Audio Signal Spectrometer

Imitating Current Hardware in Radio Astronomy

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PY 371 Electronics for Scientists
Final Project Proposal
May 01, 2023

Abstract

Radio astronomy is a field that came about in a unique way: Karl Jansky of Bell Labs detected Milky Way radiation while conducting a radio frequency interference experiment for AT&T. The evolution of technology has allowed for bigger and better instruments to observe radio sources throughout the universe. I am proposing to build an audio signal spectrometer that will produce an LED matrix spectrum of a sound input. This project mimics current hardware in radio astronomy and requires an understanding of techniques used by radio astronomers to analyze spectral data. The ultimate goal of this project is to create a device that inputs an audio signal, takes a Fast Fourier transform of the input, and prints the resultant FFT spectrum (in a frequency range from 1 Hz to 512 Hz) on an LED Matrix.

1 Plan of Implementation

Week of 03/27: Determine the feasibility of building a spectrometer given a 6-week timetable. If feasible, begin to obtain the necessary components to realize the design. Order any outstanding parts.

Week of 04/03: Finish obtaining any missing parts. Begin to write code for the Arduino to do a Fourier transform. Make sure all the components work properly.

Week of 04/10: Fully assemble the device and finish any code needed to run it. Determine where any design flaws exist (i.e. where do voltages/currents need to be adjusted).

Week of 04/17: Time to work out any flaws or debug code.

Week of 04/24: Finishing touches and conduct test runs to ensure the device works properly. Collect data to accompany final product.

Week of 05/01: Deliver final product of project at the Annual Electronics Lab Open House, accompanied by a slideshow and demonstration.

2 Parts List

- Arduino Mega 2560
- Microphone Pre-Amplifier MAX4466 (Spec Sheet)
- 8x8 LED Dot Matrix MAX7219 (Spec Sheet)
- Breadboard, 2 1KΩ resistors, and jumper wires

3 Block Diagram

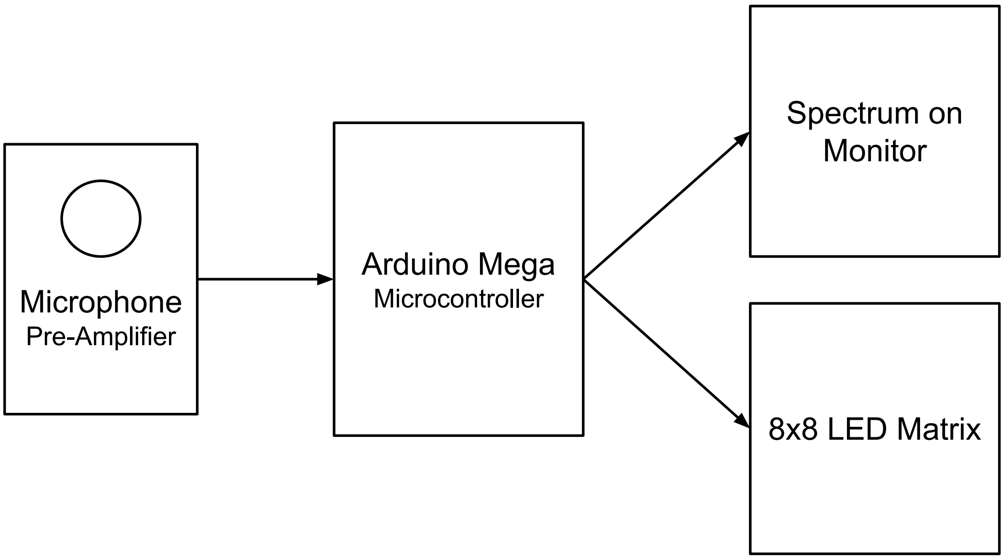

Figure 1: Block diagram for the spectrometer. The microphone detects an audio signal that is received and pre-amplified. The signal is transferred to the Arduino Mega microcontroller that performs a Fast Fourier transform. The resulting spectrum is displayed on an 8x8 LED matrix, and the array of data may be printed to plot in other software.

4 Code References

ApproxFFT (link): Used ApproxFFT, FastSine, FastCosine, FastRRS.
The majority of this code is not my own. It belongs to `https://projecthub.arduino.cc/abhilashpatel121`.

5 Schematic

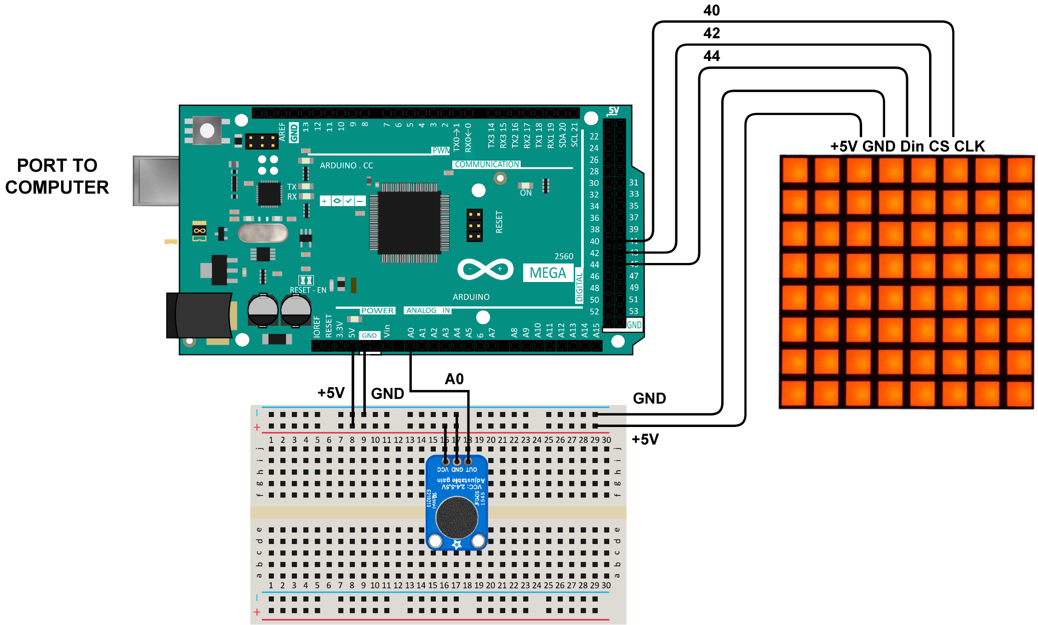

Figure 2: Schmatic for the spectrometer. The Arduino Mega microcontroller provides the +5V and 0V ground rails on the Breadboard. The respective pins on the microphone and 8x8 LED matrix are wired to high and low voltages. An audio signal is transported to the A0 analog pin from the microphone output pin. The microcontroller performs a Fast Fourier Transform, and the resultant data activates the LED matrix via the Serial-Data Input pin (D_{in}). To control the LED matrix, the Chip-Select Input and Serial-Clock Input pins must be activated.