Team E0 Statement of Work 3/21/20

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Project Name: Sonicam

Scope: A phased array of microphones for scanning and visually representing audio signals through space. Our project will include design of the microphone array, communication of the data to a PC, array processing, and display.

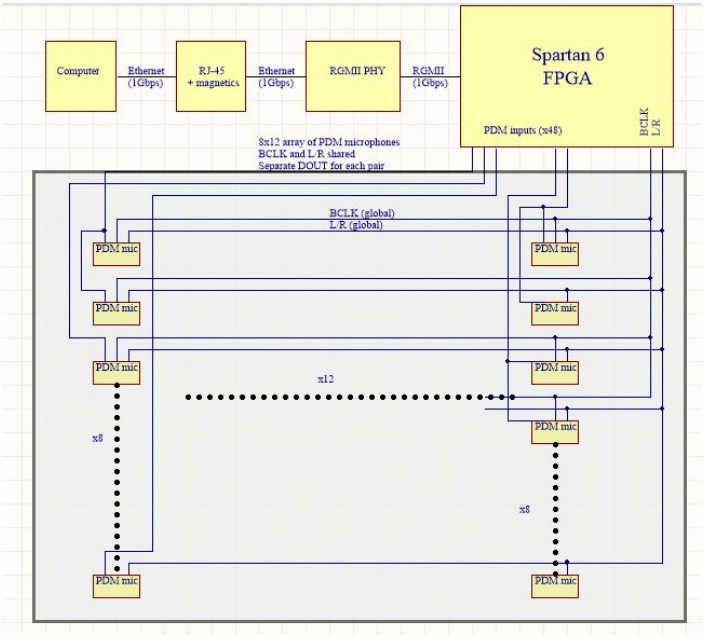
Primary changes to scope: Array will no longer be configurable to different geometries, as it was previously designed to be. It will also be simplified significantly to allow construction with limited tools and resources, and to account for the possibility of some parts suppliers no longer being open for business. Precise characterization and calibration of the audio properties of the array will also no longer be possible, results will be computed based on ideal component values or typical values from datasheets, as applicable.

Requirements:

- **Functional Requirements:**
  - Reading from and processing multiple microphones simultaneously
  - Some form of real-time visualisation of useful, processed data
- **SWaP-C:**
  - **Size and Weight:** System should be human-carryable (less than 2'x2' and 3kg)
  - **Power:** less than 25W (reasonable potential to be battery powered)
- **Cost:** Less than $600 total
- **Sensitivity:** able to locate a single source of ~70dB SPL with a background noise of ~50dB SPL

Implementation:
A 2D array of PDM 96 microphones will be connected to an FPGA, which will stream the data from them over gigabit ethernet to a computer for processing. The computer will convert the PDM bitstream to analog values, and generate a visual representation of sounds based on their location and frequency.

Block diagram:



Challenges:

- The data rate of multiple microphones is very high (~300Mbps), so we will be using Gigabit Ethernet to move it from the FPGA to the computer. Implementing Ethernet in an FPGA is fairly complicated, as is achieving a real-world 300Mb throughput of useful data after all the overhead associated with ethernet and for reassembling data at the other end. At this point, we have working GbE on an fpga, but have not yet tested the real-world throughput.
- Processing that much data in real time will also be difficult. Since each pixel in the output image requires data from all microphones, the complexity of the computation grows rapidly with the array size and the output image resolution. Some processing, particularly related to converting the microphone PDM signal to PCM, may be moved from the computer to the FPGA for speed.
- Construction of the physical array may also prove challenging, as there are almost 100 channels to connect. Making this in a reasonable amount of time, and finding and debugging problems may prove particularly difficult just due to this scale.