly from executable
  - Angle estimation has high accuracy
  - RSS model will be established.
- GUI team is focused on adding features and interfacing with Algo
  - Button functionality has been established
  - Graphing predicted vs. real source location is next project goal





Leadership Roles

1. **Tiffany Ho:**
    - Group leader
    - Documentation Coordinator
2. **Daniel Scarborough:**
    - Webmaster
3. **Ajeetpal Dhillon:**
    - Documentation Coordinator
    - Hardware/Software Lead
4. **Harry Nguyen:**
    - Financial Manager
    - GUI Team Lead
5. **Sidong Guo:**
    - Software/Algorithms Lead
6. **Andrew Dulaney:**
    - Lead for graphing options on GUI