Project 4: Music Analysis Tools

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Intro to Microcontroller Interfacing

Project Time Frame: April 29th – May 8th

Report Summary

In this report, I’ll cover what this project is all about and with the note detection algorithm that I had used to display the correct note with an error threshold. Specifically, tt will go over how we had to do the metronome and the note detection.

Project Description

In this project, a music analysis application was developed which will be displayed on the LCD screen. We implemented three different music analysis tools: a FFT Visualizer, a Metronome, and a Musical Note Detector. Along with that a light and dark mode is implemented through the entire application to allow to see better during the day and night. To transition between the different tools will be done through the right and left pushbuttons to go through each tool. The metronome will be going from 60 – 200 and beep according to the value set for the BPM. For the note detection, as one speaks you can see the note that they are speaking on the screen. I was able to implement the 2048 FFT for this project which allows to sample more points and more accurate with the readings of the notes.

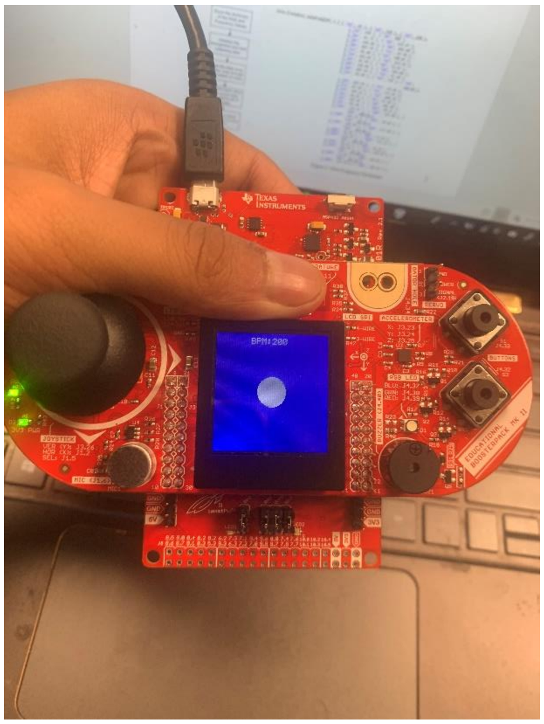


Figure 1: Metronome in Dark Mode

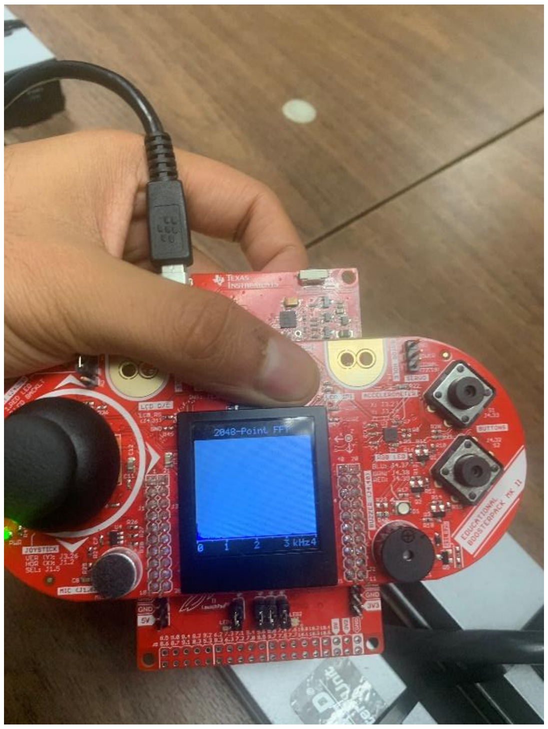


Figure 1: 2048 FFT in Dark Mode

Note Detection Algorithm

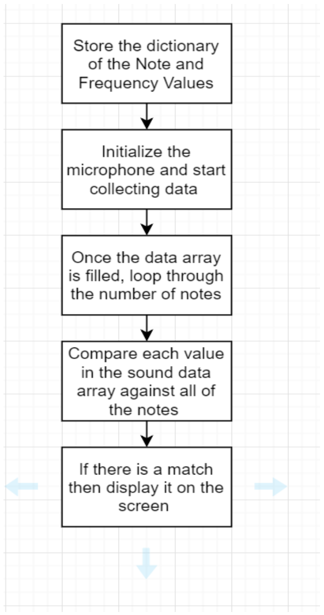
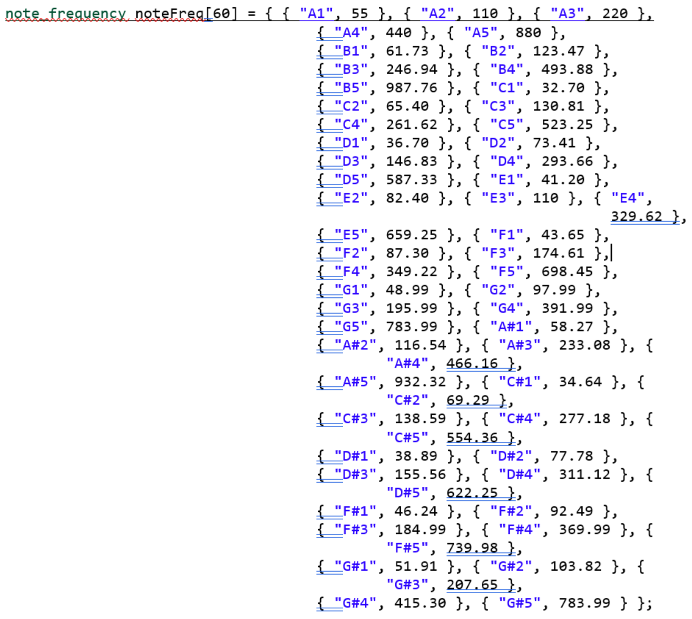

Store the dictionary of the Note and Frequency Values
Initialize the microphone and start collecting data
Once the data array is filled, loop through the number of notes
Compare each value in the sound data array against all of the notes
If there is a match then display it on the screen

Figure 3: Note Detection Pseudo Code



```
note_frequency noteFreq[60] = { { "A1", 55 }, { "A2", 110 }, { "A3", 220 },
                                 { "A4", 440 }, { "A5", 880 },
                                 { "B1", 61.73 }, { "B2", 123.47 },
                                 { "B3", 246.94 }, { "B4", 493.88 },
                                 { "B5", 987.76 }, { "C1", 32.70 },
                                 { "C2", 65.40 }, { "C3", 130.81 },
                                 { "C4", 261.62 }, { "C5", 523.25 },
                                 { "D1", 36.70 }, { "D2", 73.41 },
                                 { "D3", 146.83 }, { "D4", 293.66 },
                                 { "D5", 587.33 }, { "E1", 41.20 },
                                 { "E2", 82.40 }, { "E3", 110 }, { "E4",
                                                                   329.62 },
                                 { "E5", 659.25 }, { "F1", 43.65 },
                                 { "F2", 87.30 }, { "F3", 174.61 },
                                 { "F4", 349.22 }, { "F5", 698.45 },
                                 { "G1", 48.99 }, { "G2", 97.99 },
                                 { "G3", 195.99 }, { "G4", 391.99 },
                                 { "G5", 783.99 }, { "A#1", 58.27 },
                                 { "A#2", 116.54 }, { "A#3", 233.08 }, {
                                         "A#4", 466.16 },
                                 { "A#5", 932.32 }, { "C#1", 34.64 }, {
                                         "C#2", 69.29 },
                                 { "C#3", 138.59 }, { "C#4", 277.18 }, {
                                         "C#5", 554.36 },
                                 { "D#1", 38.89 }, { "D#2", 77.78 },
                                 { "D#3", 155.56 }, { "D#4", 311.12 }, {
                                         "D#5", 622.25 },
                                 { "F#1", 46.24 }, { "F#2", 92.49 },
                                 { "F#3", 184.99 }, { "F#4", 369.99 }, {
                                         "F#5", 739.98 },
                                 { "G#1", 51.91 }, { "G#2", 103.82 }, {
                                         "G#3", 207.65 },
                                 { "G#4", 415.30 }, { "G#5", 783.99 } };
```

Figure 4: Note Frequency Dictionary

Bonus Features

I was able to implement the 2048 Point FFT which allows for more sampling points. It required some changes to the FFT formula and the macro that was set for Sample Time. I think it's a major upgrade as it is far more accurate in its readings.

Conclusion

I learned a lot from this project as it wrapped together all the techniques we learned from the homework from the debouncing, HAL functions, structs, advanced FSM techniques, ADC, note algorithm creation, etc. This will definitely help me in the future as I work more with other types of microcontrollers.