SMART INDIA HACKATHON

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- **Problem Statement ID** —1651
- **Problem Statement Title-** Microphone array - based direction of arrival for gunshot detection
- **Theme** - Miscellaneous
- **PS Category-** Software
- **Team ID-** 14906
- **Team Name** -TEAM HAWK

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Microphone array-based direction of arrival for gunshot detection

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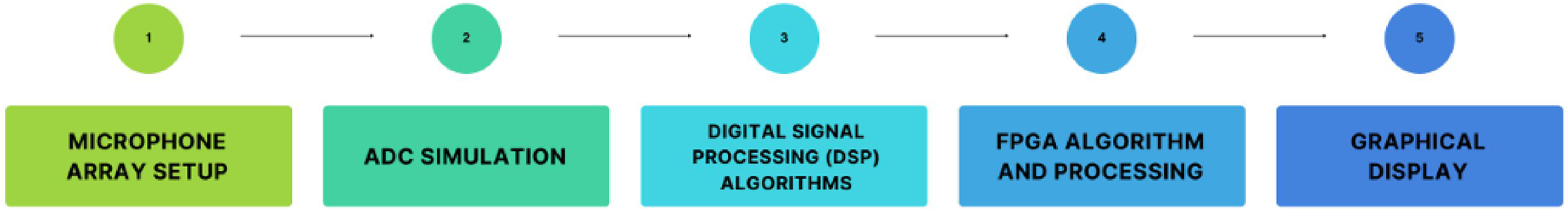
Solution:



Addressing:

- Tackles the challenge of quickly and accurately identifying the direction of gunfire in combat situations.
- Gunshots differentiation through respective Frequency(Hz).
- Accuracy of the Frequency

Uniqueness:

- Cost-Effective FPGA Solution
- Enhanced Accuracy with Cross-Correlation
- Optimal Frequency Filtering(Only GunShots fz)
- Environmental Noise Filtering
- sound classification to distinguish between different types of gunfire.
  (e.g., handgun vs. rifle)

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TECHNICAL APPROACH

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Signal Processing:

- Multi-channel signal simulation.
- ADC simulation
- Bandpass filtering & focus on specific frequency bands.

Feature Detection:

- Simple thresholding for gunshot detection.

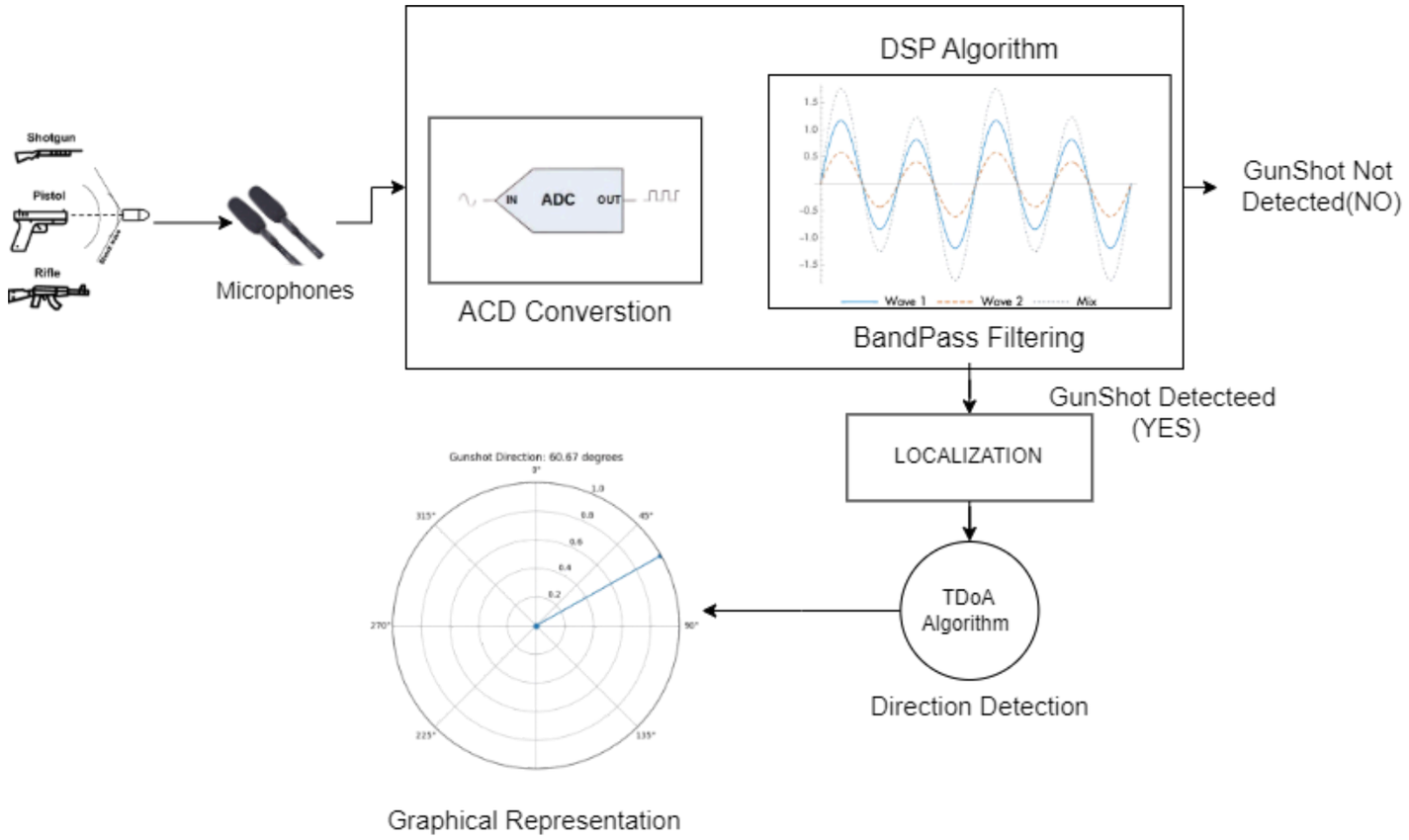
Localization(FPGA alg):

- Sound classification
- Sound direction estimation using TDoA Algorithm

Visualization:

- Time-domain plots and polar plots for signal and direction interpretation.

WORK FLOW ARCHITECURE:



Product Status: Software based implementation is done ,providing hardware components like microphones and graphical LCD display is pending progress.

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FEASIBILITY AND VIABILITY

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1. Technical Feasibility:

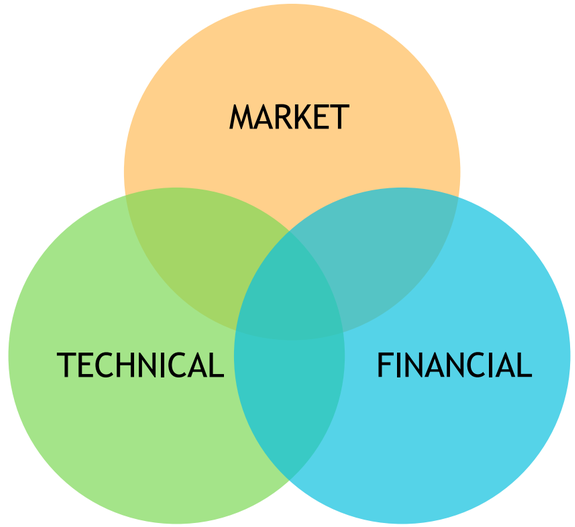
- FPGA technology and omnidirectional microphones
- Sound classification and localization using TDoA

2. Market Feasibility:

- Strong demand in military, law enforcement, and private security
- Real-time threat awareness as a key selling point

3. Financial Feasibility:

- Significant upfront investment for FPGA development and testing
- High potential for long-term revenue through military/law enforcement contracts
- Recurring income via customization, support, and maintenance agreements



POTENTIAL CHALLENGES:

- Ensuring accurate detection in situations,multiple gunshots or background noise.
- Convincing defense and security organizations to switch to a new technology.
- Slow procurement processes in military and government sectors, delaying sales.
- Ensuring steady revenue after the initial product sale.

SOLUTION:

- Implement machine learning or advanced algorithms to improve detection accuracy.
- Offer demo versions or pilot programs to showcase the benefits to potential clients.
- Target private security and law enforcement markets to generate revenue faster.
- Provide ongoing maintenance, upgrades, and support services to ensure continuous income.

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IMPACT AND BENEFITS

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EXISTING MODEL:

- Detecting other external sounds instead of Gun shots like FireCrackers as GunShots source.(False Alarm)
- Limited capability; mainly record events without analyzing them in real time.
- can miss threats entering through unchecked areas.
- Limited by physical infrastructure and human resources.

OUR MODEL:

- We reduced false alarms through precise detection capabilities and intelligent analysis like using modern efficient algorithms.
- High capability; use AI and machine learning to analyze threats in real time.
- Our model is capable of detecting threats across multiple areas and entry points.
- Easily scalable with software updates and integration with existing digital systems.

BENEFITS OF THE SOLUTION:

1.Real-Time Detection(Immediate)
2.High Accuracy(Over 89.7% Accuracy)
3.Frequency Filtering(Only Filtering GunShots Source)
4.Faster Detection due to less Complexity(Effective Algorithms)

TARGET AUDIENCE

- MILITARY FORCES
- PREVENT HUNTING
- PRIVATE SECURITY
- BORDER SECURITY
- PUBLIC WELFARE

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RESEARCH AND REFERENCES

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FOR IDEALOGY

- "Fundamentals of Sound Localization with Microphone Arrays" Research Paper:SoundLocalizationResearch
- https://liu.diva-portal.org/smash/get/diva2:1806215/FULLTEXT01.pdf

FOR IMPLEMENTATION

- Kaggle Datasets-https://www.kaggle.com/datasets/emrahaydemr/gunshot-audio-dataset
- https://www.youtube.com/watch?v=HdVOT3rC9W4&t=720s
- https://www.researchgate.net/publication/363142743_A_comprehensive_study_towards_high-level_approaches_for_weapon_detection_using_classical_machine_learning_and_deep_learning_methods

FOR BUSINESS ASPECTS

- Research Book: Gunshot Detection Systems Market Size, Share & Trends Analysis Report By End Use, By Application, By Installation, By Region, And Segment Forecasts, 2024 - 2030.