Acoustic Source Localization

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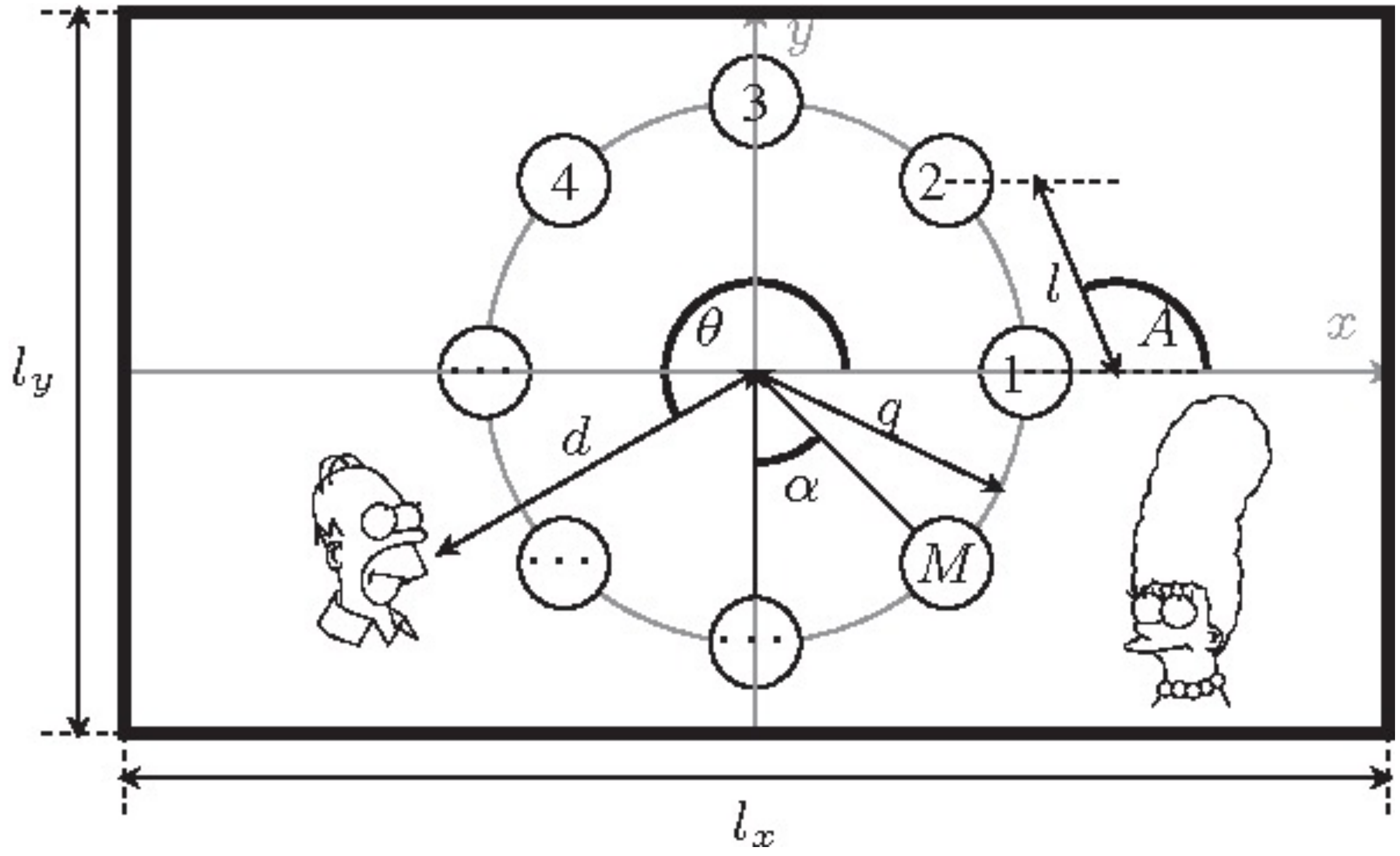
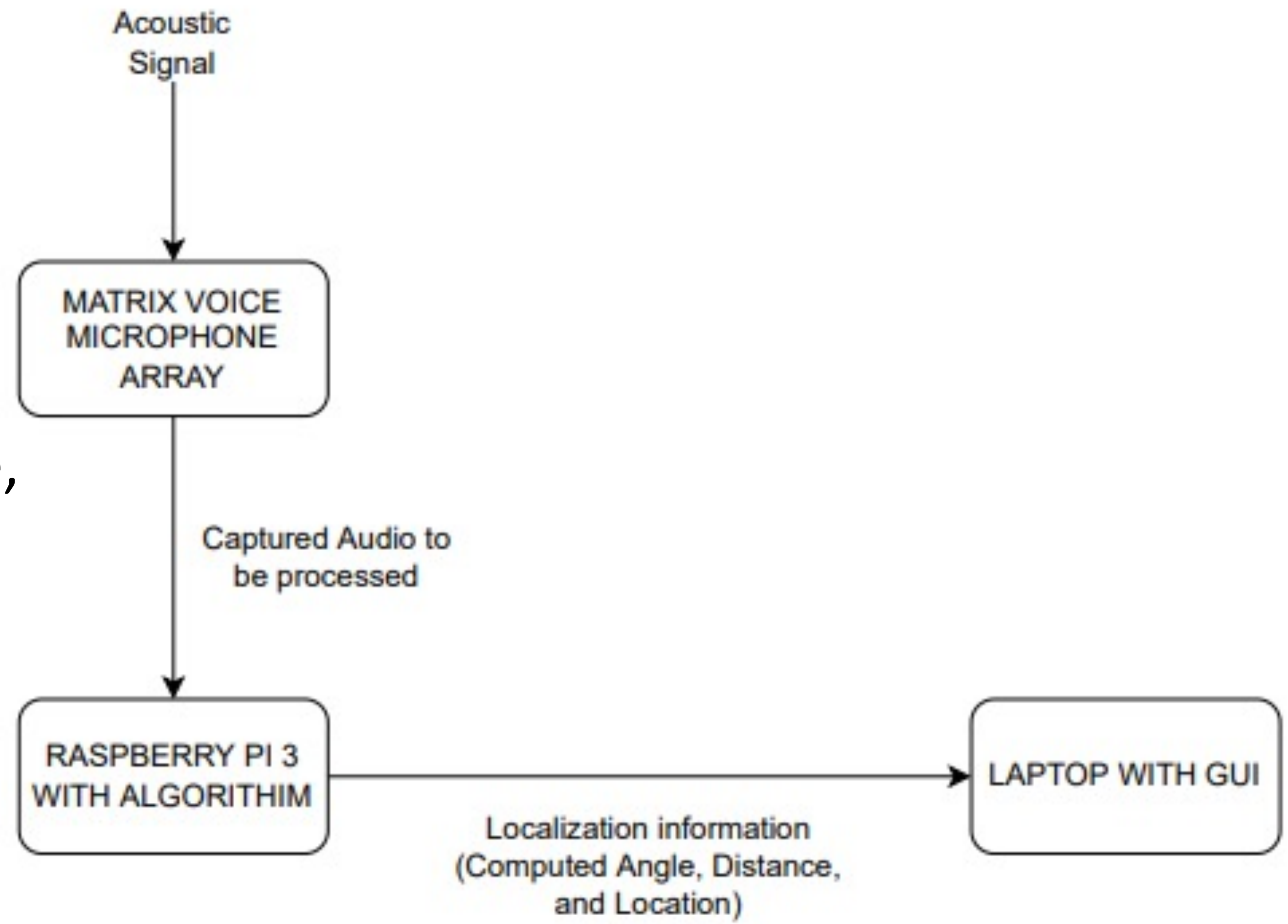


Introduction

- 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

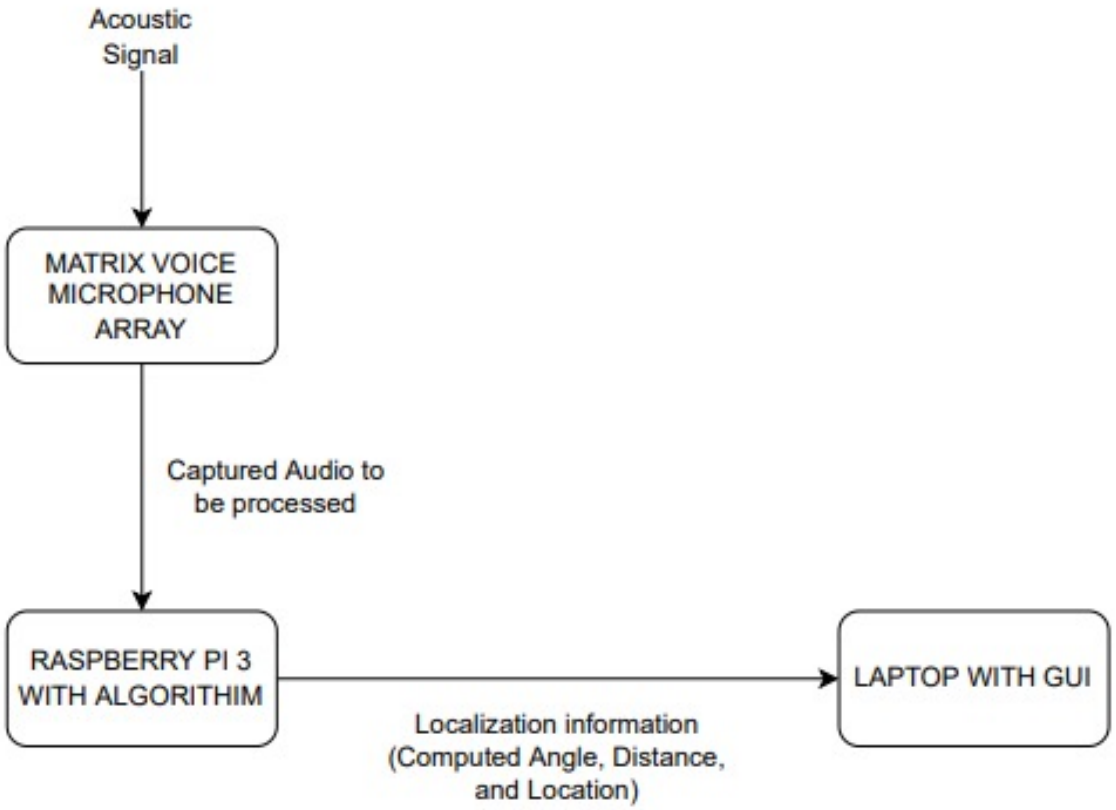
Project Description

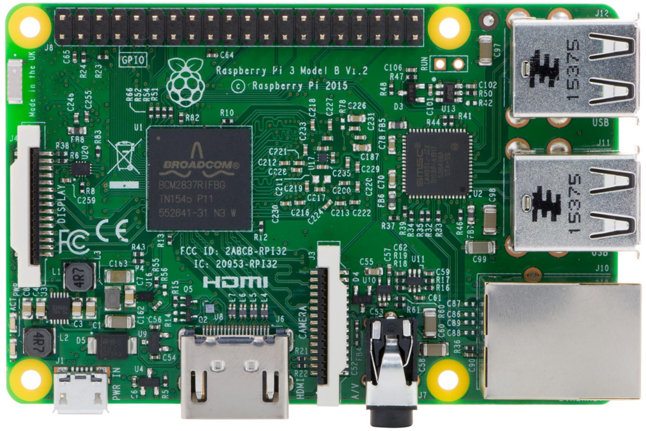
- Localization Software for Acoustic Signals
- Motivation
  - Applications in Emergency Rescue, child and elderly care
- TDOA for Angle
- Signal Strength for Distance

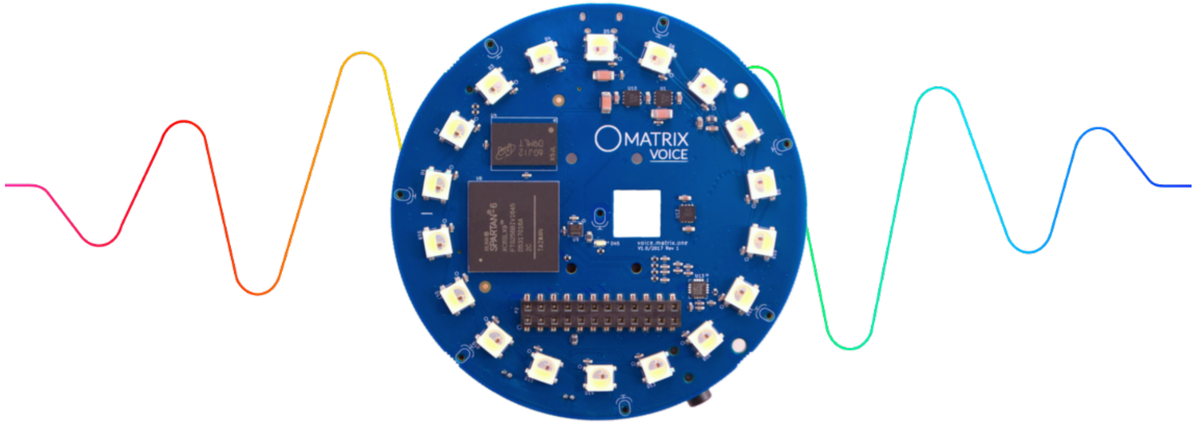


Design Details

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







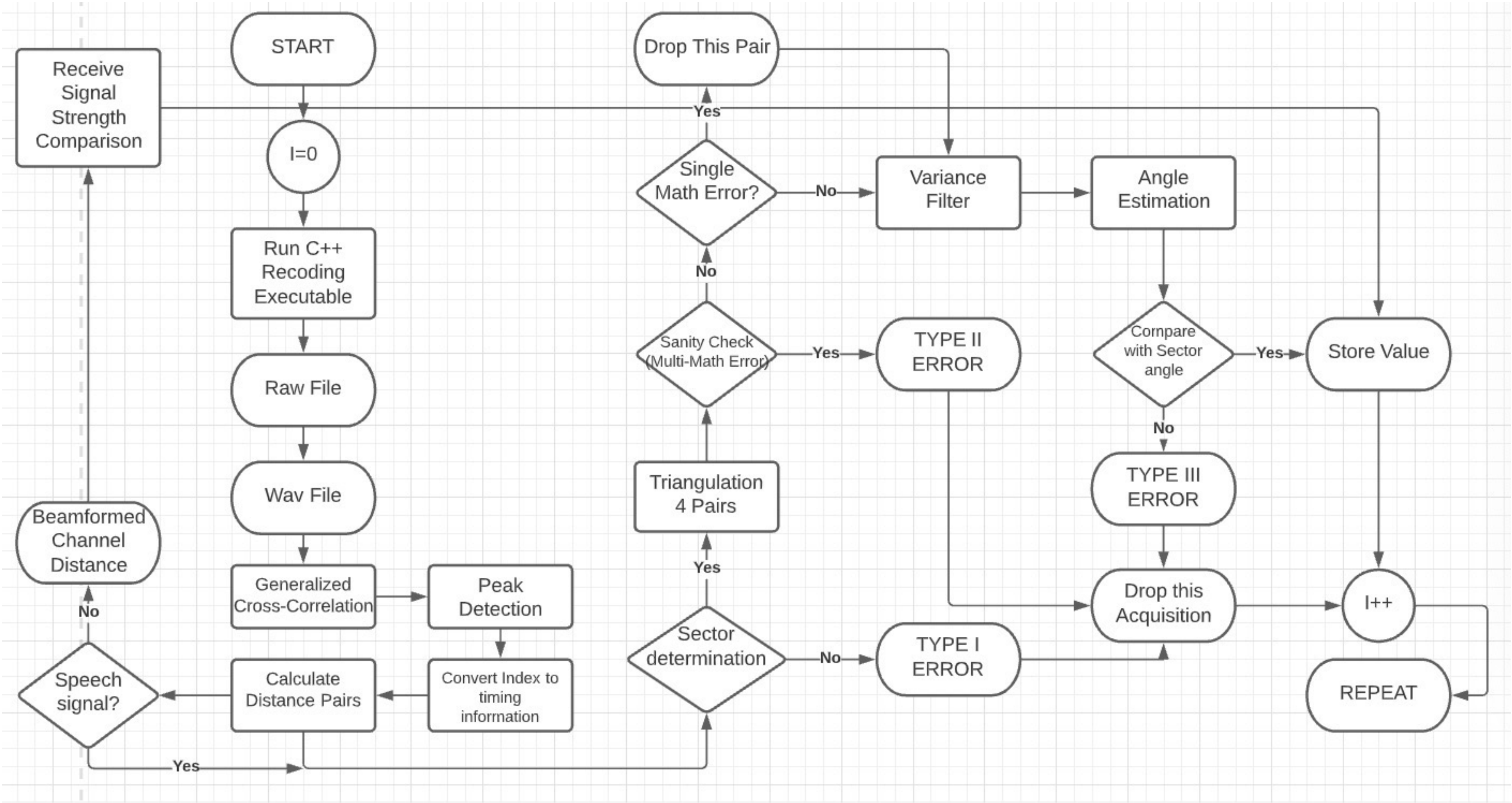
Raspberry Pi and Matrix Setup

- 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

Design Specification

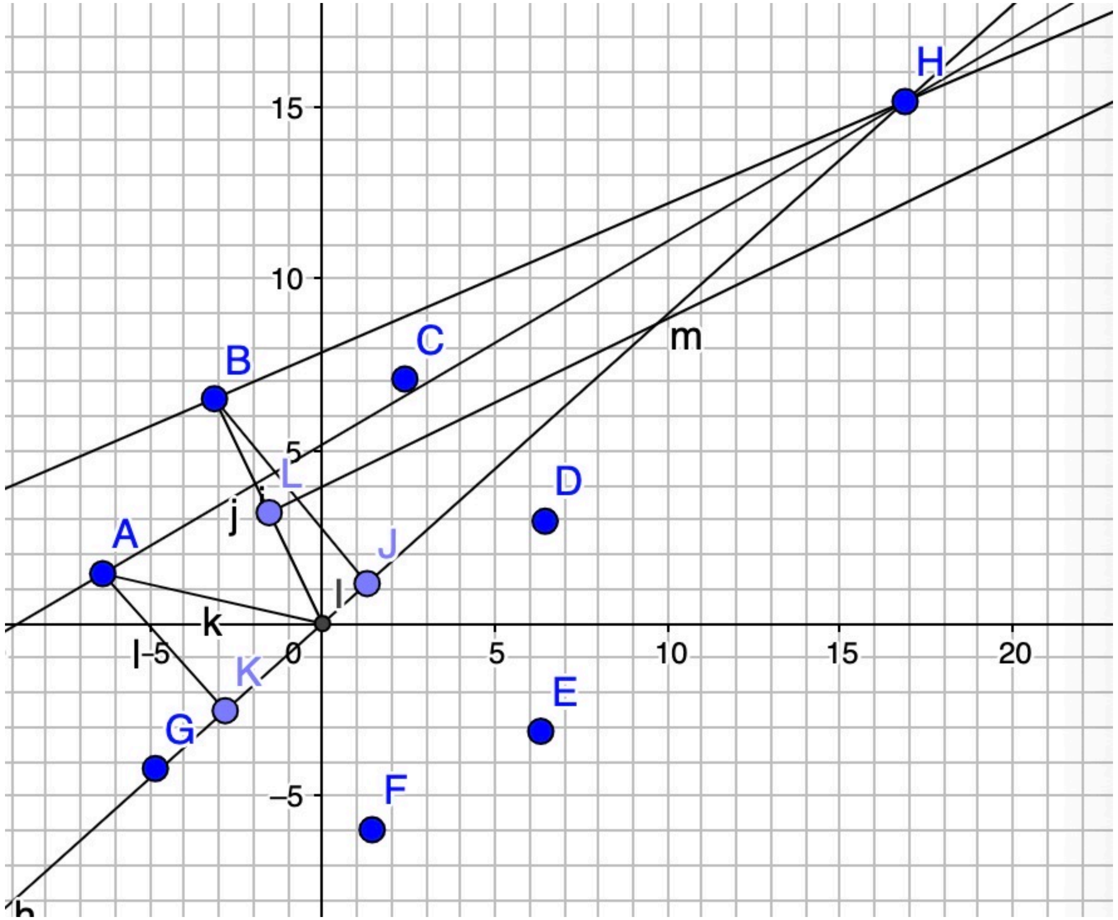
Parameters	Specifications
Audio Specification	8-96 kHz
Bit Depth	Signed 16 bits
Operation Range	20 meters
Cost	Below $200
Angle Accuracy	Average difference within 3 degrees
Distance Accuracy	Average difference within 30 centimeters
Processing Delay	Average processing delay within half second

Design Approach-Algorithm



Angle Calculation

1. Uses Pesudo Far-field Assumption
2. Average over multiple angle estimation
3. Uses an outlier filter to enhance stability
4. Uses decision-feedback to perform error correction



Comparison to other methods

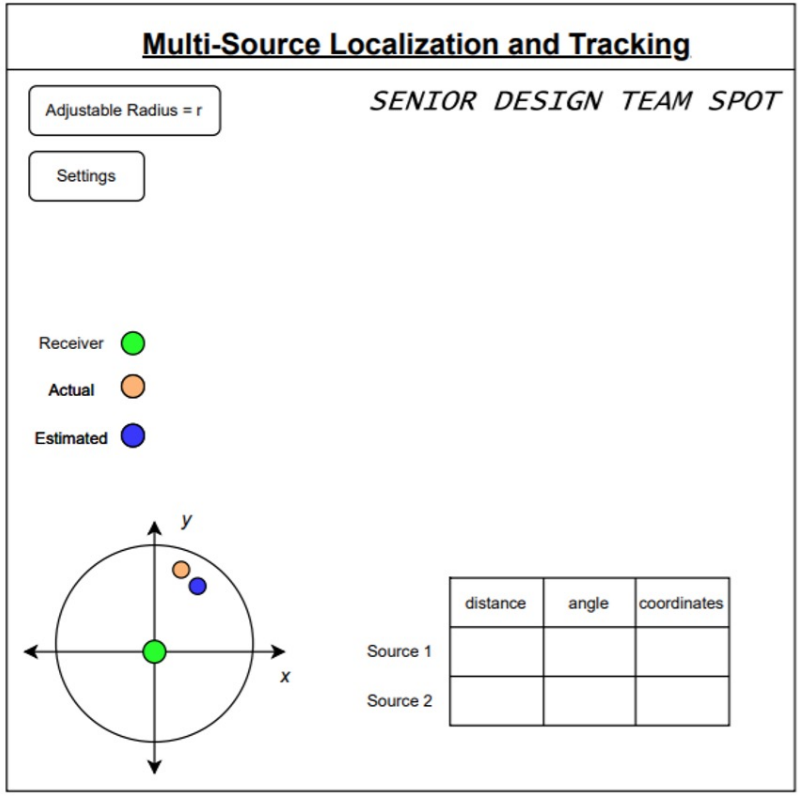
- ODAS (Open Embedded Audio System)
- Gillete-Silverman Algorithm
- Far-field Algorithm
- Closed-form approach
- MUSIC (Multiple Signal Classification)

Tracking and Multi-source

- ODAS' probabilistic approach
- Prediction->Likelihood (Prior and Posterior probability)->add and remove sources-> update.

Project Demonstration

- Video of working project
- Will provide overview of GUI
- Will test speech/acoustic signals
- Will show successful tracking algorithm
- GUI will show both actual and expected data



Schedule, Tasks, & Milestones

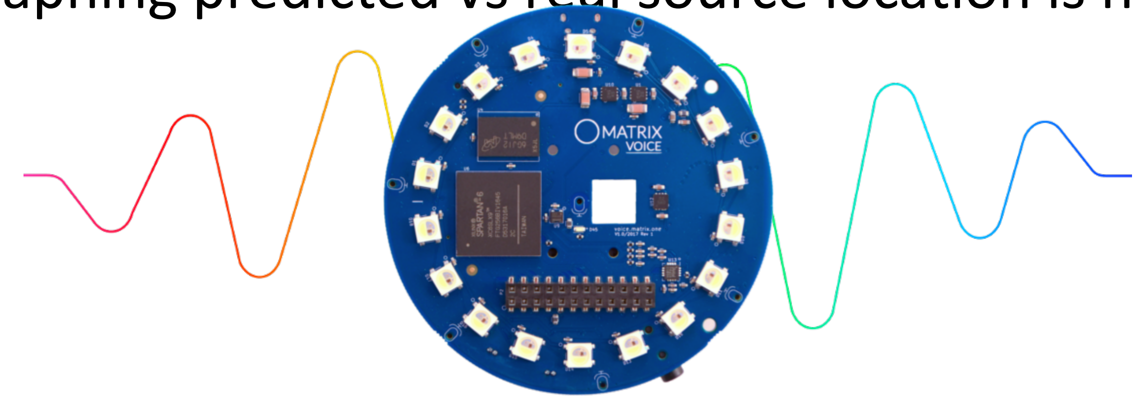
SENIOR DESIGN SCHEDULE	Week	5	6	7	8	9	10	11	12	13	14
Task											
PROPOSAL		ALL									
PROJECT SUMMARY		ALL									
GUI DESIGN			ALL (GUI)								
ORDER 2nd MATRIX			HARRY								
Design Review Presentation					ALL	ALL					
Update Project Summary					ALL	ALL					
Microphone Test			AJ								
Far-Field Test			AJ + SIDONG								
Decide on Plan A or B			AJ + SIDONG								
Build GUI (2D PLANE)			Daniel	GUI(TBD)	GUI(TBD)	GUI(TBD)					
Build GUI (Display Data)			Tiffany	GUI(TBD)	GUI(TBD)	GUI(TBD)					
Build GUI (QoL Features)			Andrew	GUI(TBD)	GUI(TBD)	GUI(TBD)					
Test GUI							GUI(TBD)	GUI(TBD)			
SINGLE SOURCE TEST				AJ+SIDONG	AJ+SIDONG						
MULTI SOURCE TEST						AJ+SIDONG	AJ+SIDONG				
TRACKING					AJ+SIDONG	AJ+SIDONG	AJ+SIDONG				
INTERFACE GUI WITH ALGO								GUI(TBD)	GUI(TBD)		
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

- Requested budget for another Matrix Voice is $90
- Collectively, about 20-25 hours per week for labor and research
  - 12 to 15 hours for research
  - 4 to 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 training is
  - Implement time difference followed by angle calculation.
  - 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
   - Software/Algorithms Lead
4. **Harry Nguyen:**
   - Financial Manager
5. **Sidong Guo:**
   - Software/Algorithms Lead
6. **Andrew Dulaney:**
   - Hardware Lead