SMART INDIA HACKATHON 2024

Ministry/Organization :DRDO, Ministry of Defense

PS Number: SIH1651

Problem Statement Title: Microphone array-based direction of arrival for gunshot detection

PS Category- Software

Team Name: Sonic Aimers

Team Leader Name: Prince Kumar

Institute Code: U-0953

Institute Name: Indian Institute of Information Technology Bhagalpur

Theme Name: ShotSense

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ShotSense - Real Time Gunfire Detection

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IDEA / SOLUTION :

Implementation of a **ShotSense** for the detection of direction of arrival for gunshot.

- 8-microphone array captures sound, with **signals processed by FPGA** for gunshot detection. After analog-to-digital conversion and bandpass filtering, the direction is determined using triangulation.
- A **thermal camera** captures the initial gunshot event, providing visual confirmation and aiding in distance calculation by **measuring the time difference between thermal detection and sound arrival**.
- A **VGG19**-based convolutional neural network classifies the sound, **differentiating gunshots from background noise**.
- Results, including gunshot direction and distance, are displayed on an LCD, using both thermal and sound data for accurate localization.

Problem Resolution :

- **Early Warning and Threat Detection:** The system detects the sound of gunshots and alerts soldiers to the direction of the threat, allowing them to take **defensive actions** or seek cover more effectively.
- **Real-Time Processing:** The FPGA-based system **processes signals in real time**, providing immediate feedback on the direction of the gunshot to ensure quick responses

Unique Value Propositions (UVP) :

- Immediate and Precise Alerts.
- **Pinpoint** Directional Accuracy.
- Scalable and **Modular** Design
- Use of advanced algorithm for performance
- **High Accuracy** in Noisy Environments.
- **Intuitive** User Experience

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Technology Stack & Key Features

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Software

- **HDL** acts as the programming language that allows us to define the hardware-level functionality of an FPGA.
- **MATLAB** used for designing and simulating digital signal processing (DSP) algorithms such as the **bandpass filter**.
- Machine Learning Model like **CNN,RNN and SVM** for sound classification.
- Algorithms like **Triangulation algorithm** or **Beamforming Algorithm.**

Hardware

- **Omnidirectional** Microphones
- FPGA Development Board .
- **ADC chips** for signal conversion.
- **Thermal Sensor** for sensing the heat produced by gun.
- Graphical LCD display to show the direction.
- Power supply unit (**PSU**) to power the FPGA board, ADCs, microphones, and other components.

- **Real-Time Gunshot Detection:** It uses microphones to figure out where the gunshot came. This helps determine the direction of the shooter.
- **Multiple Microphones :** The system uses several microphones(around six) to listen for gunshots from all directions, making the detection more accurate.
- **Signal Processing:** The system filters out unnecessary sounds and focuses on the frequency of gunshots to detect them better.
- **Low Delay:** The system is very fast because of the FPGA, allowing it to process gunshots with almost no delay
- **Graphical Display:** Screen shows the direction of the gunshot, usually with an arrow or an angle, so the user can quickly see where the shot came from.

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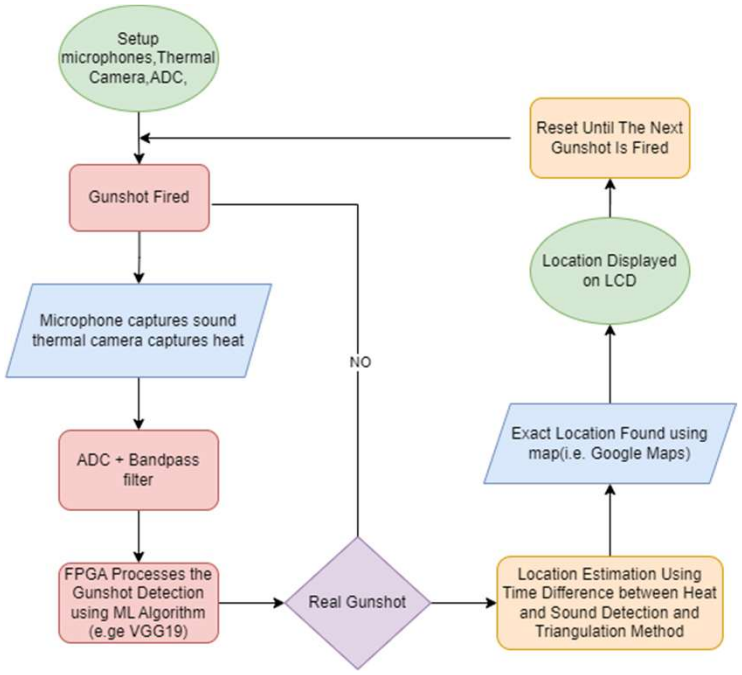
Future Enhancements

- **Multiple Gunshot Detection:** Implement algorithms to detect and differentiate multiple gunshots occurring **simultaneously**.
- **Advanced Noise Filtering:** Incorporate advanced noise filtering techniques to **improve accuracy** in **noisy environments**.
- Integration with Other Systems**:** Explore integration with other defense systems, such as **automated response mechanisms** or communication networks.
- **Use of Advance Algorithm:** Use of algorithms like **VGG19** for finding the exact location from where the gun has been shot.

Tech Flow



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Team Members Details

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