Acoustic Source Localization

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Introduction:

- Uses a microphone that detects the location of sounds.
- Two main steps:
  - Time difference estimation
  - Triangulation
- Biggest challenge:
  - Obtaining sound location information through multilateration.

Figure 1: Original Matrix

Objective:

- Create a software that can capture incoming sounds and the position of the sound will be reflected on the GUI.

System Design:

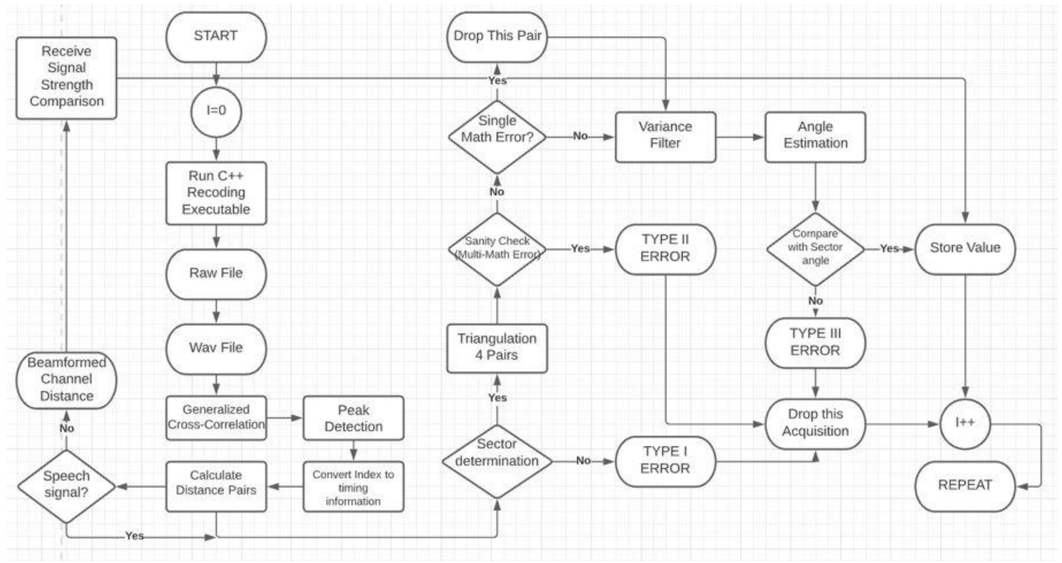

Figure 2: Software Flowchart

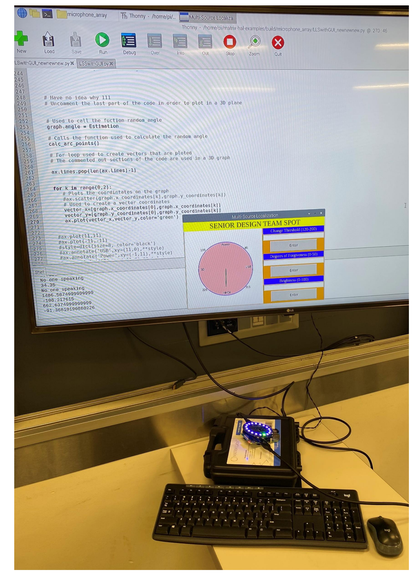

Figure 3: Matrix with GUI on Monitor

Experiment:

- Circular 8-microphone array is used to detect sounds.
  - LED lights on the array show the direction that the sound originated from.
- Algorithm uses four sets of microphone distance pairs to triangulate the source.
- Algorithm is run through a Raspberry Pi, which also feeds data back to the GUI.

Relevant Equations:

$$J(\theta) = \sum_{n=0}^{N-1} (x[n] - s[n])^2 = (x - 2H\theta)^T (x - 2H\theta) \quad (1)$$

$$\tau_{1n} c = \sqrt{(x - x_1)^2} - \sqrt{(x - x_n)^2} \quad (2)$$

$$d_1^2 - d_n^2 = \sqrt{(x - x_1)^2} - \sqrt{(x - x_n)^2}$$
$$d_1^2 - d_n^2 = x_1^2 + y_1^2 - x_n^2 - y_n^2 - 2(xx_1 + yy_1) + 2(xx_n + yy_n) \quad (3)$$

$$\tilde{\theta} = \frac{1}{2}(H^T H)^{-1} H^T x \quad (4)$$