ADA - Acoustic Detection Array

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A sonic impulse detection system

Background

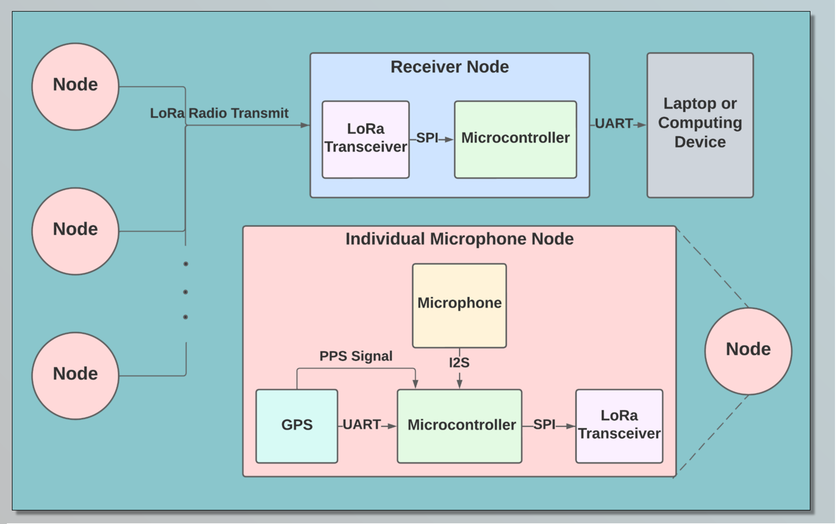
Our project aims to solve multiple location finding problems related to poaching in the wild, blast fishing, and other alarmingly loud sounds.

Overview

We will accomplish this by constructing multiple devices each armed with acoustic sensors and communication equipment. This will allow us to accurately and precisely locate the origin of a high impulse acoustic sound. Our project involves the design and construction of a complete array of nodes utilizing various hardware parts, a unique PCB, and software signal processing algorithms.

Functional Flow Diagram

The project uses multiple acoustic detection nodes that are deployed in a field. The individual nodes wirelessly transmit the timing and waveform of the detected sound to a central node that processes this information to determine the origin of the noise.



Software - Nodes

Each node should only send data to the central node if it detects an impulse. It is difficult to directly use a magnitude threshold for this because that is prone to error from nearby noises such as wind, talking, etc. To improve this, we implemented a filtered moving average threshold that filters for specific impulse frequencies that we want to detect.

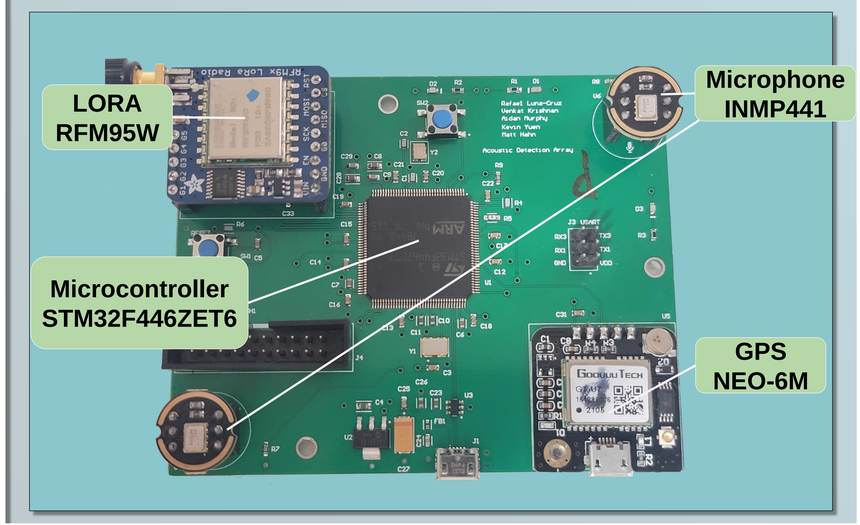
Software - Multilateration

Solver
A SymPy numerical Solver is used to make guesses about the origin of sonic events

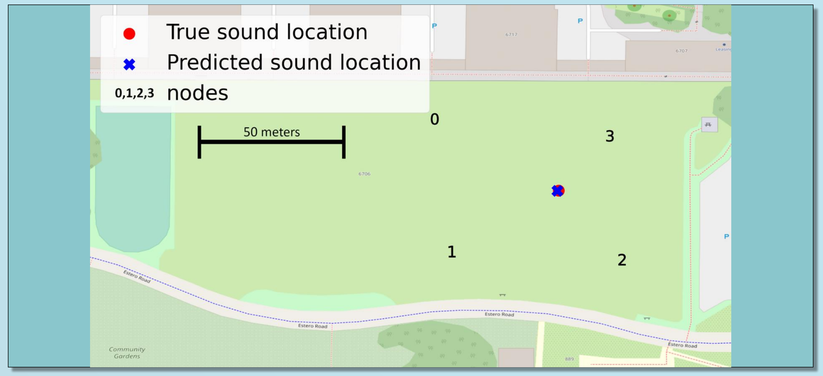
Equation Culling and Fitting
A Scipy least squares regression tool is used to fit the guesses to an origin point

Printed Circuit Board

The PCBs are each hand-assembled, with pins for ST-LINK debugging, programming, and data collection.



Field Test Results



The test displayed above was conducted with nodes at a range of 60 meters. Numerous tests indicate that predictions made by the ADA have a maximum error of 9 meters. As the distance between nodes increases, this error remains the same. Some amount of error is unavoidable in our application due to the lack of precision from GPS coordinates.

Conclusions

During the production of this product, we experienced challenges involving creating an accurate setup, since it is difficult to find an isolated area where we can freely create large impulse noises. Thus, we tested our device with a quieter 120 dB sound, which lowered the range of detection. However, if we used a larger impulse such as a gunshot at 150 dB, we would be able to detect this up to 1000 meters away based on the rate at which sound decays. Thus, these parameters are favorable for deployment in the real world where our system will accurately locate impulse noises.

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