

E1.01: Dual-Use Wideband Microphone Array System

Phonons & Photons

Texas State University

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Purpose

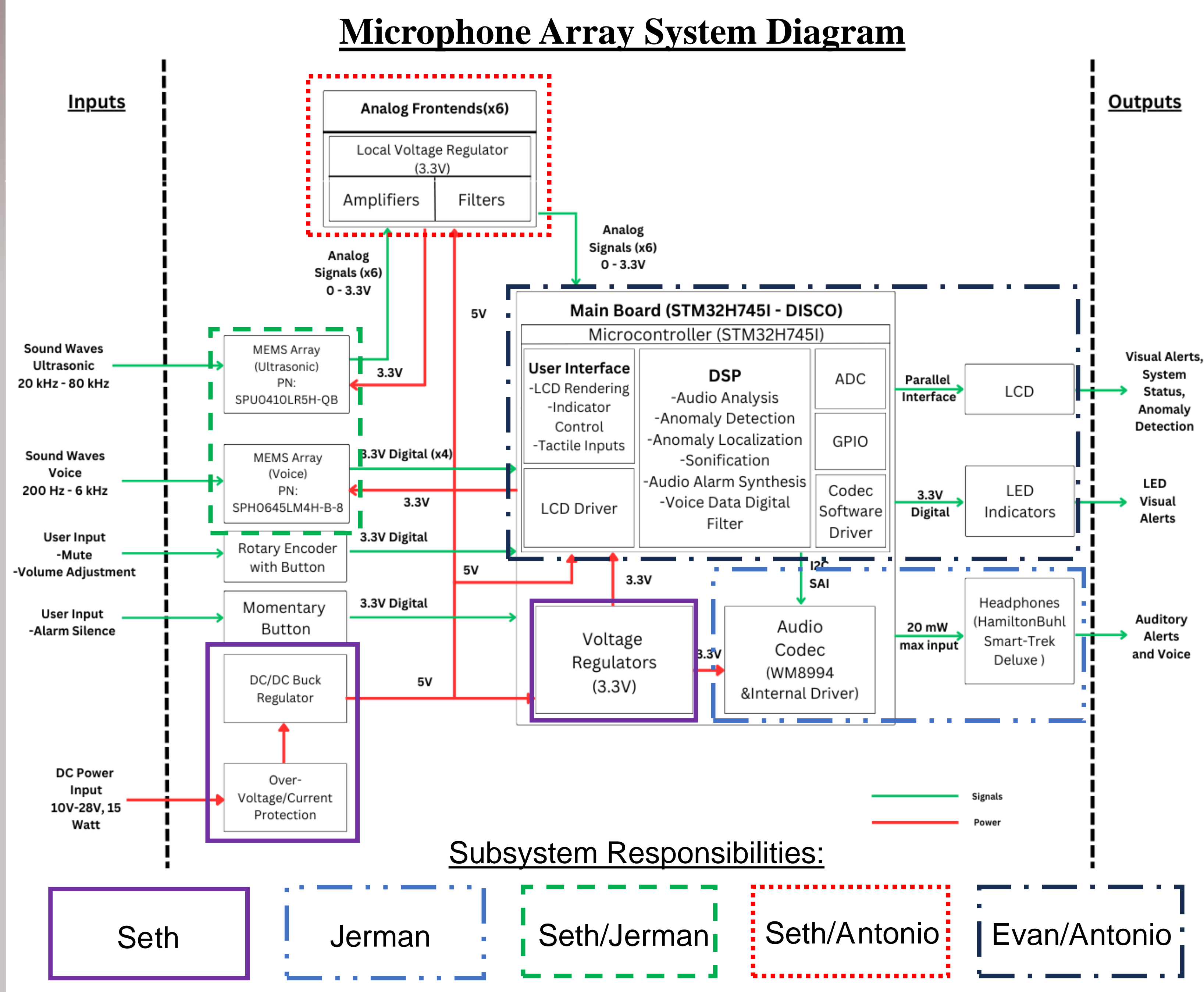
The goal of this project is to be able to function as a medium for voice transmission as well as be able to detect and locate ultrasonic anomalies. Upon detection, the system will alert crew members through audible and visual cues. Combining these two functions increases safety and can save valuable space onboard space craft or habitats.

What is an Ultrasonic Anomaly?

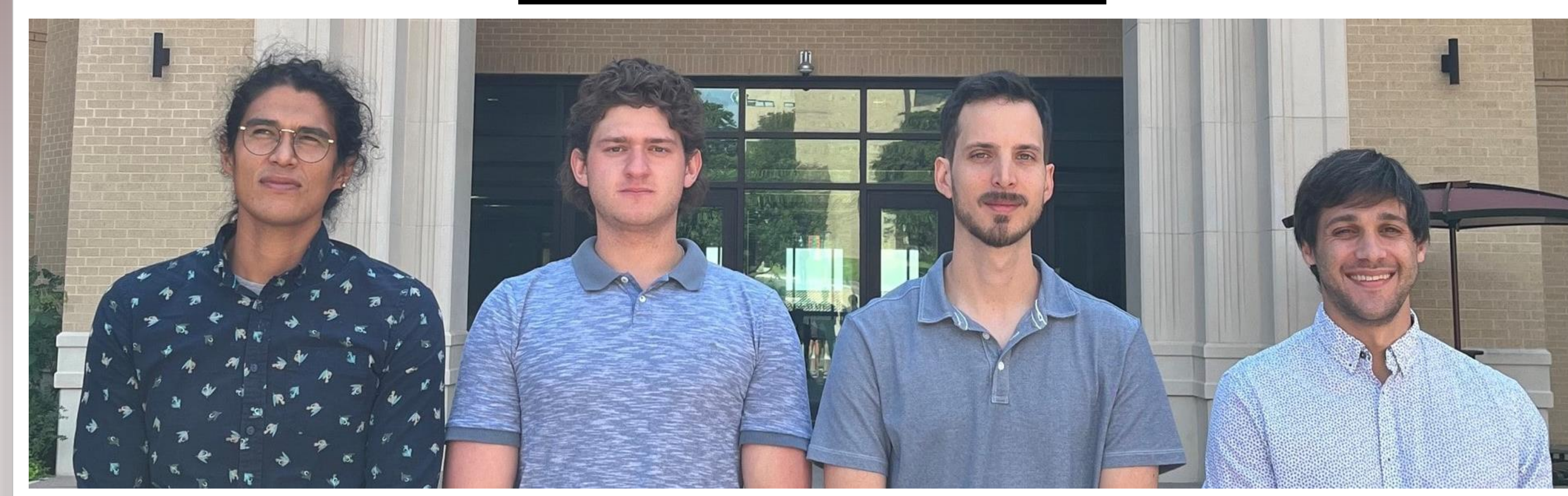
A frequency signal that cannot be heard by the human ear and is a sign of malfunctioning equipment. When equipment starts to fail, or a valve begins to leak, it can be detected before it turns into a serious problem. This potential problem is seen through the ultrasonic emission of these failures. Detecting this problem early can help keep crew members safe before a small problem turns into a big problem.

Design Requirements and Features

- ❑ Array of MEMS microphones to create a proof-of-concept detection system.
- ❑ Provide and transmit hands free voice communication to users.
- ❑ Ultrasonic anomaly detection that alerts users through a 1 Hz tone that is silenced when acknowledged by user.
- ❑ Anomaly detection uses a sonification feature to alert users to signal's intensity.
- ❑ An interactive screen will display volume, acknowledgement controls and signal the presence and location of anomaly detection.



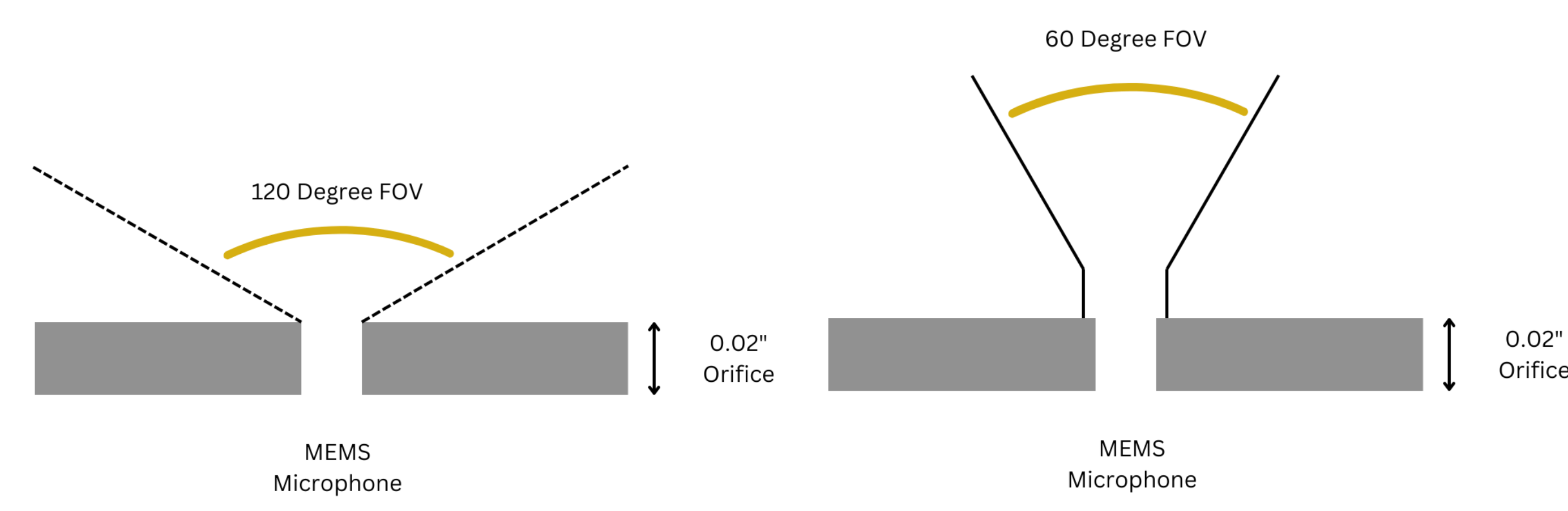
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Design Decisions

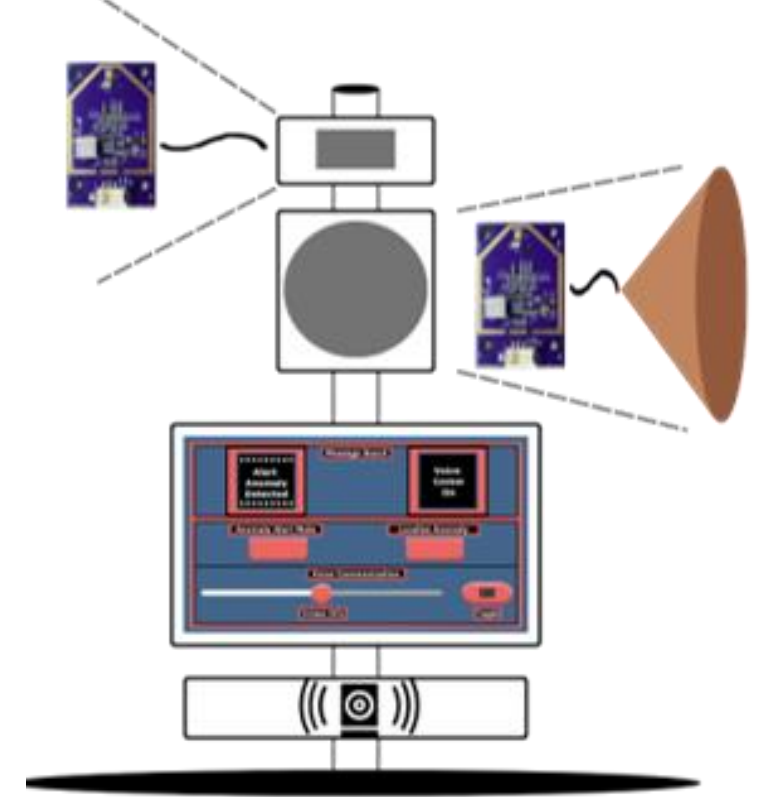
- ❑ Modularity
- ❑ Size and weight
- ❑ Power draw & heat
- ❑ Anomaly localization
- ❑ Range of detection
- ❑ Field-of-view



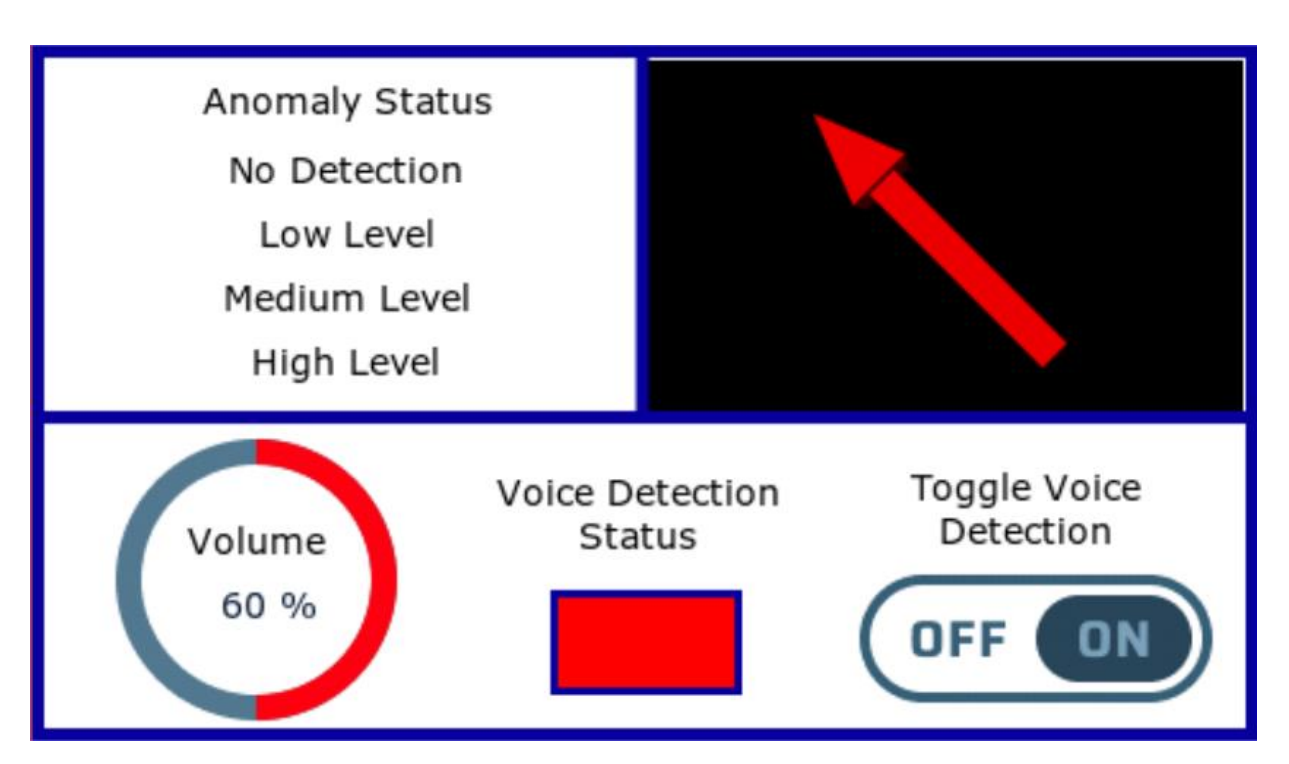
Design 2 Plans

- ❑ Expanding field-of-view for both voice/ultrasonic array.
- ❑ Redesigning user interface to be more user friendly.
- ❑ Emit alerts to an external headset.
- ❑ Implementing anomaly localization function.
- ❑ Addition of VoIP functionality and voice-over to alert to anomaly presence and location (Stretch goal).

System Integration



User Interface Redesign



Cost/Budget

| Component | Quantity | Price Each | Subtotal Cost |
|--|----------|------------|-----------------|
| STM32745I-Disco | 1 | \$87.87 | \$87.87 |
| SPU0410LR5H - QB | 12 | \$1.24 | \$14.88 |
| SPH0645LM4H-B-8 | 5 | \$6.95 | \$34.75 |
| Custom Analog PCBs for SPU0410LR5H - QB | 15 | \$5.09 | \$76.28 |
| Analog PCB Components | Varies | Varies | \$147.12 |
| HamiltonBuhl Smart-Trek Deluxe | 1 | \$9.50 | \$9.50 |
| Testing Equipment (tweeter & ultrasonic emitter) | 1 | \$32.96 | \$32.96 |
| 5V Regulator | 1 | \$13.95 | \$13.95 |
| Total Unit Cost | | | \$417.31 |

Design Gallery

Conical horn design

Analog amplification and filtering PCB

Digital MEMS PCB

Machine learning localization regions

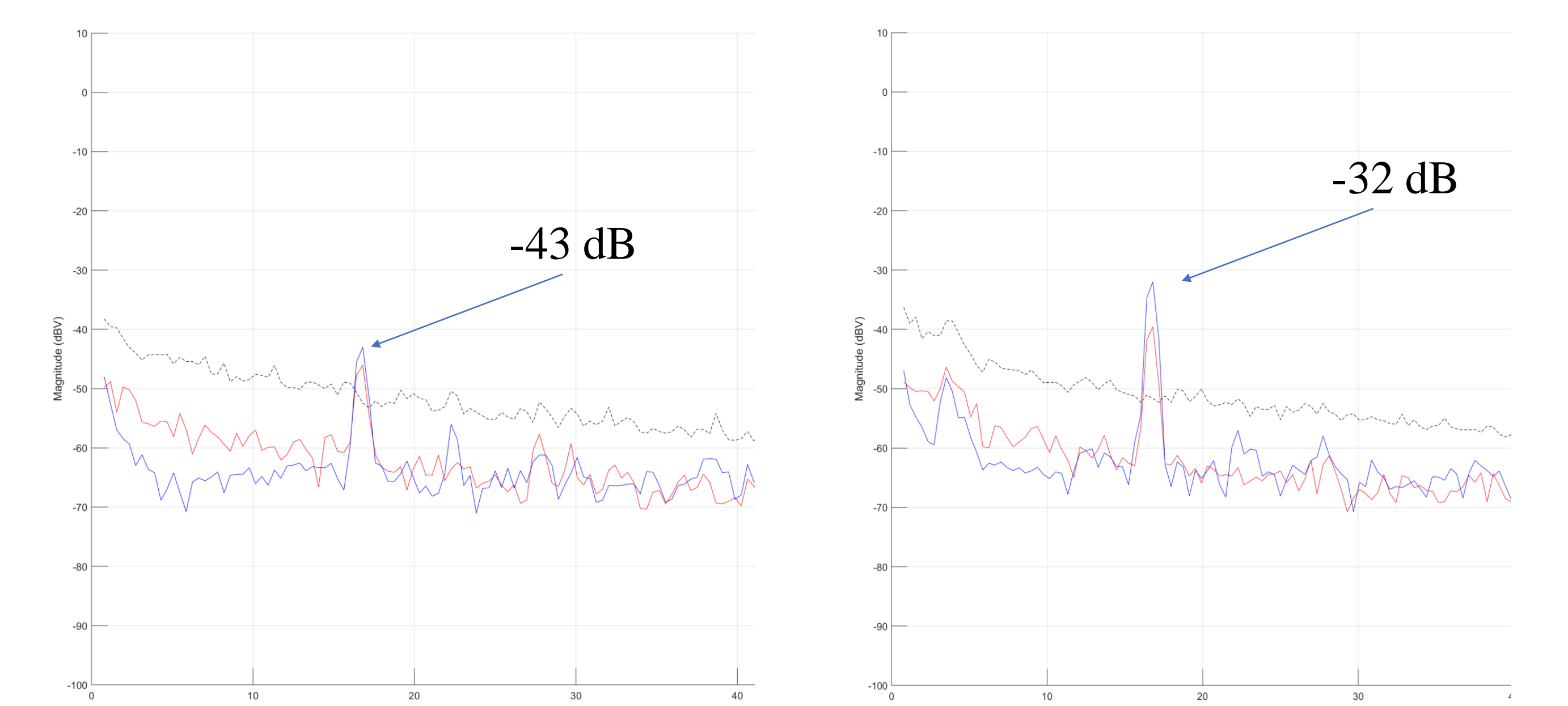
Printed horn with adjustable wedges

Graphical Interface

FOV without conical horn

FOV with conical horn

Ultrasonic Anomaly Range Test (1.5m)



Ultrasonic Detection without Conical Horn

Ultrasonic Detection with Conical Horn

12 dB of gain equates to a 4x increase in the range of detection!

Acknowledgments

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