ACOUSTIC FINGERPRINT LOCALISATION

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AIMS

Project Goals

Through the use of Thingy:52's microphone sensor, this project aims to localize a user's position within GP South on levels 1 and 2 by analyzing acoustic background spectrum (ABS). The goal is to develop an AI model that can accurately identify, the level, room, and location within the room.

Key Performance Indicators (KPI)

1. Thingy:52 can record audio data for up to 30 seconds
2. 90% of the audio data can be broadcasted over Bluetooth from the Thingy to the PC (32KB per second)
3. AI model can classify audio data with at least 70% accuracy
4. M5 Core2 can visually represent all 20 of the available locations in GP South when indicated by MQTT
5. Room localisation is accurate up to 2 metres.

SYSTEM OVERVIEW

The system is organised into 4 parts:

1 Thingy:52

The thingy is a sensing module that provides audio data to the system. It:-

- Reads microphone data into an audio buffer, and
- Advertises the audio data via Bluetooth GATT

2 GUI

Users interact with the system through the pc GUI, it processes the raw audio data and uses the AI classifier (ABS Mind) to determine the location.

System Diagram
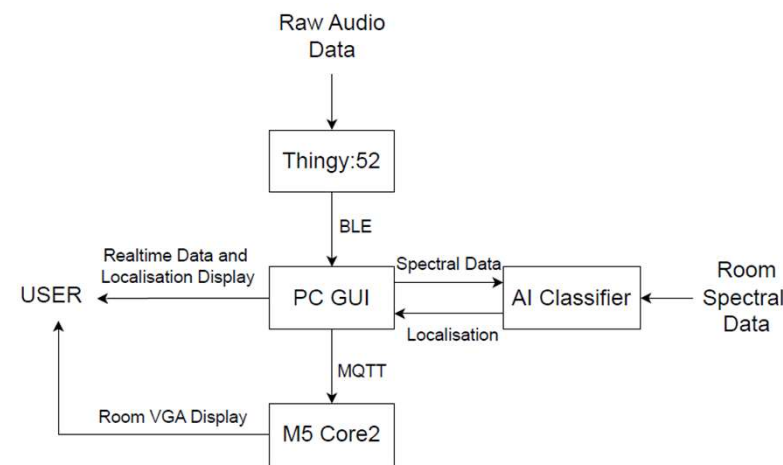
A layout of the system interactions

3 ABS Mind

The ABS Mind is a k-Nearest Neighbours (k-NN) classifier used to process input and predict the location identifier based on the Fourier Spectrum of audio samples. The program:

- Preprocesses input training data with Fourier Spectrum analysis,
- Trains itself with increasing values of k to determine the most accurate k-NN model,
- Self-serialises to save on training time, and
- Outputs it's best guess as to the location of the user based on the ABS.

4 VGA Monitor

The VGA Monitor, built on the M5 Core2 platform, offers a visual display of the ABS mind location prediction with a corresponding colour for easy identification.

RESULTS

Thingy:52 Audio and Bluetooth

After successful configuration, the Thingy52 has the ability to:

- read audio acoustics at 32KB per second, and
- broadcast the data over Bluetooth General ATTribute to the base node PC at ~6kB per second.

Although the audio can still be interpreted, the PC only receives less than 19**%** of the data. it is irregular and somewhat inaccurate as a result.

ABS Mind Audio Classification

The ABS Mind:-

- Can read up to 500 audio samples
- Perform audio analysis within 10 seconds
- Can self-serialise and load pre-existing ABS Mind objects for faster predictions
- Can classify AudioMNIST data with a success rate of 42%
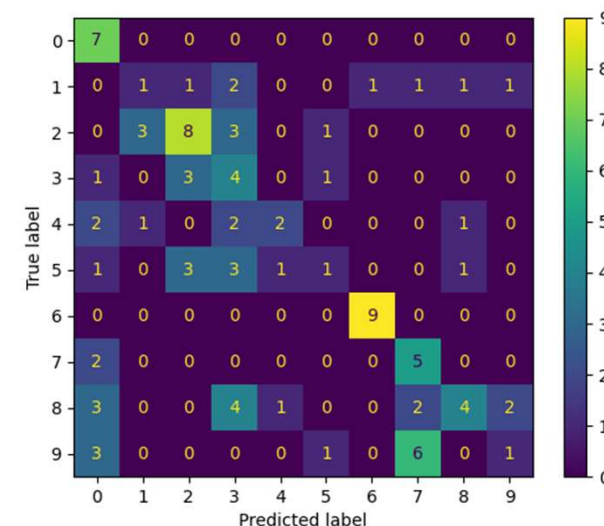
The ABS Mind confusion matrix (k=49)

VGA Monitor

The VGA Monitor could display location information and colour.

CONCLUSIONS

The project was able to meet 2 of the KPIs, made good progress on 2 others and failed 1:

1. The Thingy:52 could record up to 30 seconds of data – **PASSED**
2. Less than 90% of the audio data could be received – **PARTIAL**
3. The AI Model could classify with a success rate of 42% - **PARTIAL**
4. The VGA Monitor visually displayed the 20 locations – **PASSED**
5. Room localization could not be performed – **FAILED**

Summary

The project did not meet the KPIs set forth. Progress was made in several key areas, but the project was unsuccessful in integrating the modules together.

Future works should focus on:

- Improving data transfer between the microphone module and GUI
- Investigating alternatives for BLE communication or
- Attempting to increase the advertisement size of the data.
- Data preprocessing in the AI model could be improved by increasing the sample resolution of target frequencies.