Bat News Travels Fast

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Introduction

Understanding and replicating how bats use sonar to echocolate has far-reaching applications for signal processing and Naval technology. Dr. Robert Stevenson of the Notre Dame Electrical Engineering department and Dr. Laura Kloepper, an expert on bioacoustics, received a grant from the Office of Naval Research to explore Brazilian free-tailed bats' swarming and biosonar behavior.. Our device will be used in this research to record the sonar signals and to store the data for future processing.

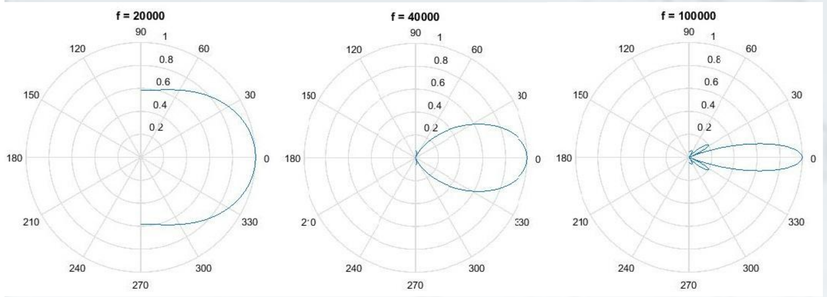

Figure 1: MATLAB Plots Showing Array Directionality

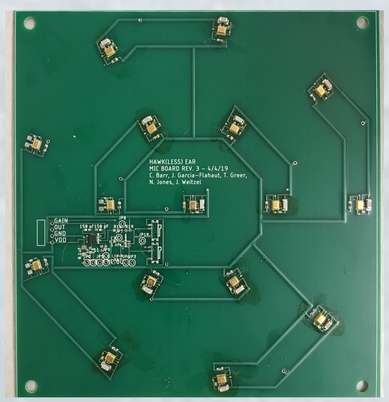

Figure 2: Microphone Board Showing Circular Array

System Design

Microphone Array: A circular array made up of 16 microphones directionally captures biosonar signals from a specific group of bats in the frequency range 10-100 kHz. The directional responses are shown in Figure 1 for various frequencies in our desired range.

PIC32 Microcontroller: A central microcontroller oversees the device, controlling data sampling and storage, as well as the user interface. Data is sent through a low pass anti-aliasing filter and sampled at 250 kHz.

SD Card/ Memory: A MicroSD card is used to store data, and can store several hours worth of continuous recording. The PIC communicates with the SD card over an SPI interface.

WiFi Module: The ESP8266 serves as an access point for the web server. It is used to control the device and to download recorded data.

Power: The device is powered by a LiPo battery and is equipped with a charging circuit

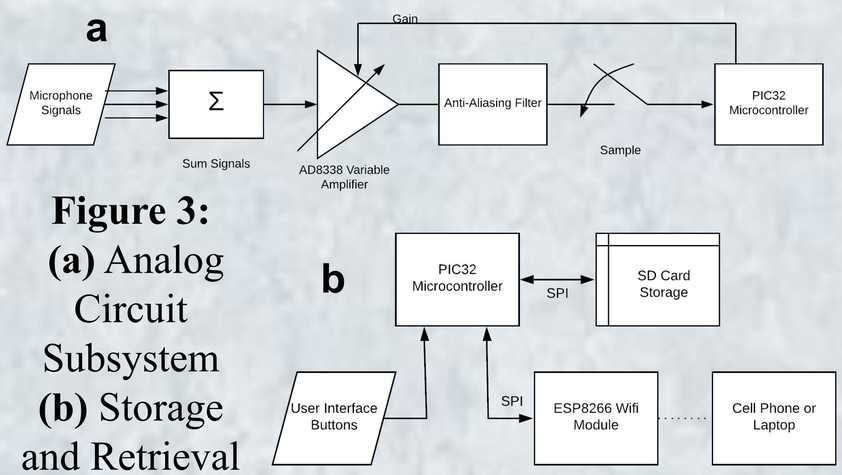

Figure 3: **(a)** Analog Circuit Subsystem **(b)** Storage and Retrieval Subsystem

Results and Conclusions

By sampling at a high rate and using a directional microphone array, our device is able to accurately capture biosonar signals. While unable to use live bats during testing, our team used an ultrasonic emitter that sends out 40 kHz "chirps" to test the device. An FFT of a recorded "chirp" is shown in Figure 5.

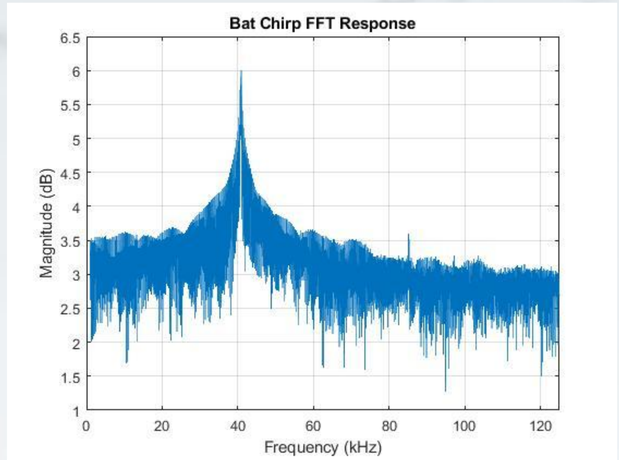

Figure 5: FFT of Sampled Data

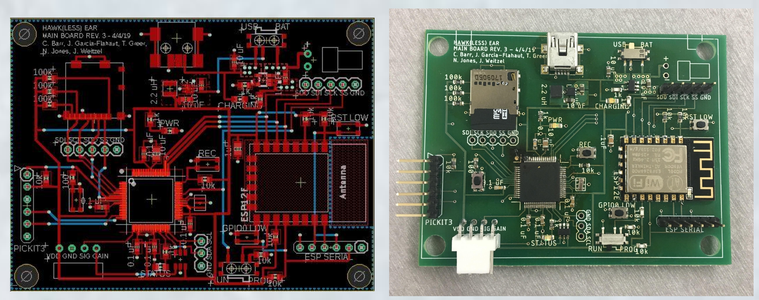

Figure 4: Main Board