Maestro Mittens

Team # 32
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1. **Introduction**
    a. **Objective and Background**
        i. Goals: What problem is being solved?
            - Some people have difficulty creating harmonic melodies, and learning how to create good sounding note combinations can be daunting.
            - Music theory is complex, so unless you have years of musical experience, freestyling on any instrument is not feasible.
            - Music classes are expensive
        ii. Functions: What is the product supposed to do?
            - Produces notes in the same key so you are never out of tune; the music produced is harmonic.
            - In “piano mode” moving your hands to the right/left will produce higher or lower pitches.
            - In “guitar mode”, bending your fingers in different combinations would produce different chords, also in the same key. The strumming hand would determine the tempo of the sounds produced.
        iii. Benefits: How is it good for the consumer?
            - Allows those with limited musical abilities/skills to be able to play various instruments with ease
            - Consumer would not have to carry around heavy instruments
            - Can accompany or freestyle with other instruments
        iv. Features: What aspects make it marketable?
            - Can be set to multiple instrument modes
            - Easy to use instrument simulator
            - Fun way to stimulate interest in making/playing music
            - More affordable than buying multiple instruments

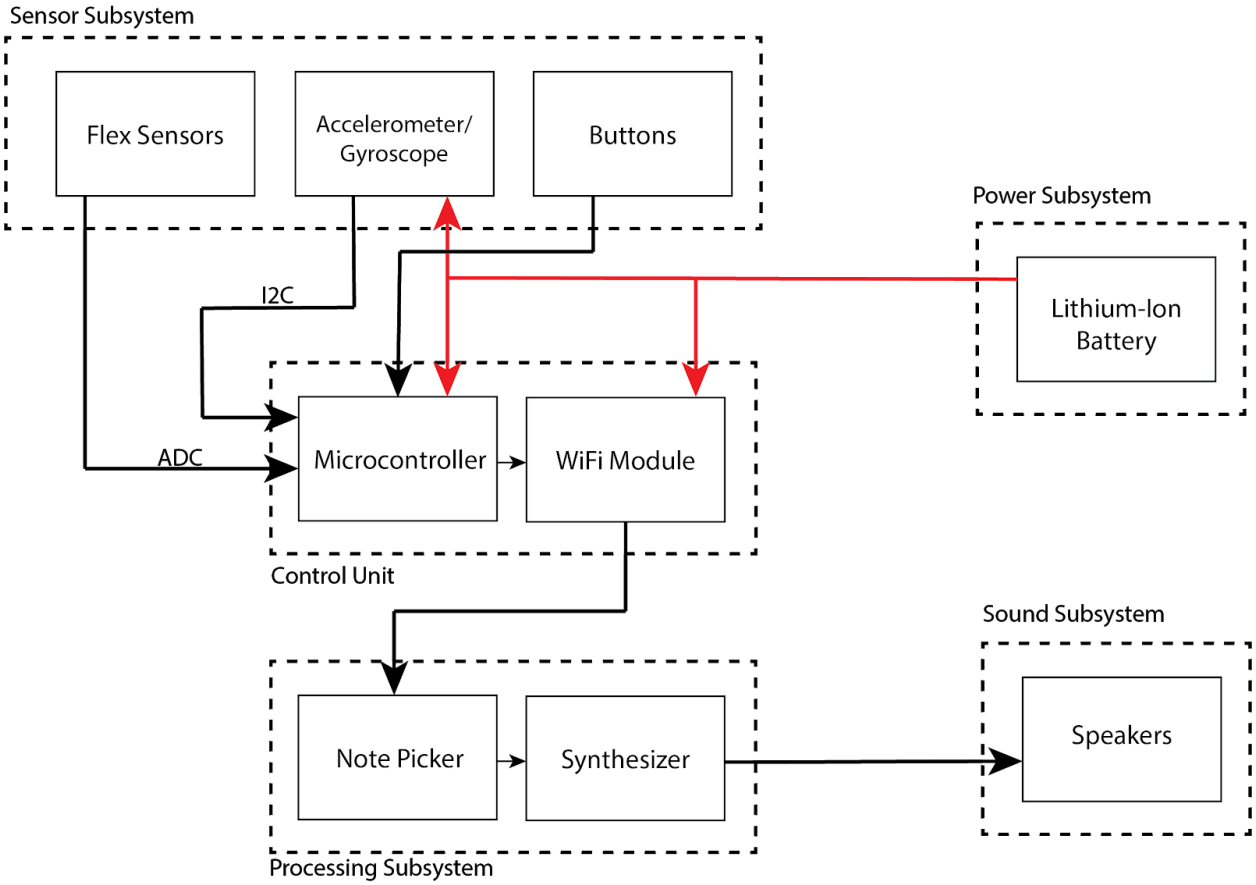
    b. **High-Level Requirements List**

        i. What quantitative characteristics must you project exhibit to solve the problem?
            - The flex sensors and accelerator/gyroscope should be calibrated enough to detect finger, wrist and arm movement when they occur with enough precision that a note could be replicated by repeating the same movement.

- The signals from the sensors should be sent to our computer fast enough so that the audible delay between the hand movement and sound is negligible to the human ear.
- The computer should appropriately interpret the signals to produce the proper notes such that there are no dissonant notes played or abrupt unintended jumps in pitch.

2. Design

a. Block Diagram - what are the individual components?



b. Block Descriptions

i. Sensor Subsystem:

- The Sensor subsystem is responsible for receiving the user's arm and finger movement and sending it to the control unit.
- Consists of flex sensors, accelerometer, gyroscope, and buttons.
- A flex sensor (4.5" - SEN-08606) will be attached to each finger of the glove to detect when the user moves their finger.

    a. Requirement 1: when bent to about 45° the flex sensors subcircuit output a voltage approximately 1.2V larger than when they were unbent
- The accelerometer and gyroscope (MPU6050) detect the user's hand motions and estimate their position.
    a. Requirement 2: The accelerator/gyroscope should be able to provide the microcontroller with an approximate distance between the user's hands within about 10 cm
- The buttons will allow the user to select the instrument.

ii. **Control Unit:**
- The control unit is in charge of receiving the data from the accelerometer/gyroscope via I2C (Inter-integrated Circuit) Protocol.
- The flex sensors will transmit voltages which will go through an ADC(Analog to Digital Converter) to the microcontroller
- The buttons will be present on the microcontroller, providing input to know the instrument being played.
- The microcontroller will be connected to a Wifi board to transmit the data received to the processing subsystem.
- Requirement 1: Microcontroller must have an ADC and be able to communicate over I2C
- Requirement 2: Wifi module data rates will be around 66 Kbps .

iii. Power Subsystem:
- The power subsystem is responsible for supplying all of our components with power.
- It consists of a lithium ion battery.
- Requirement 1: all of our components will operate under 3.3V of supply power.

iv. Processing Subsystem:
- Note picker system will be dependent on the instrument selected. Using the finger given and movement detected (based off of speed and angle), and based on other notes played recently, will decide a note accordingly.
- Synthesizer will convert the given note into an audio signal to be sent to the sound subsystem.

v. Sound Subsystem:

- Using the system's built-in speaker, the final audio signal will be played.

c. Risk Analysis

i. Identify the block or interface that you that poses the greatest difficulty or risk to implement.

- A big risk for the project is the sensors. Sensor readings can be quite unreliable at times, and we will be using multiple sensors which will all affect a single note value.
- Our system could be calibrated to cancel out noise that is not relevant to the program. That way minor motions aren't incorrectly interpreted as playing a note. We could observe the sensor values at rest, when there are no movements being made, as well as implement the project to require somewhat exaggerated gestures to guarantee a note being played right.
- The sensors of course are integral to the user experience. The user would like to see every movement they perform being translated into sound. Too much noise and unexpected behavior could be detrimental to the overall experience. It is quite important that we avoid this issue.