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Acoustic Camera Based on Zynq

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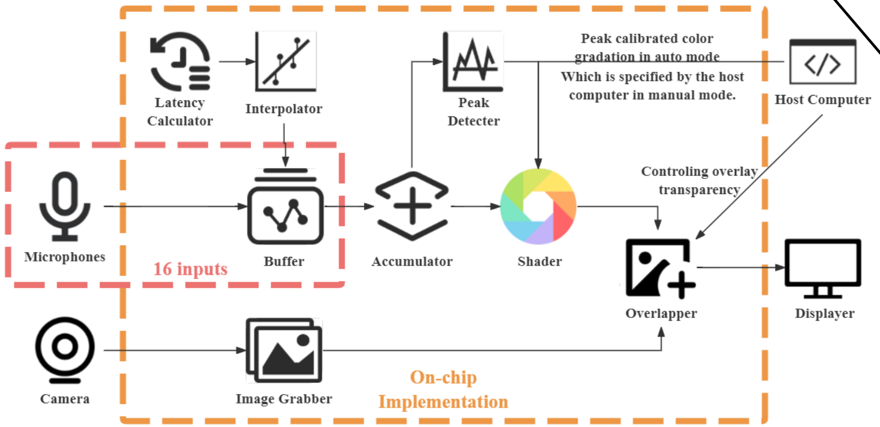
INTRODUCTION

This project presents a Zynq-based acoustic camera that combines FPGA's high-speed parallel processing with ARM's flexibility to achieve precise, real-time sound source localization and visualization.

Typical application case

The acoustic camera is suitable for applications such as **rapidly locating abnormal noises in industrial equipment** to assist in fault diagnosis, **monitoring environmental noise levels** to assess impacts and support urban planning, **detecting noise sources in home appliances** to guide design improvements, and **analyzing noise distribution** from roads and railways to provide scientific data for traffic planning and **noise mitigation**.

Key technical issues addressed:
1.Parallel Computing: Utilizes FPGA for high-speed sound source localization (20,000 ops/sec).
2.Heatmap Overlay: Combines acoustic heatmaps with video for intuitive results.
3.Real-time Adjustment: Allows real-time parameter adjustments via host computer.
4. User-Friendliness: Intuitive interface with real-time threshold adjustments.



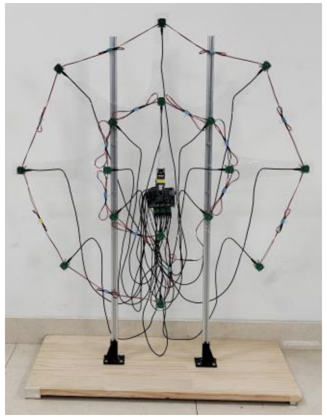
System Architecture

High-Performance Parallel Processing:
The project significantly improves computational speed and real-time performance for sound source localization by leveraging the parallel computing capabilities of FPGA, achieving a localization frequency of 20,000 operations per second.

Acoustic Field Visualization:
The system innovatively overlays acoustic heatmaps with video footage, providing intuitive localization results and greatly enhancing user experience.

Flexible System Adaptability:
The system allows users to adjust heatmap display parameters in real-time via the host computer, increasing flexibility and adaptability to various application scenarios.

CREATIVE DESING



On board test by AMD ZYNQ7020

RESULT

Throughout the development of the acoustic camera project, we successfully enhanced **system robustness and functionality** through three key iterations. These improvements resulted in a high-performance acoustic camera **capable of operating seamlessly on the Zynq-7020 platform**. Each iteration brought the system closer to its goal of eliminating timing violations, while optimizing key features for better efficiency and reliability. The project now meets the performance requirements and is ready for deployment in real-world applications.

The acoustic camera is equipped with 8 MEMS microphones with a **sensitivity of -26 dBFS**, covering a broad sound analysis frequency range from 50Hz to 10kHz. It can refresh at 60 FPS, providing continuous sound imaging with a spatial resolution of 0.42° and an effective detection range from 0.5m to 2.5m. It can also detect and **clearly display** up to two sound sources within the visual field.

Future improvements include increasing the number of microphones and adjusting the array structure for more precise localization. The implementation of adaptive beamforming algorithms will enhance multi-source detection.