Auditory Localization using Trilateration in Two Dimensions

Final Project in DT Signals & Systems

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Problem Statement

"*Use computer microphones from at least 3 laptops to record a 'gun shot' sound from a speaker.*"

- Develop an algorithm to determine the location of "gun shot"
- Vary the volume of gun shot, the distance of "gun shot" to study the robustness of your algorithm
- Add different background noise to the "gun shot" data, then analyze your performance of algorithm

Problem Approach

Use a microcontroller to sample three microphone sensors and use trilateration to find the source of the sound (in this case a buzzer triggered by an interrupt).

Two approaches:

Amplitude - find a predictable relationship between distance and amplitude, then run the trilateration.

Time Diff - detect the differences between arrival times and multiply by the speed of sound to find the distance.[1]

Definition

Trilateration is a localization method which uses known points and their distances to an unknown point to find it.

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[1]343 m/1000 ms

Data Collection - Experiment Setup

Figure: Sensor arrangement.

Data Collection - Experiment Setup

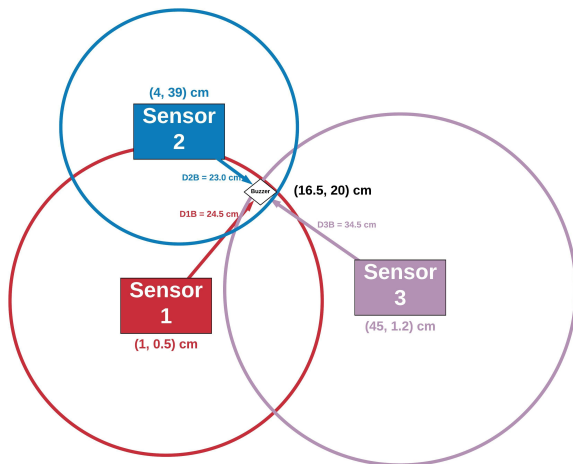Figure: Sensor arrangement explained.

Data Collection - Experiment Setup

Figure: Experiment diagram.

Figure: Data collection results[2].
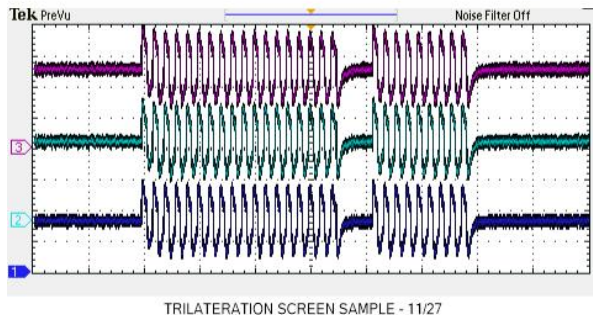
Data Collection - Experiment Results

Believe it or not, there is a delay in the arrival times of the audio samples, allowing us to apply the time difference approach.

Data Analysis - Data Preparation

Figure: Oscilloscope data export format.
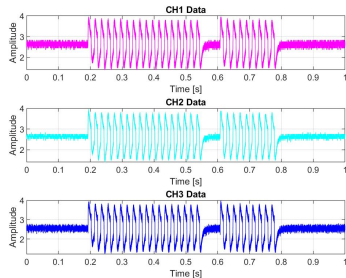
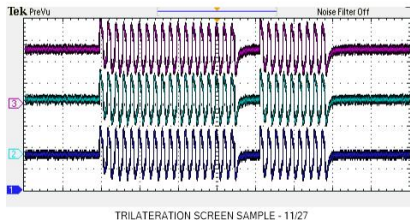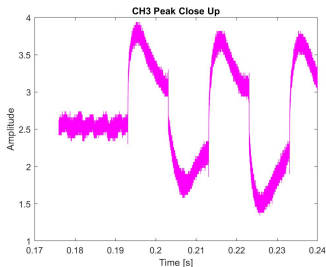# Data Analysis - Data Preparation

Figure: Comparison of data import.

Data Analysis - MATLAB Synthesis

We can use findpeaks() to locate extrema in the data.

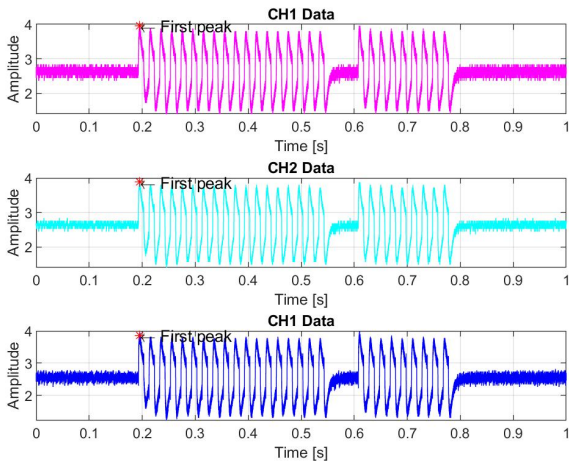# Data Analysis - Results

Figure: MATLAB peak search results.
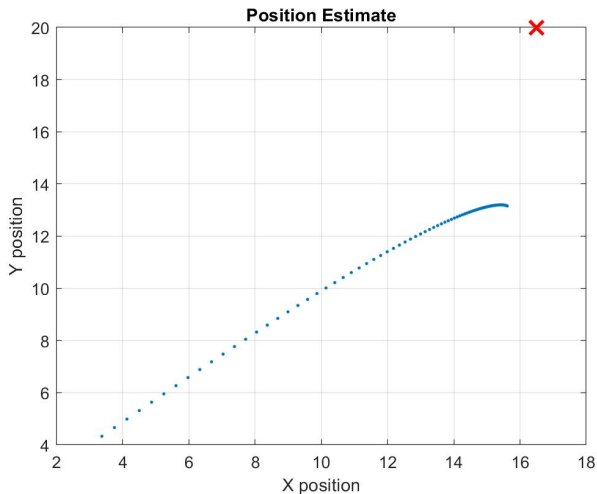
Data Analysis - Results

Figure: Trilateration results.

Going Further

There are several areas for further development:

- Use the envelope to utilize the amplitude approach.

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Questions?