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| Milestone report 2 |  |
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|  | 07 Sep. 23EEE3097 |
|  | Travimadox Webb Best NkhumeleniRumbidzai Mashumba |

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# Introduction

The Time-Difference-of-Arrival (TDoA) algorithm stands as a fundamental tool in sound source localization, allowing us to discern the origin of sound in our environment. By harnessing the capabilities of multiple microphones and meticulously measuring the temporal disparities in sound arrival at each sensor, TDoA provides a means to approximate the directional source of acoustic emissions.

In the pursuit of advancing our understanding and application of sound source localization, this milestone endeavors to construct a comprehensive simulation. The objective is to craft a simulation environment that emulates our real-world system with the utmost fidelity. Our aspiration is to render this simulation as faithful and precise as possible, replicating the intricacies and nuances that typify real-life scenarios. In doing so, we embark on a journey to uncover insights and enhance the robustness of sound source localization in practical contexts.

# Admin Documents

## Contributors table

|  |  |  |
| --- | --- | --- |
| **Name** | **Contribution** | **Percentage** |
| Best Nkhumeleni | Report Writing |  |
| Rumbidzai Mashumba | Results analysis |  |
| TraviMadox Webb | Simulation Setup  ATPs |  |

All of our code is on our [GitRepo](https://github.com/Travimadox/AcoTriangulator) //cant seem to find our git repo, so I have travis linked for now

## Timeline and progress

Insert timeline here.

# Simulation setup

### Simulation Environment and tools used.

Our simulation comprises four distinct MATLAB scripts, each serving a unique purpose:

1. **TDOA2 - Single Sound Source Localization:**

This script is designed to simulate the localization of a single sound source. It calculates the approximate position of the sound source and provides a visual representation of its location.

2. **TDOA3 - Multiple Sound Source Localization:**

In contrast to TDOA2, this script focuses on scenarios involving multiple sound sources. It enables the simulation of localization for multiple sound sources simultaneously and provides visual outputs displaying the approximate positions of each source.

3. **TDOA4 - Impact of SNR (Signal-to-Noise Ratio):**

This script assesses the performance of our localization system in varying levels of noise. By manipulating the SNR, it allows us to understand how the system's accuracy is affected under different noise conditions. This analysis is crucial for evaluating the robustness of our sound source localization approach.

4. **TDOAIMPACTOFNOISE - SNR and Performance Analysis:**

This script builds upon TDOA4 and is dedicated to a more comprehensive analysis of the impact of noise on our localization system's performance. It quantifies the system's accuracy and reliability in the presence of noise, making it an essential tool for evaluating the real-world applicability of our localization method.

We opted to use MATLAB scripts for our simulation because they allow us to replicate the entire data transmission process seamlessly. This process involves data being collected by microphones connected to a Raspberry Pi, then pre-processed on the Raspberry Pi, and finally transmitted to a laptop for the last stage of processing and display.

In our simulation, we can accurately simulate this entire data transmission sequence by introducing well-defined random delays. This approach ensures that we account for and replicate the real-world behaviour of the system, making our simulation a faithful representation of the actual data flow and processing.

We made the assumption that there would be negligible or minimal delay between the final data processing and the data display stage. This assumption is based on the fact that the final processing step is expected to be rapid and efficient, having little impact on the overall performance of our system. Therefore, we focused our simulation efforts on the more critical components of data transmission, preprocessing, and their associated delays, as these are the key factors influencing our system's behaviour.

# System Design and Implementation:

# Simulation Results and Analysis:

When the SNR goes up, the system gets less accurate.

A graph of noise level and signal level

Description automatically generated

A graph with a line

Description automatically generated

The biggest contributor to error in position of the sound source, is the synchronization delay between the pi’s

Transmission and processing of data can fairly reliably be modelled by random well bounded delays.

# Evaluation (ATPs):

I’ll use the ones Travi made since that got full marks.

# Conclusion:

In conclusion, our research underscores two fundamental principles for optimizing sound source localization systems. First and foremost, we have established the paramount importance of minimizing noise interference. Noise, in all its forms, poses a formidable challenge to the accuracy and reliability of sound source localization. Our findings emphasize the need for comprehensive noise mitigation strategies to enhance the efficacy of these systems.

Secondly, we have underscored the critical role of synchronization in the context of Raspberry Pi devices. Achieving precise synchronization is pivotal to ensuring the integrity of data acquisition and processing. It serves as the linchpin in our pursuit of accurate sound source localization.

As our research journey draws to a close, we leave with a clear directive: to continue refining and expanding upon these principles. In doing so, we can propel the field of sound source localization toward greater precision and applicability, ultimately enhancing its utility in diverse real-world scenarios.