E2.01 Dual-Use Wideband Microphone Array System

Team Sonus

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Background

Our project is a proof-of-concept dual-use wideband microphone array system that relays voice communications and alerts users if ultrasonic anomalies (leaks, failing equipment, etc.) are detected. The system detects these voice communications and anomalies with MEMS (micro-electromechanical system) microphones. If a voice (200Hz – 6kHz) is detected, then that voice gets relayed. If an anomaly is detected (>20kHz), then audio and visual alerts will go off indicating the detected intensity of that anomaly. This project is important because it can serve as early automated leak detection for pressurized vessels such as spacecraft, aircraft, industrial equipment, etc as well as show the viability of a dual use system which helps reduce size, weight, and power consumption.

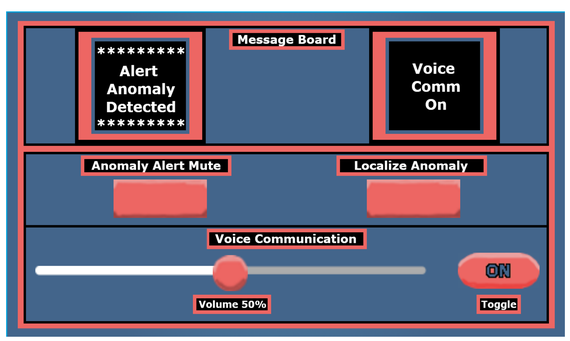
Design Requirements

- Use MEMS microphones to create the proof-of-concept system.
- Provide hands free voice communication to users.
- Detect Ultrasonic anomalies and alert users with auditory and visual warnings at a 1 Hz rate and mute when acknowledged by a user.
- The auditory alerts must be a sonification of the anomaly similar to that of a Geiger counter.
- A screen will display the status of all the MEMS microphones in the array.
- As a stretch goal we want to implement localization of detected ultrasonic anomalies.

Design Considerations

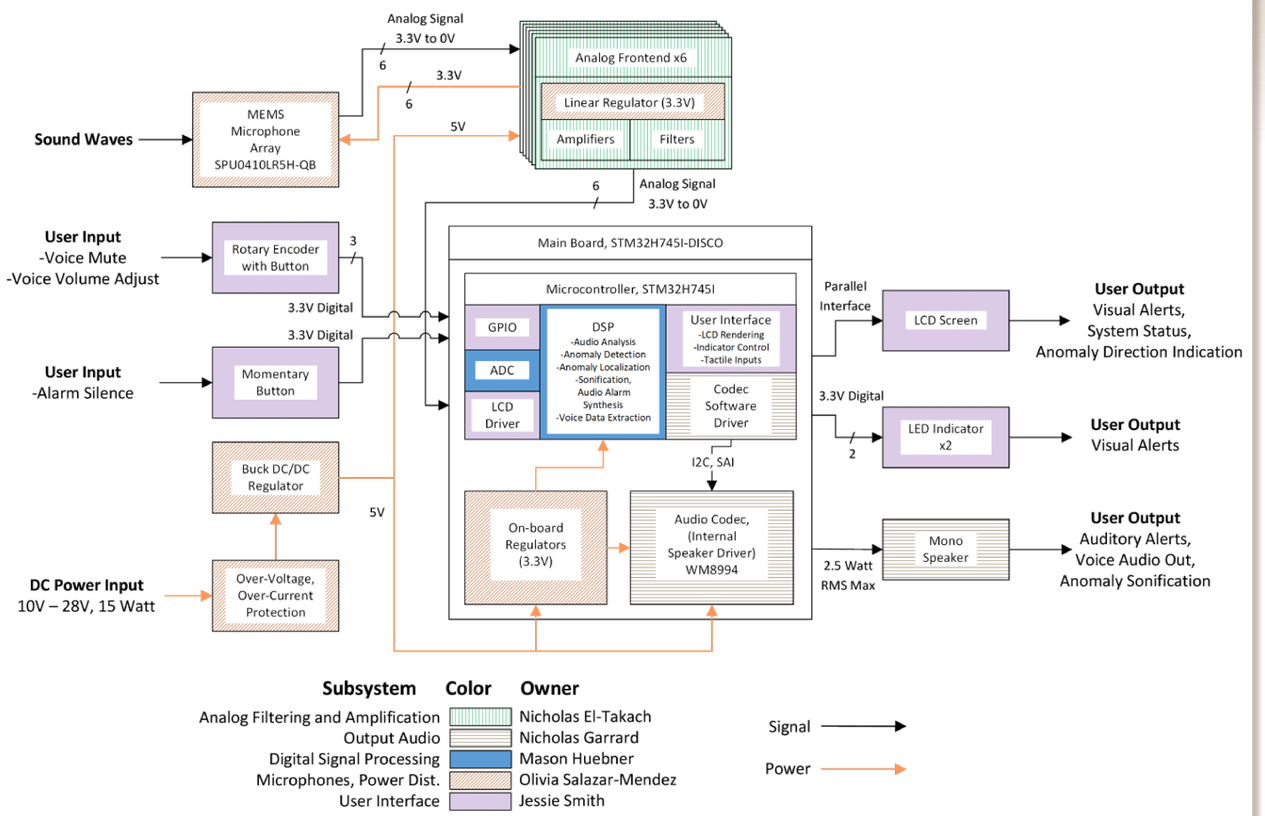
- Redundancy
- Size and weight
- Power draw & heat
- Anomaly localization
- Universal UI

Graphical User Interface (GUI)



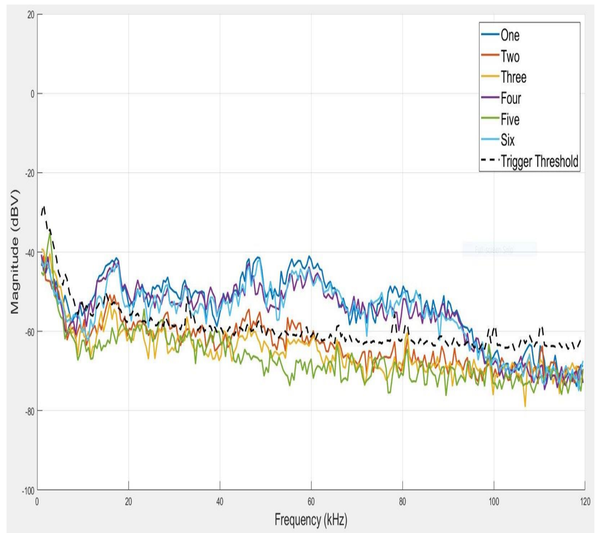
*Physical buttons accompany the GUI for gloved hands.
**Colors carefully chosen to be colorblind friendly.

Overall Block Diagram



Final Results

Requirement	Measured Results	Outcome
Omnidirectional Anomaly Detection	Anomalies were detected from all sides of the array	Pass
Anomaly Detection Threshold Generation	An input signal provided at startup does not trigger detection, but additional signals do. Startup signal ignored, increased magnitude or different frequency triggers detection.	Pass
Test users perform complex UI task with average time <6s	4.8 s	Pass
Produce Alarm at 1 Hz rate	750 Hz tone occurred every 0.95 seconds. Therefore 0.95Hz	Pass
Dynamic Anomaly Sonification	Sonification Data: Simulate 25kHz Anomaly Expected Data: 525 Hz tone Test Result: 538 Hz Simulate 50kHz Anomaly Expected Data: 2150 Hz tone Test Result: 2153 Hz Simulate 120kHz Anomaly Expected Data: 6700 Hz tone Test Result: 6675 Hz	Pass



Design Features

Feature:	Description:
Omnidirectional Anomaly Detection	Detect wideband signals (Ultrasonic, Voice) in all directions.
Hands-Free Voice Communications	Voice (200 Hz - 6kHz) is passed and annnounced through the local speaker.
Auditory and Visual Alerts	Alert users if an anomaly is detected with lights and an alert tone. Sonification of the anamoly will alert users of the intensity.
User Interface	Alarm toggle switch with voice communication toggle and volume control.

Mason Olivia Jessie Nick E. Nick G.

90 Second Pitch Video

WATCH! SHARE!

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