EMBEDDED CHALLENGE

GROUP 19: Pierson Cai, Traman Gupta, Elaina Zodiatis

Youtube video : https://youtu.be/VMxEjceP52M?si=IoP2tkF-8fLa6Y03

The main objective for our project was to utilize the gyroscope on the STM32 F429
Discovery board to detect a Parkinson's resting tremor between 3 to 6 Hz. Data from the
gyroscope was continuously read and then processed using FIR and low pass filters. The data for
the X, Y, and Z axis were filtered, and the peaks within the frequency window were counted.
When any axis value fell within the 3 to 6 Hz frequency range, a tremor was detected and a
message was displayed on the LCD screen.

The MBED DSP library was used for the FIR filter. When creating the FIR Filter, FIR
filter coefficients needed to be created. To calculate these 31 values, 31 because of the resolution,
a python program was written. This python program had scipy, matplot, and numpy and
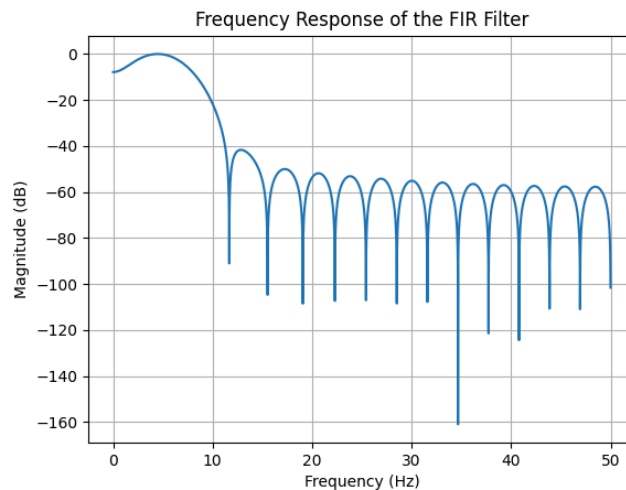displayed the coefficients on the graph as shown below (Figure 1).

Figure 1: Freq response graph

The coefficients were also displayed using an array that we could paste into the cpp file.

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After running the raw data through a couple of different filters, the data is put into an array that is used in the count_peaks function to count peak amplitudes that occur in tremor movement. Peak detection is used to calculate the frequency of movements in different axes through the logic that Hertz is equal to the number of cycles per second. For example, if in a given array of data for 1 second there are 4 peaks, this equates to 4 cycles during that second or 4 Hertz. In this case, the system will be notified that a possible tremor has occurred.

The code consists of taking in two parameters, data (an array of data) and size (the size of the array). The function count_peakers will return the count of how many peaks are detected within the given array of data through detecting points where the value is greater than the previous value, the next value, and is above the peak threshold pre-defined in the code. The count peaks function is the basis for calculating frequency in Hertz and is important in detecting possible tremors.

```
// Function to count peaks in a given data array
int count_peaks(float* data, int size) {
    int count = 0;
    for (int i = 1; i < size - 1; ++i) {
        if (data[i] > data[i - 1] && data[i] > data[i + 1] && data[i] > PEAK_THRESHOLD) {
            count++;
        }
    }
    return count;
}
```

Figure 2: Code of count_peaks function

The LCD screen was used to display an image and message when a tremor was detected. The LCD library was used which came with the board. Our message, "Tremor detected, Proceed with caution!", was displayed alongside a sad face to indicate a tremor being detected. These messages flashed (Figure 3) on the screen when the 3-6 Hz range was detected and disappeared once the tremor stopped.
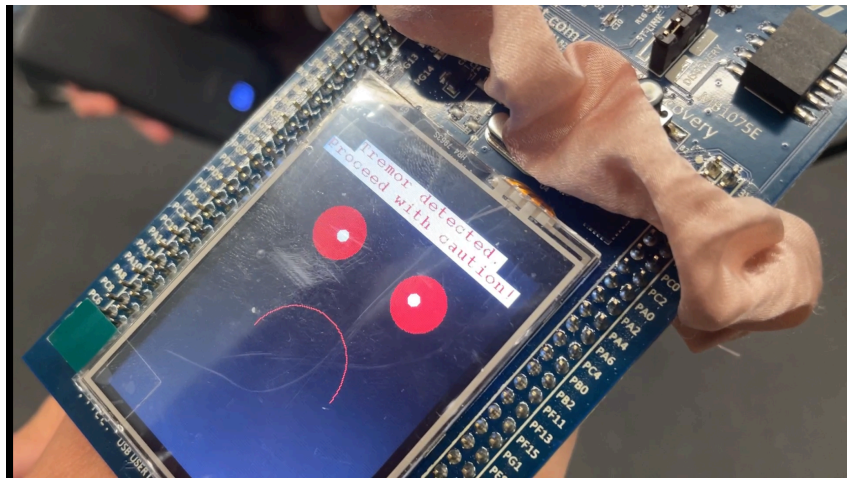

Figure 3: LCD screen display when tremor detected

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