TEXAS SPACE GRANT CONSORTIUM
DESIGN CHALLENGE

TOPIC # - TDC - 32 - F23

DUAL-USE WIDEBAND MICROPHONE ARRAY SYSTEM CHALLENGE

BACKGROUND

For present low earth orbit human space missions, mission control serves as “additional crewpersons” by monitoring spacecraft systems on their consoles on earth to provide timely notification to the crew if equipment issues occur. As NASA looks into deep space missions, the round trip delay of communication signals will make it difficult for mission control to help monitor the spaceship in real-time. The deep space crew will have to rely on space vehicle monitoring systems to provide them with situational awareness of the vehicle. However, because of weight constraints, it is desired that future spacecraft systems provide multiple functions to save weight and power. One technology area that NASA would like to investigate is the development of a dual-use acoustic processing microphone array system that not only provides for hands-free voice communication including the ability to localize and track a speaker in a room, but also monitors the condition of the equipment operating and integrity of pressurized volumes by scanning for anomalous ultrasonic signatures. For monitoring the condition of the equipment or leaks in pressurized volume, the system would first be able to localize the problem acoustically. Then, it would translate the acoustic signature into an auditory annunciation indicating severity of the problem via sonification (non-speech audio to convey information) to the crew.

PROBLEM STATEMENT/CONSTRAINTS

Develop a “proof-of-concept (ie., non-flight system)” dual-use non-tracking acoustic microphone array system application that uses MEMs microphones and is able to simultaneously detect voice (200-6000 Hz) and ultrasonic noise sources (> 20Khz). If it is voice, the microphone array will pass the audio through to a headset/speaker. If it is an ultrasonic source, the system will provide a sonification of the signal (detection tone and how intense it is—think of a Geiger counter). Both the audio and ultrasonic acoustic processing must occur simultaneously. At a minimum, detection of one ultrasonic source like a pressure leak is desired. And, the system will give priority to the ultrasonic source over the audio. The mic array can be wired or wireless. A display screen will provide status of the MEMS-based microphone array system. The desired goal and stretch goal are:

Goal: A non-tracking dual-wideband MEMS-based microphone array system “proof-of concept” prototype that can provide for hands-free voice communications as well as detect at least one anomaly in the equipment/habitat such as a failing pump or a leak in a pressure shell. If a leak is detected, the system will announce both auditory and visually the warning that a leak has been detected. The warning will occur at a 1 hz rate and will be silenced when the annunciation is acknowledged by the user. Performance will be determined by conducting speech intelligibility testing of speech recorded using the array microphone.

Stretch goals: (1) Microphone array can provide angle of incidence information relative to the array normal axis for localization of an ultrasonic sound source. (2) Use beam forming to track/follow a moving speech source to maximize speech to noise ratio. (3) Provide synthesized or recorded speech annunciations indicating detection of ultrasonic noise and location or direction(4) provide a VoIP interface for audio, warning annunciation and acknowledge commands.

Deliverables: Design Documentation and final project plan

DESIGN TEAM PROFILE

NASA MENTOR:	Andy Romero
LEVEL:	Upper Division [JR/SR];
MAJOR / DISCIPLINES:	EE, CE, ME, Physics
AREA OF RESEARCH:	Audio
TEAMS:	Mentor will allow one team
DURATION:	Two-Semester

NASA