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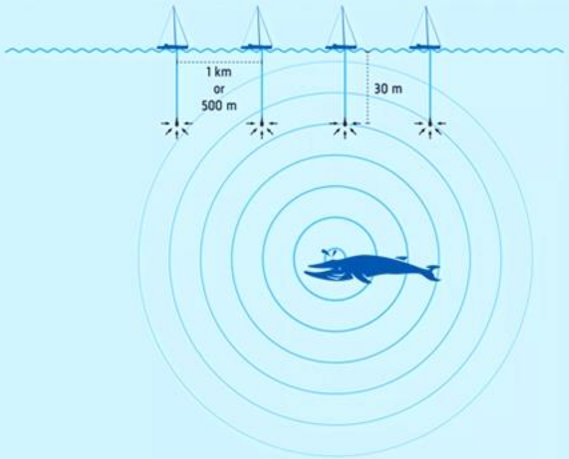


UNIVERSITÉ DES MASCAREIGNES
SAVOIR, C'EST POUVOIR

Localization and tracking of moving targets by **hydrophones**

MASTER ARTIFICIAL INTELLIGENCE AND ROBOTICS

MR. KHADIMOULLAH RAMOTH / PROF. OUIDDAD LABBANI IGBIDA

SEMESTER 2 – 2023

HEMANT **RAMPHUL**

I21913

Agenda

- Introduction
- The tasks accomplished in the S1.
- The aim of the project S2.
- Localization Techniques
  - Sound localization and target
  - Design concept
  - Hardware Block Diagram
  - Live data in Matlab via Arduino (Experiment and Result)

Introduction

- **Localization and tracking of moving targets by hydrophones:** technique to determine position and motion in water through analysis of received sound signals.

- **Triangulation**: Placing hydrophone array at different locations to determine sound source position and track movement.

- **Localization and tracking process**:
  - Signal processing: Filtering, analysis, and feature extraction from acoustic signals.
  - Acoustic modeling: Estimating acoustic propagation properties of underwater environment.
  - Numerical methods: Beamforming and time delay estimation for direction and time difference of arrival estimation.

The tasks accomplished in the S1.

- Research delves into the comprehensive exploration of hydrophones, encompassing their characteristics, technologies, and wide-ranging applications.
- The methodology utilized for the localization and tracking of a target. *(Triangulation technique with 3 hydrophones)*
- The implementation involves establishing the structure and determining which algorithms to use.

The aim of the project S2.

WHAT?

To accurately identify the source location of a sound.

WHERE?

In a spatially segmented environment.

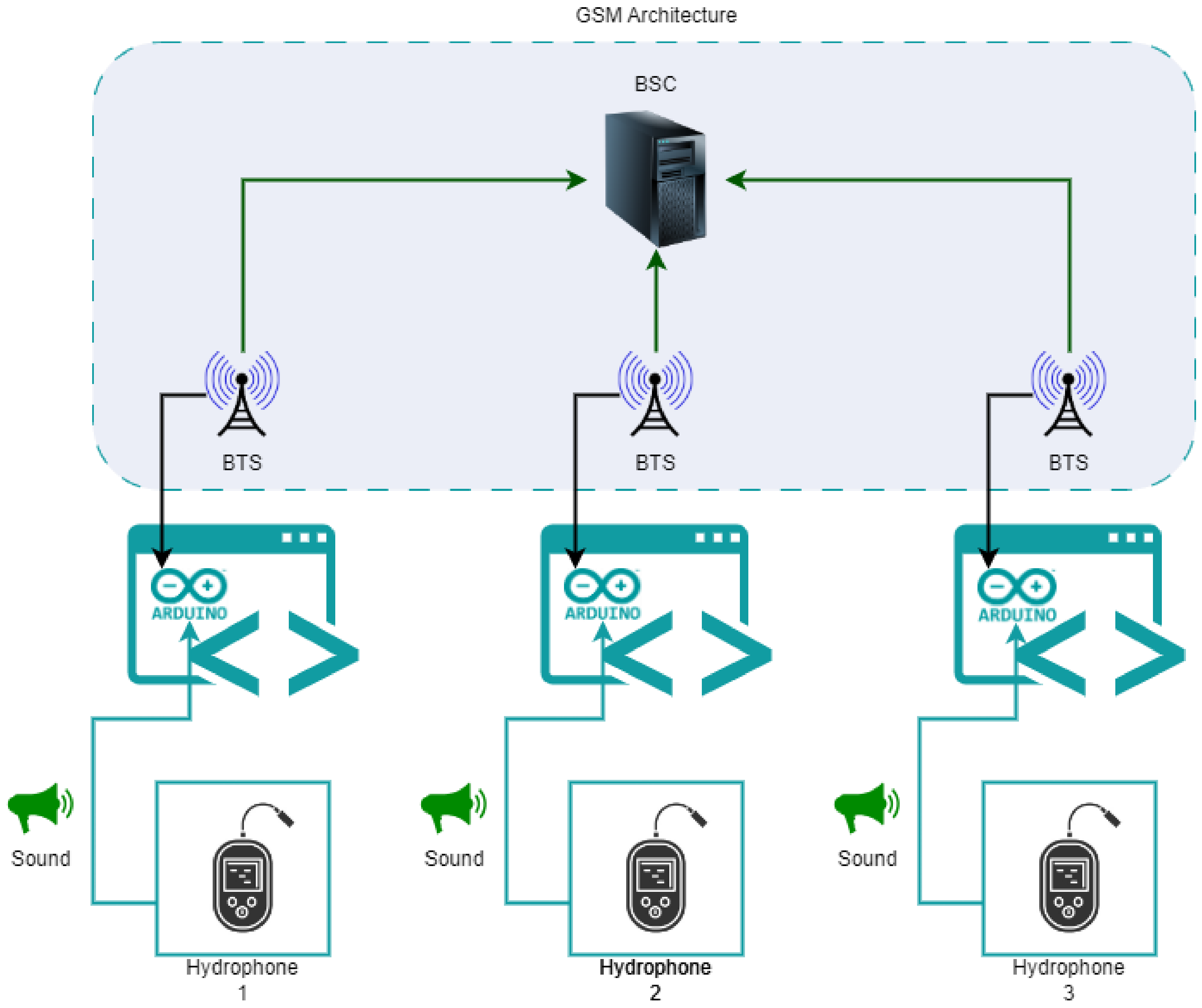
HOW?

By employing hydrophones (*microphones used for experimental purposes*) and measuring the sound intensity.

Sound localization & target

Prototype

- Hydrophone Localization and Tracking System
- Data Transmission
- GSM Module Integration
- Remote Monitoring and Control
- Data Management and Analysis

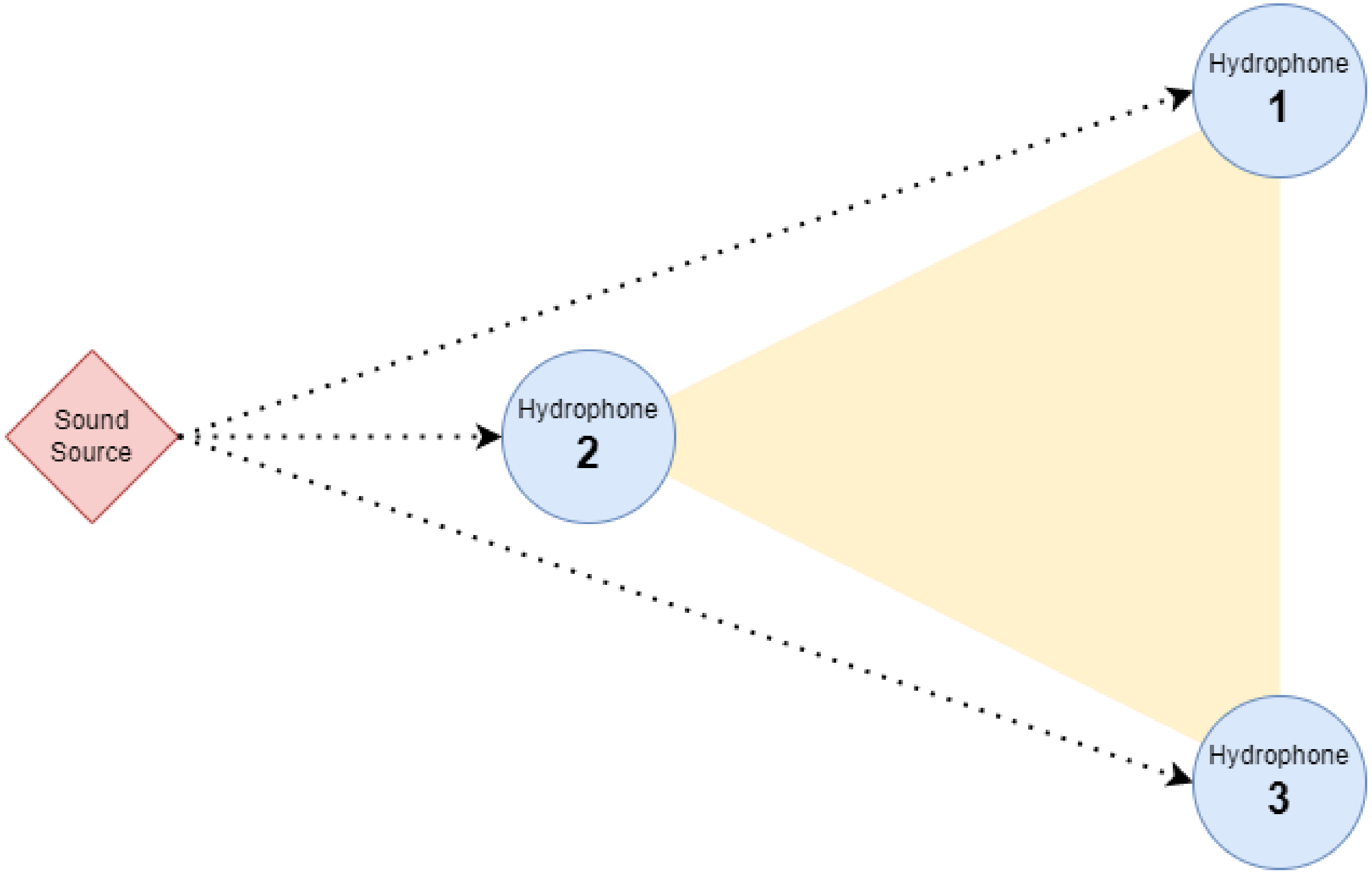


Sound localization & target

Design Concept

Important Note:

Sound localization based on an acoustic source using **multiple microphone array** (instead **hydrophone array**) in an indoor environment

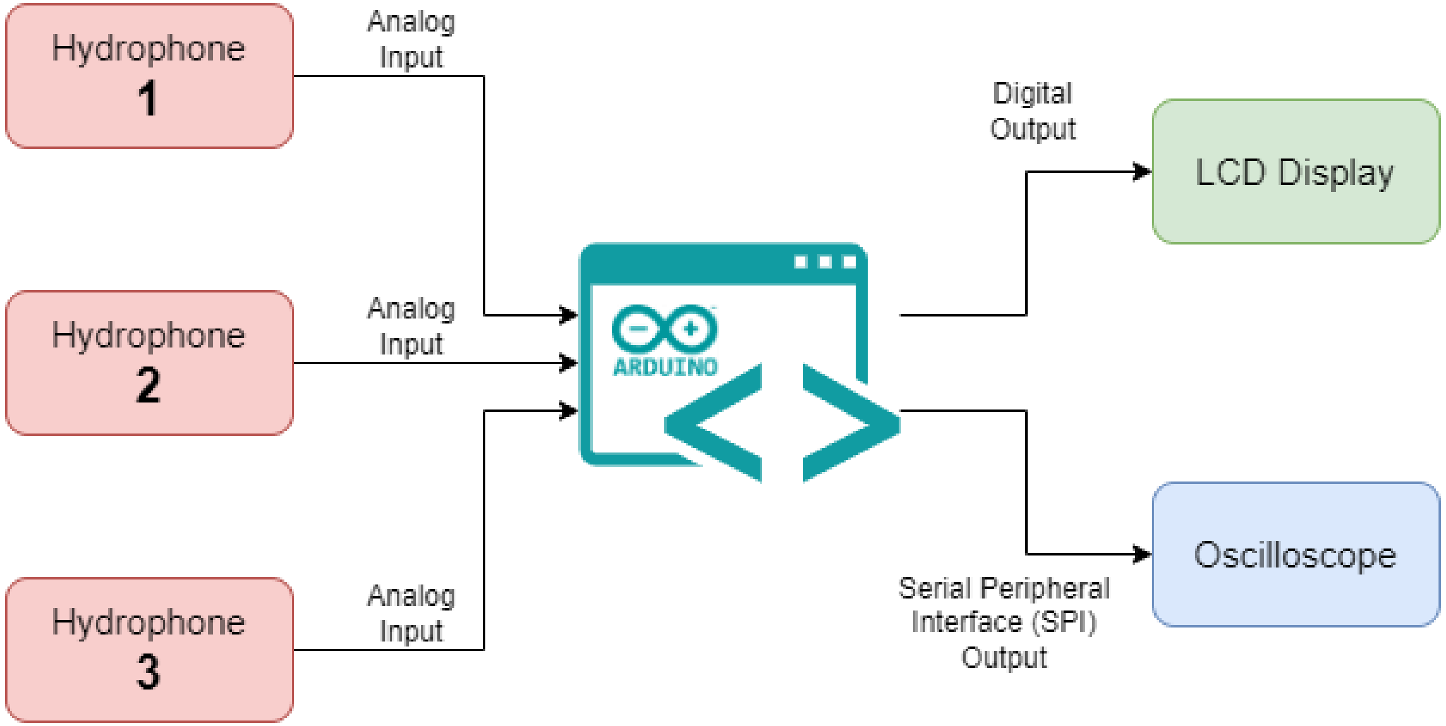


Sound localization & target

Hardware Block Diagram

Prerequisites:

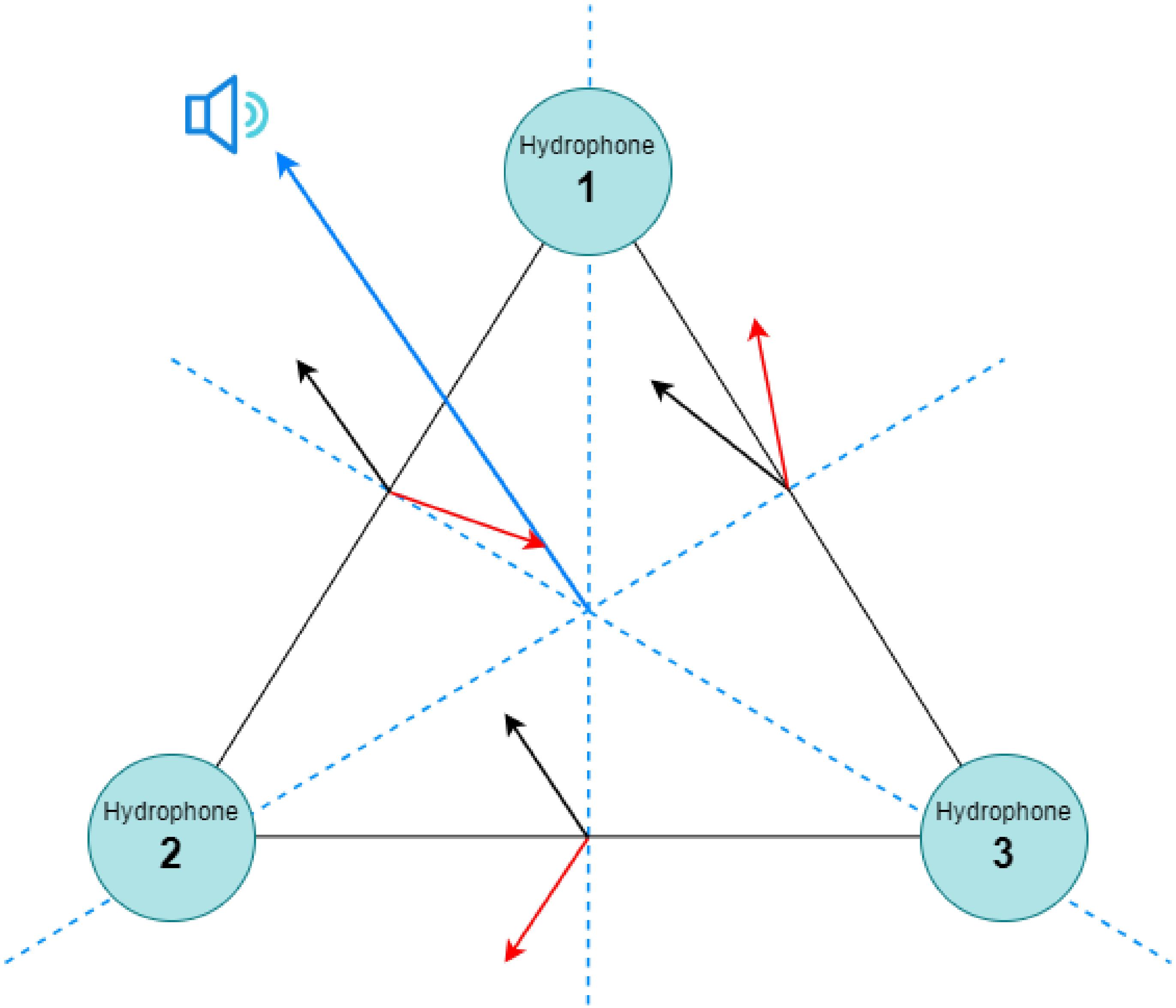
- **Arduino IDE**
- **MATLAB** for computation and demonstration
- Calibration process of the **microphones** (instead **hydrophones**)



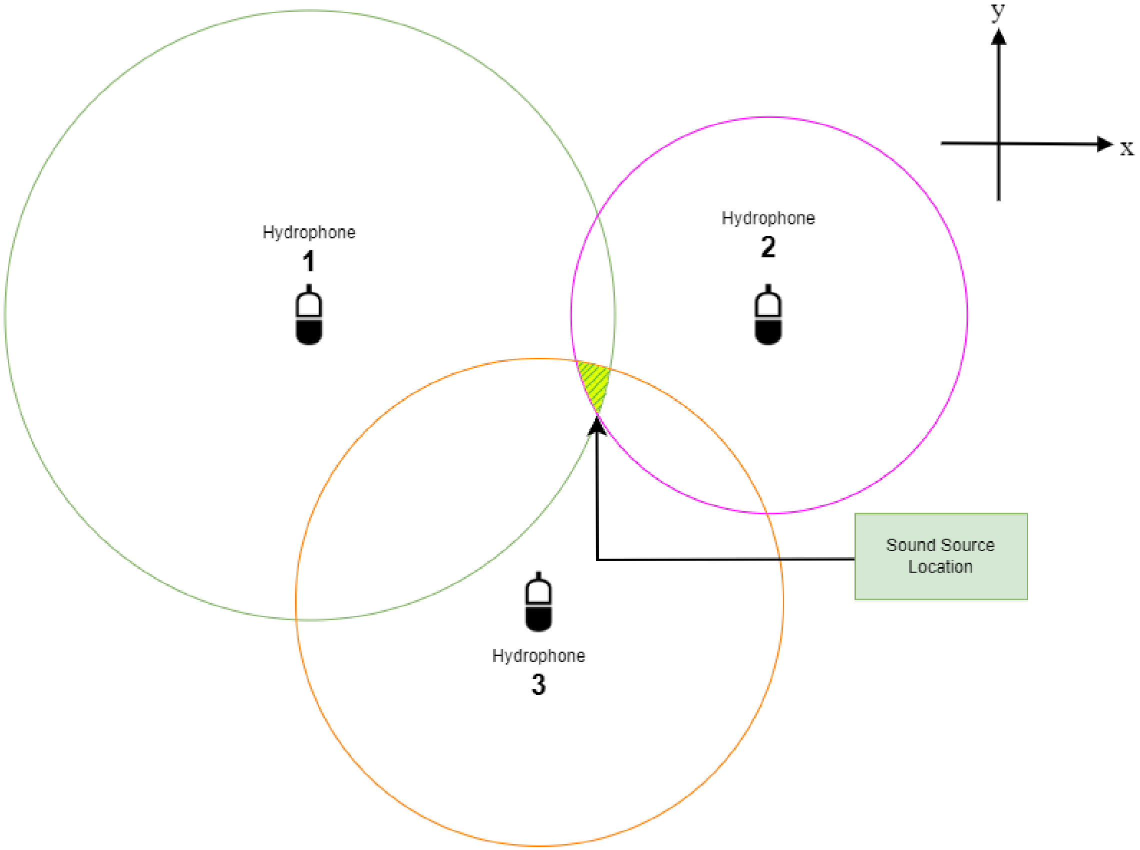
Sound localization & target

Mathematical technique

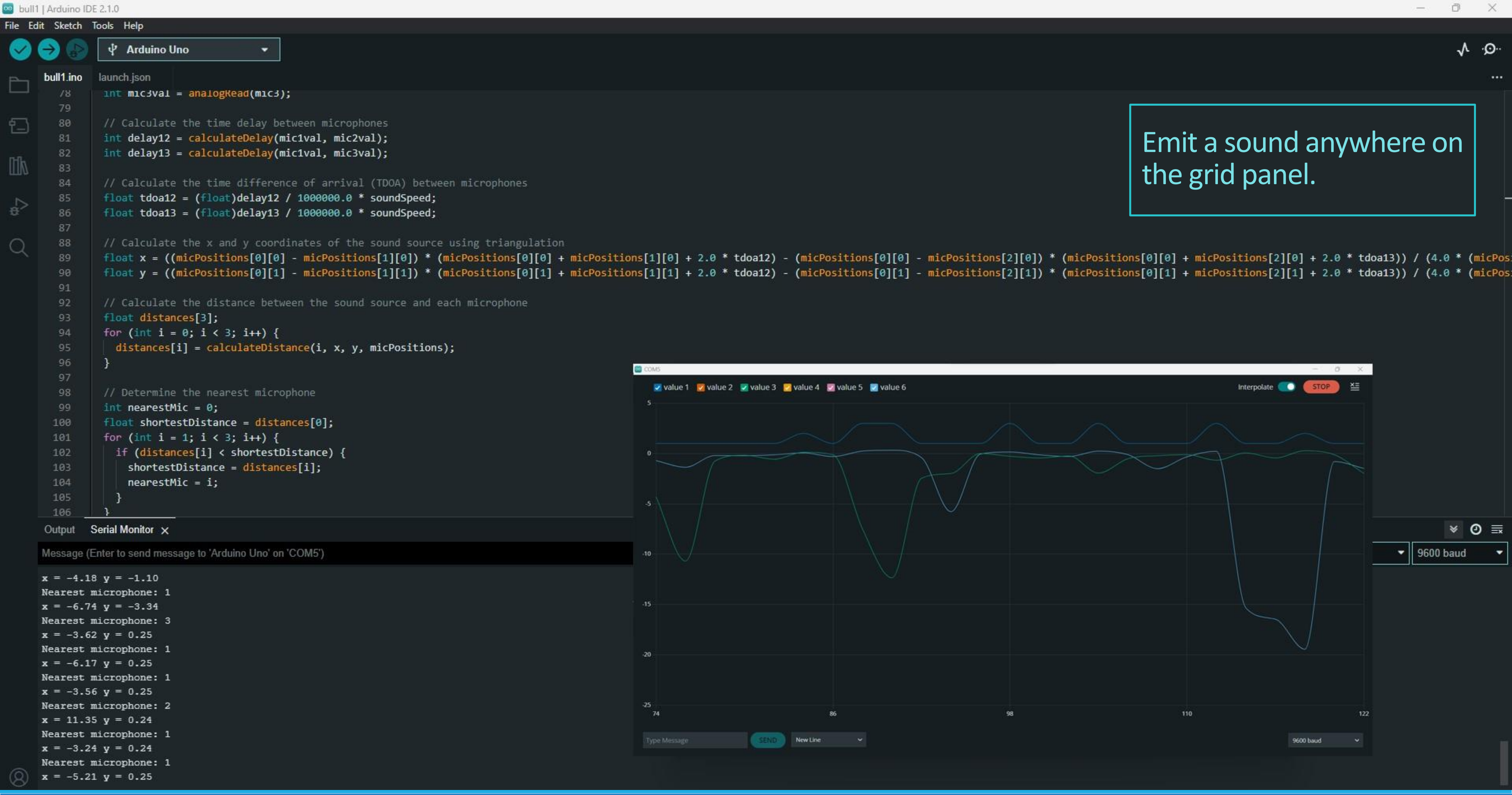
- Cross-correlation technique.
- To compute the time delay between two signals.



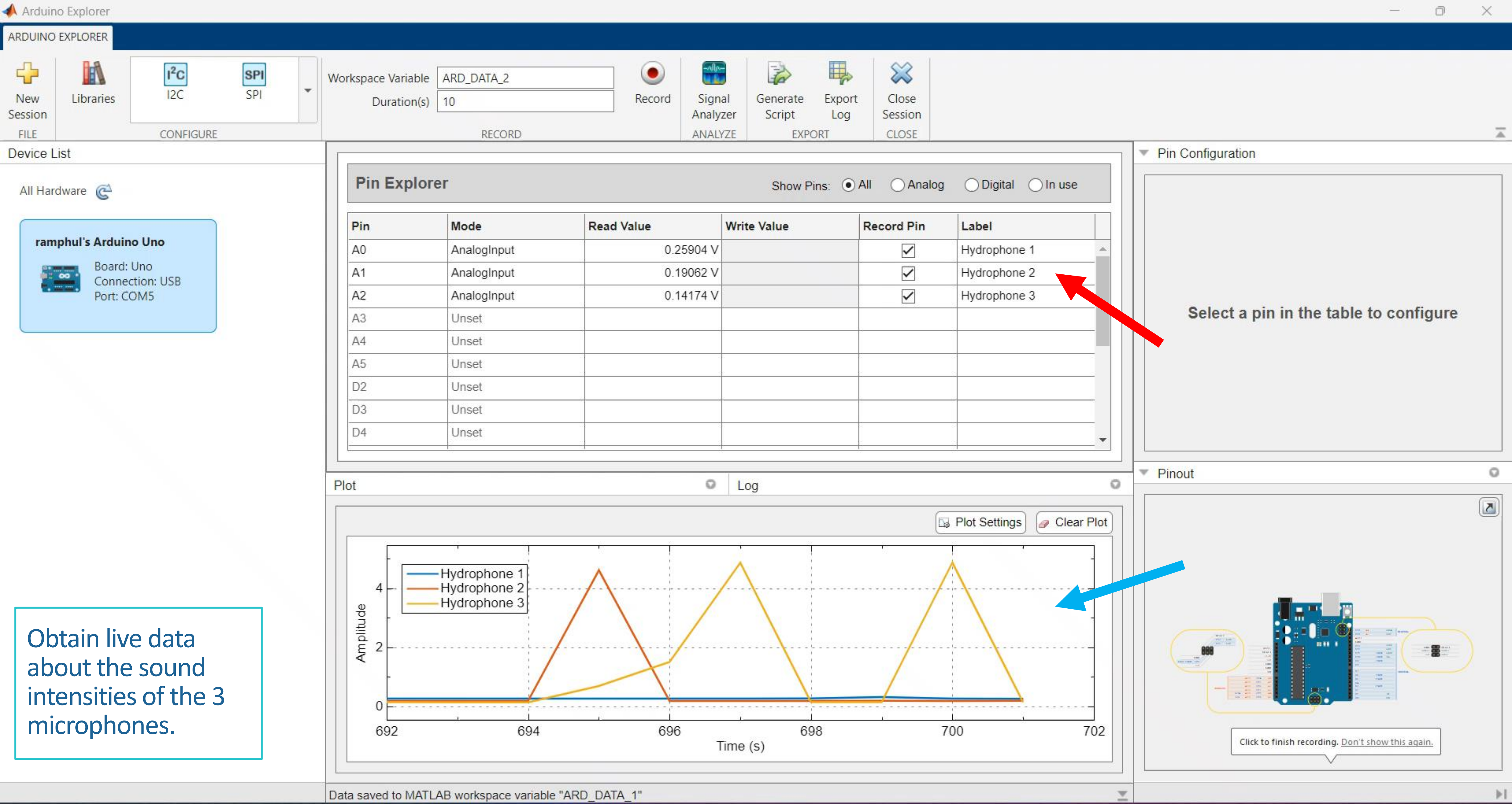
Sound localization & target
The approach



Calculate	Scale down	Display
Calculate the distance between the source and the sensors.	Scale down the results until the smallest probable non-zero area for the location of the sound source is found.	Display a simplified map containing the results.



Emit a sound anywhere on the grid panel.



Obtain live data about the sound intensities of the 3 microphones.

Live data with time and spectrogram analysis

Further development

Better performing hardware.

An uninterrupted process.

Positioning microphones further away.

Conclusion

- Understanding the principles of target localization and tracking has been achieved.
- The algorithm operates within a limited space using the triangulation method with a basic algorithm.
- This approach can yield greater efficiency when employed with recommended equipment and in an appropriate environment.
- Overall, this project has provided valuable insights and expanded knowledge in various aspects of the field.

THANK YOU