WaveMix

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Senior Design Project 2026 | Team 13 Midway Design Review

Agenda

The Team

ANANYA ROHATGI

SENSOR SIGNAL PROCESSING

FRONTEND DEVELOPMENT

CO-PROJECT LEAD

Computer Engineering

SAMANVAY UPADHYAY

HARDWARE DESIGN & INTEGRATION

EMBEDDED SYS PROGRAMMING

CO-PROJECT LEAD

Computer Engineering

SOPHIA ZENG

PCB DESIGN & HARDWARE TESTING

HARDWARE DESIGN

LOGISTICS LEAD

Computer Engineering

SREENIYATHI KASIREDDY

AUDIO PROCESSING & EFFECTS

FRONTEND DEVELOPMENT

BUDGET LEAD

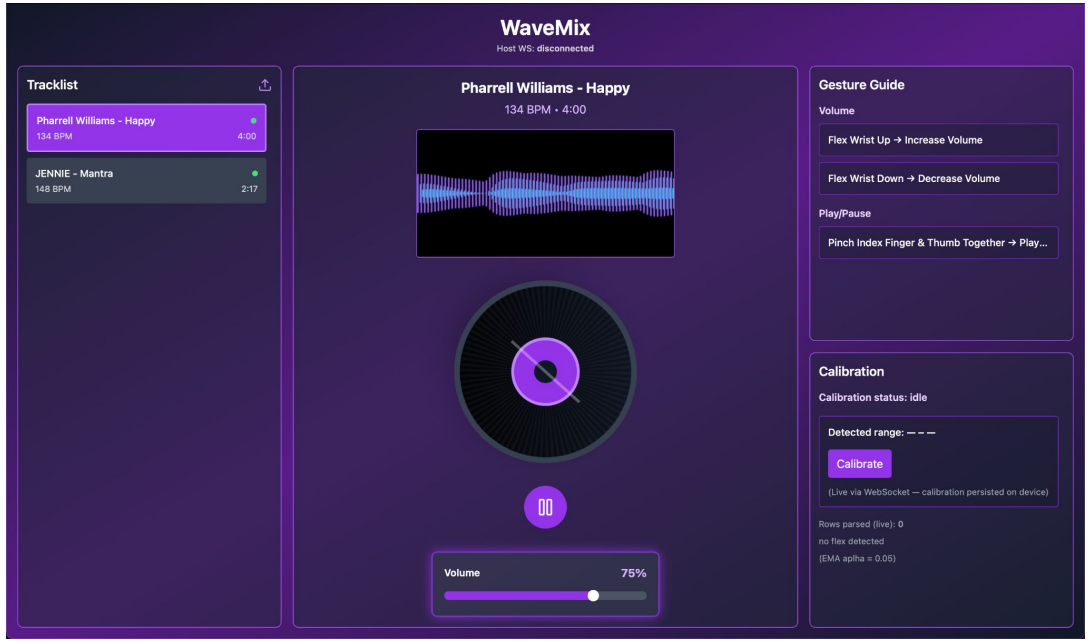
Computer Engineering

Problem Statement

Traditional DJing requires technical expertise and specialized hardware. This setup can be expensive, complex and intimidating for non-professional music enthusiasts or hobbyists. Current products do not appeal to this large audience due to their cost ranging between $300-$3000 and high complexity. Therefore, our project aims to provide an affordable, gesture-controlled DJ mixing experience. Users can mix music in real-time using custom software and gloves, without purchasing expensive external software or learning complex professional platforms.

Fig. 1 – Traditional DJ setup [1]

Our Idea – WaveMix



- We are proposing a gesture-controlled DJ system that allows users to mix music in real-time using intuitive hand and finger movements, combining affordability with a more expressive, performative DJing experience.
- This system will be a software-based DJ simulator paired with sensor gloves, creating a portable and wireless solution designed to operate with any computer, tailored for hobbyists and DJing enthusiasts.
- Our system features include:
  - Real-Time Hand and Finger Gesture Control
  - Custom Virtual DJ Software Interface
  - Wireless, Portable Operation
  - Reduced Learning Curve
  - Dynamic Visual Feedback

Comparison Table (Updated)

	Movement Based Control	Gesture Based Control	Suitable for All Types of Users	Compatibility with Music Softwares
MiMu Gloves				
Rukusfx Music Mixer				
WaveMix				

Goals & Testing Plan

Project Goals (Updated)

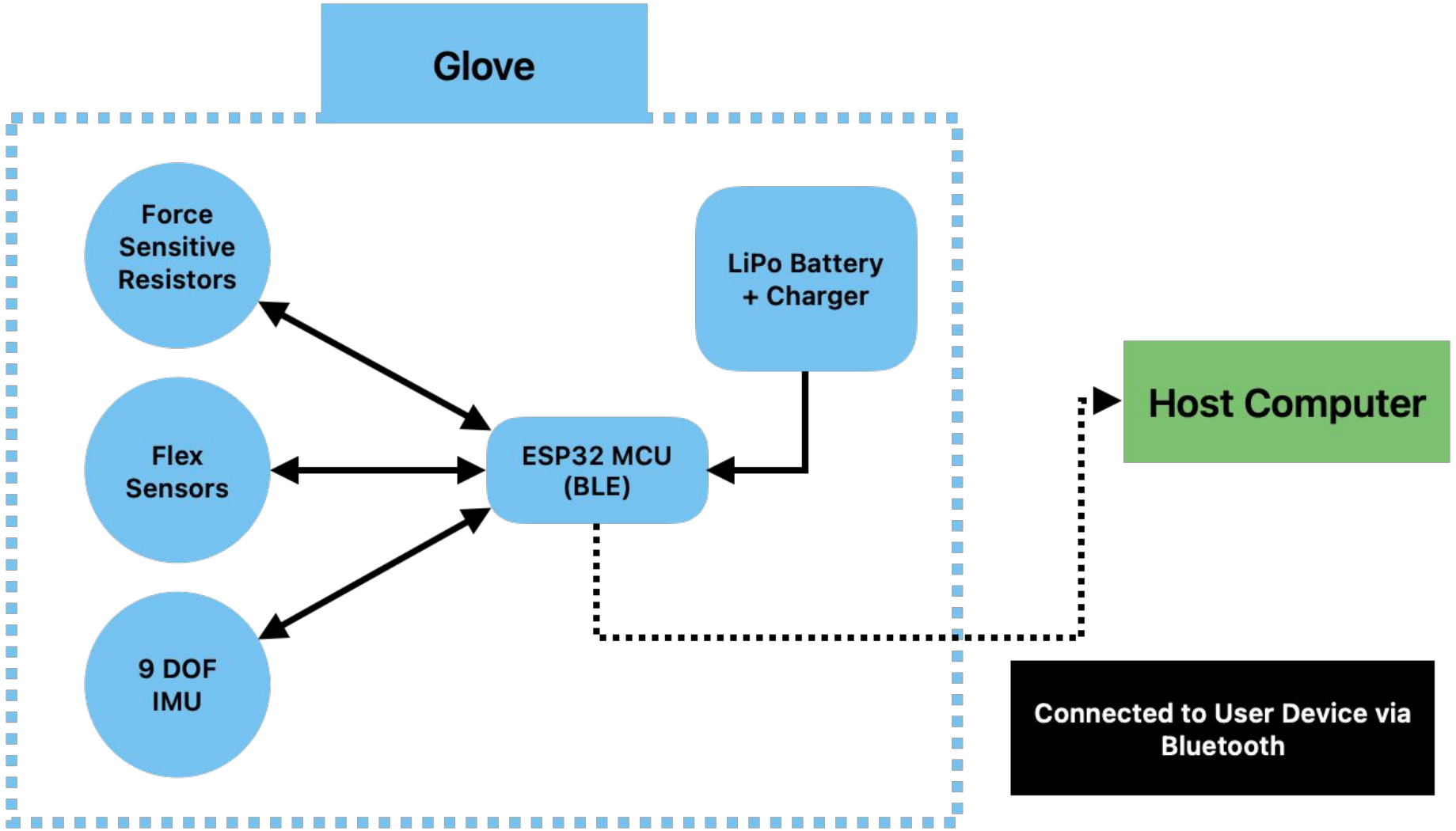
1. **Inclusive Live Music Performance:** Allow users of all experience levels, to enjoy the live process of altering and mixing music.
2. **Accurate Sensor Data Capturing:** Implement algorithms to read and combine data from flex sensors and FSRs to capture hand and finger movement accurately in real-time.
3. **False Movement Detection:** Develop algorithms to distinguish intentional gestures from incidental movements using thresholds requiring consistent sensor readings over a brief window before triggering commands.
4. **Comfortability:** Users should be able to use the glove(s) component easily, without any bulkiness, uncomfortable movement, or hindrance from electronic components. The glove(s) should also support a minimum of 2 hours of continuous operation.
5. **Interactive UI/UX Design:** Design a clean and intuitive visual interface that mimics a virtual DJ setup and displays changes made by the user in real-time. This includes controls for effects and volume, waveforms, and a list of controls.
6. **Low-Latency Wireless Communication:** Establish a stable BLE connection between the glove and software application with latency under 50ms to ensure a seamless user experience.

System Specifications and Testing Plan

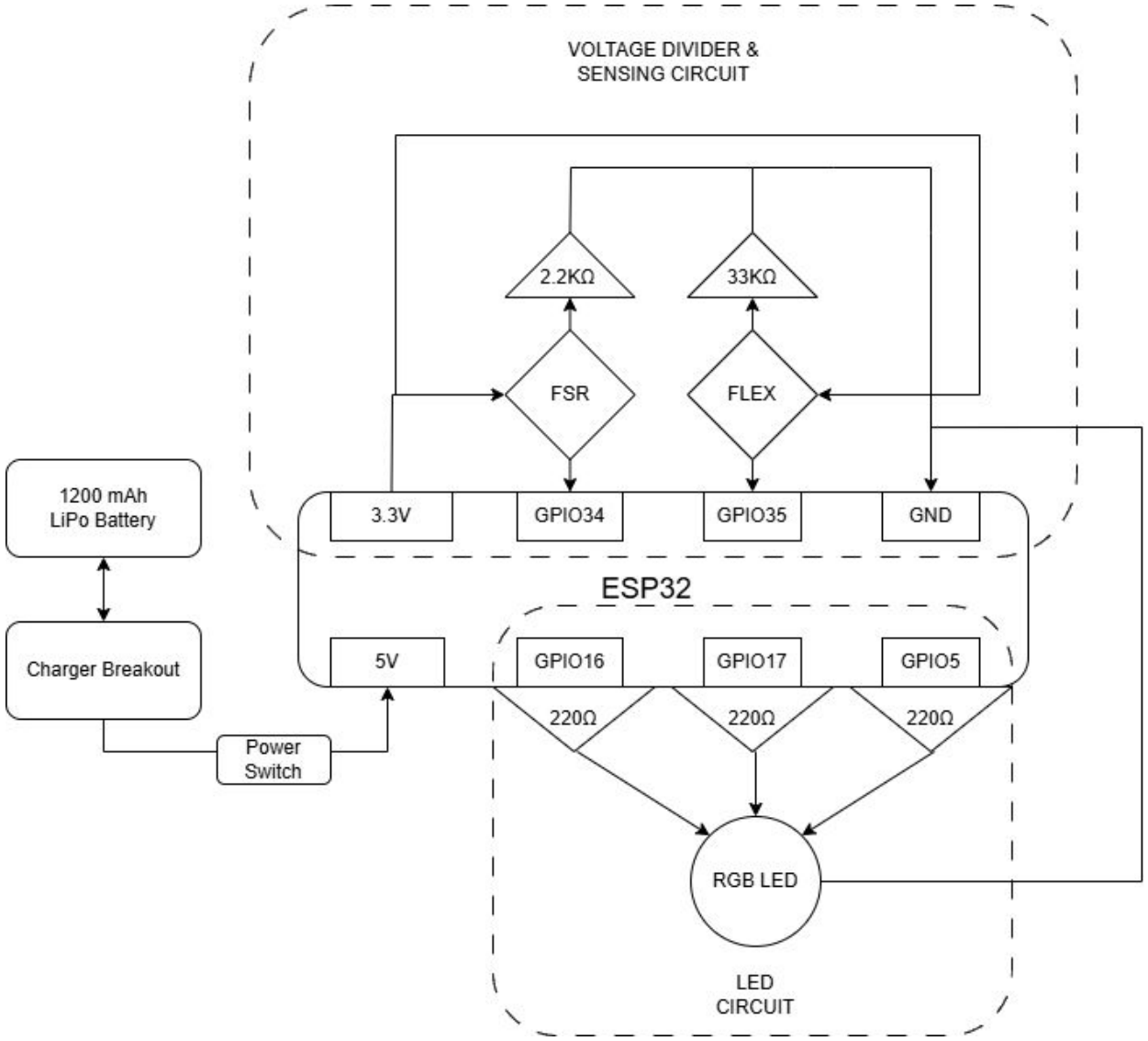
Specification	Testing Plan
Form Factor: One lightweight glove with sensors, wrist-mounted battery pack and microcontroller.	**Gesture Recognition:** Precision ≥ 90% for core gestures, false positive rate < 5%.
Sensors: 1 × flex sensors (wrist), 3 × FSRs (fingertips)	**Robustness:** BLE reconnects after packet loss, consistent sensor output across different environment conditions like temperature, crowded network, etc.
MCU & Comms: ESP32 MCU, Bluetooth Low Energy communications.	**Latency:** ≤ 50 ms (target), 100 ms (goal)
Power: 3.7V 1200 mAh LiPo battery	**Battery:** Minimum 2 hours of continuous operation target.
UI: browser-based digital DJ controller with waveform, tracklist and general visual feedback	**Storage**: Storing raw capture locally in successful transmits.
Robustness: Glove usable across a range of hand sizes and movements.	**Usability & Learnability:** Average novice learns main gestures within 15 minutes, Glove scores above 75 on SUS

System Design Documentation

PDR Hardware Block Diagram



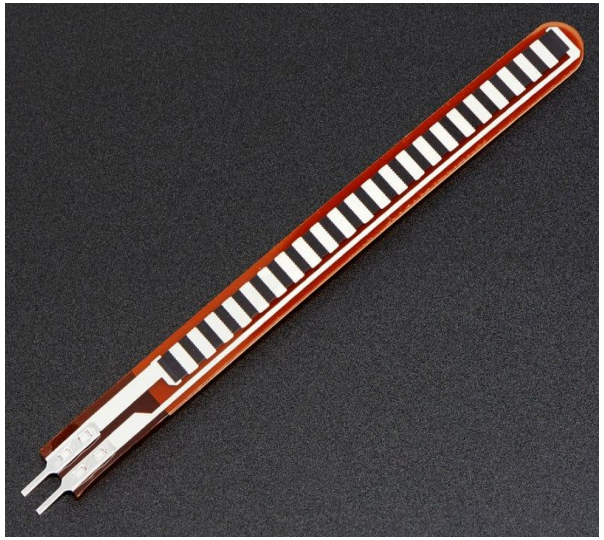
Hardware Block Diagram (Updated)



Hardware Parts Overview

Common Cathode RGB LED

- Blinks green when ESP32 is trying to connect to host computer
- Turns solid green when connected.
- Turns Yellow when FSR is being utilized for play and pause



Spectra Flex Sensor

- Flexing changes sensor resistance between 25k to 50k Ω
- Utilized with a voltage divider circuit with a fixed resistor value of 33kΩ to get ADC values on ESP32

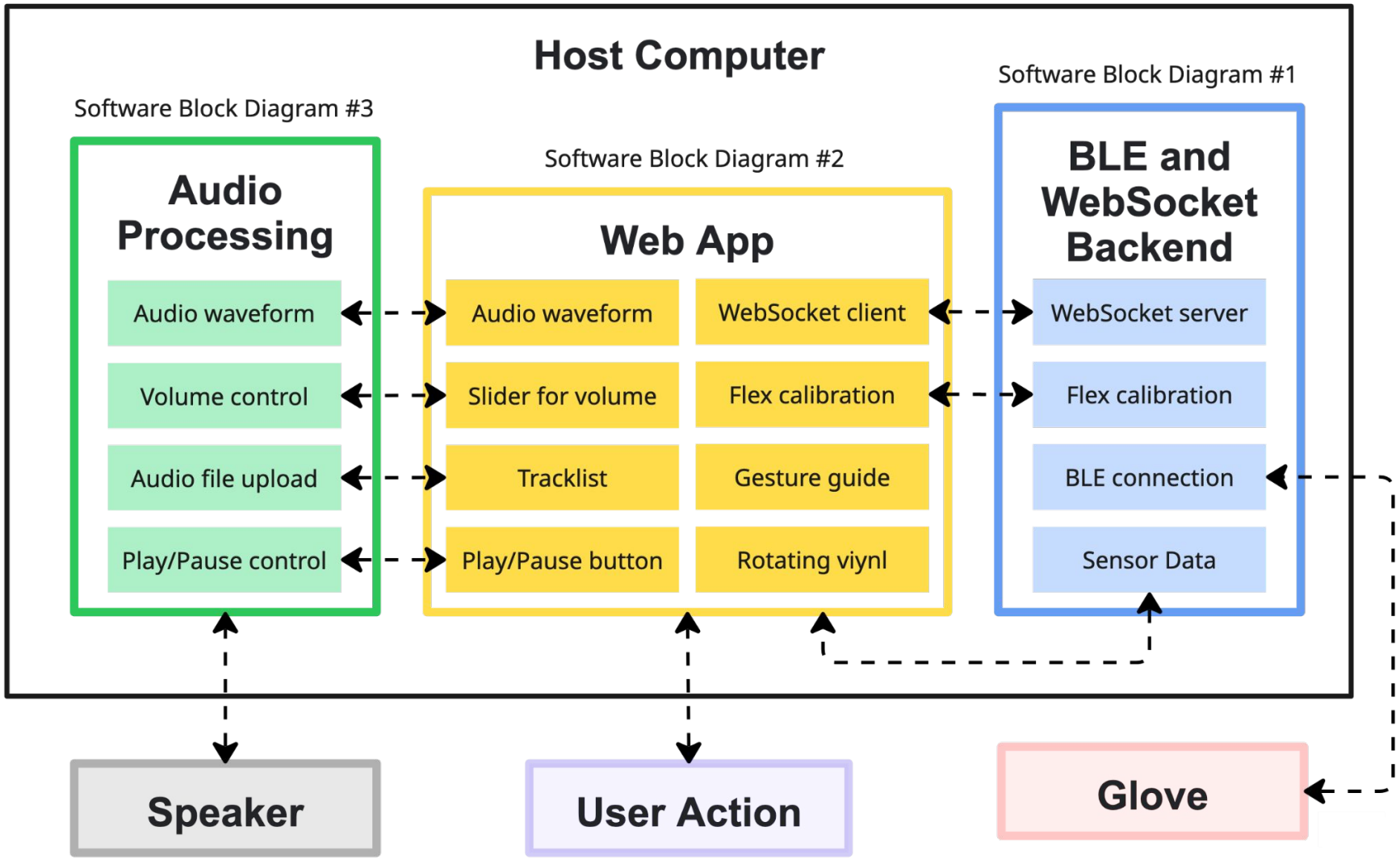
FSR-402

- Applied force changes sensor resistance between ∞ to 500 Ω
- Utilized with a voltage divider circuit with a fixed resistor value of 2.2kΩ to get ADC values on ESP32

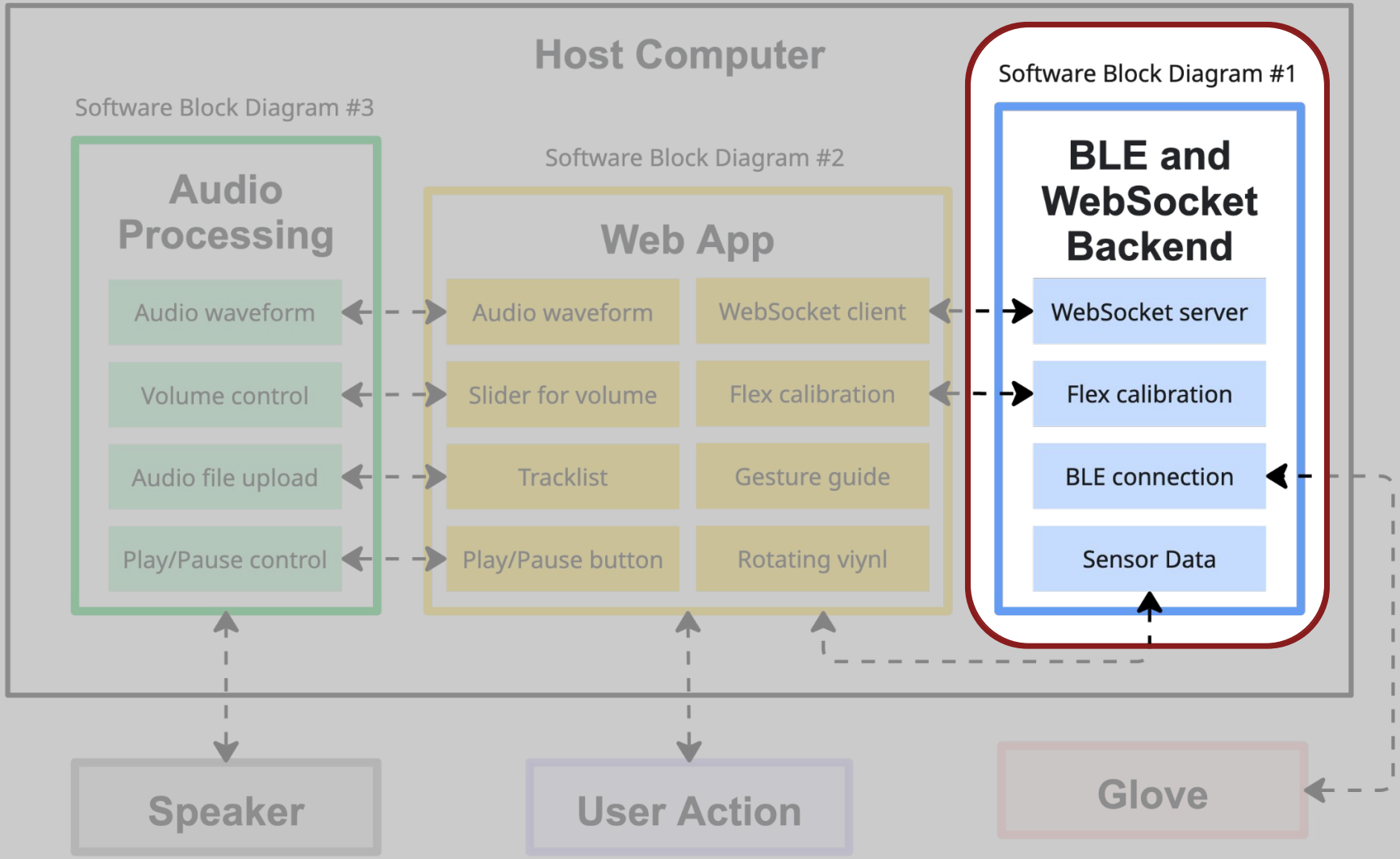
ESP32 MCU

- Utilizes ADC to get sensor values from FSR and Flex
- Sends PWM signal to get different different LED lights
- Connects to host computer over BLE.

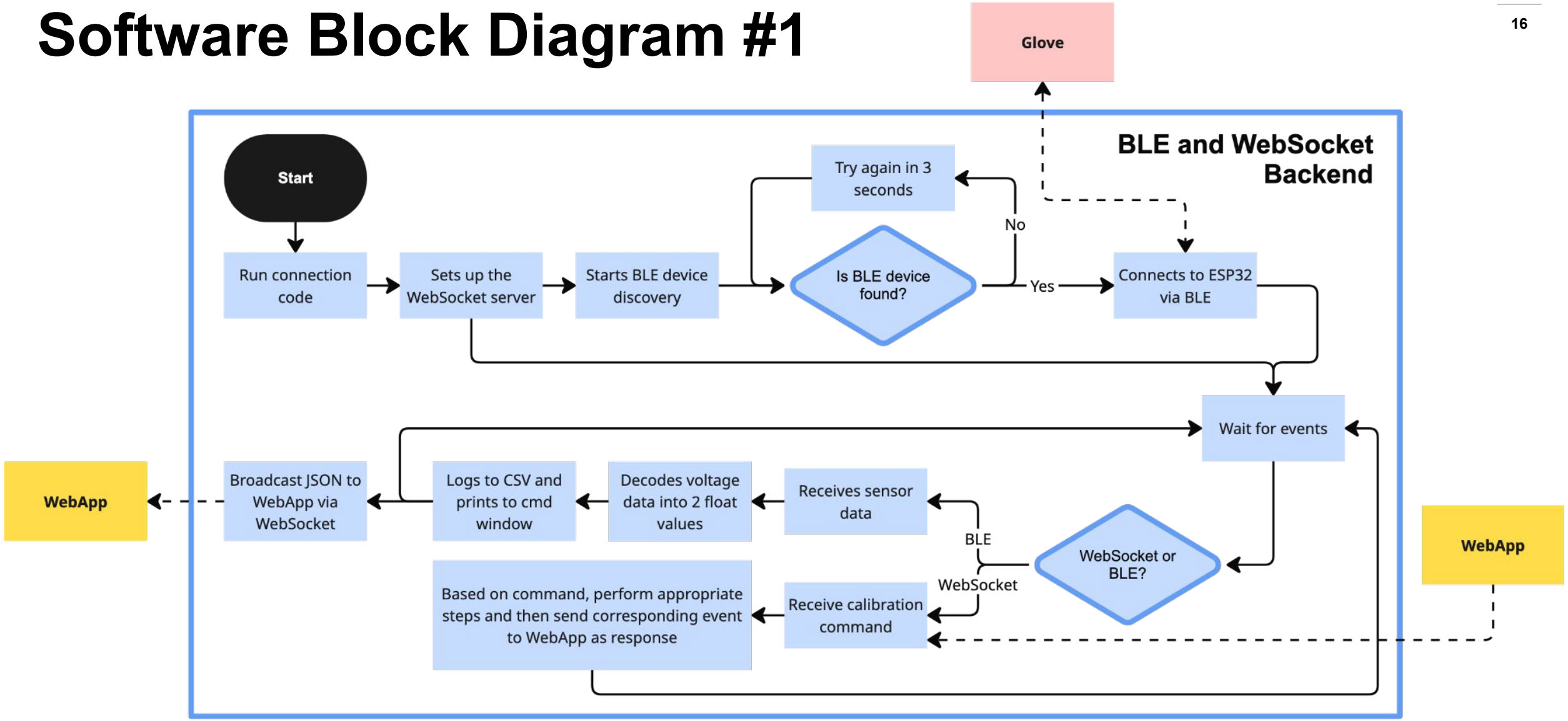
Software Block Diagram



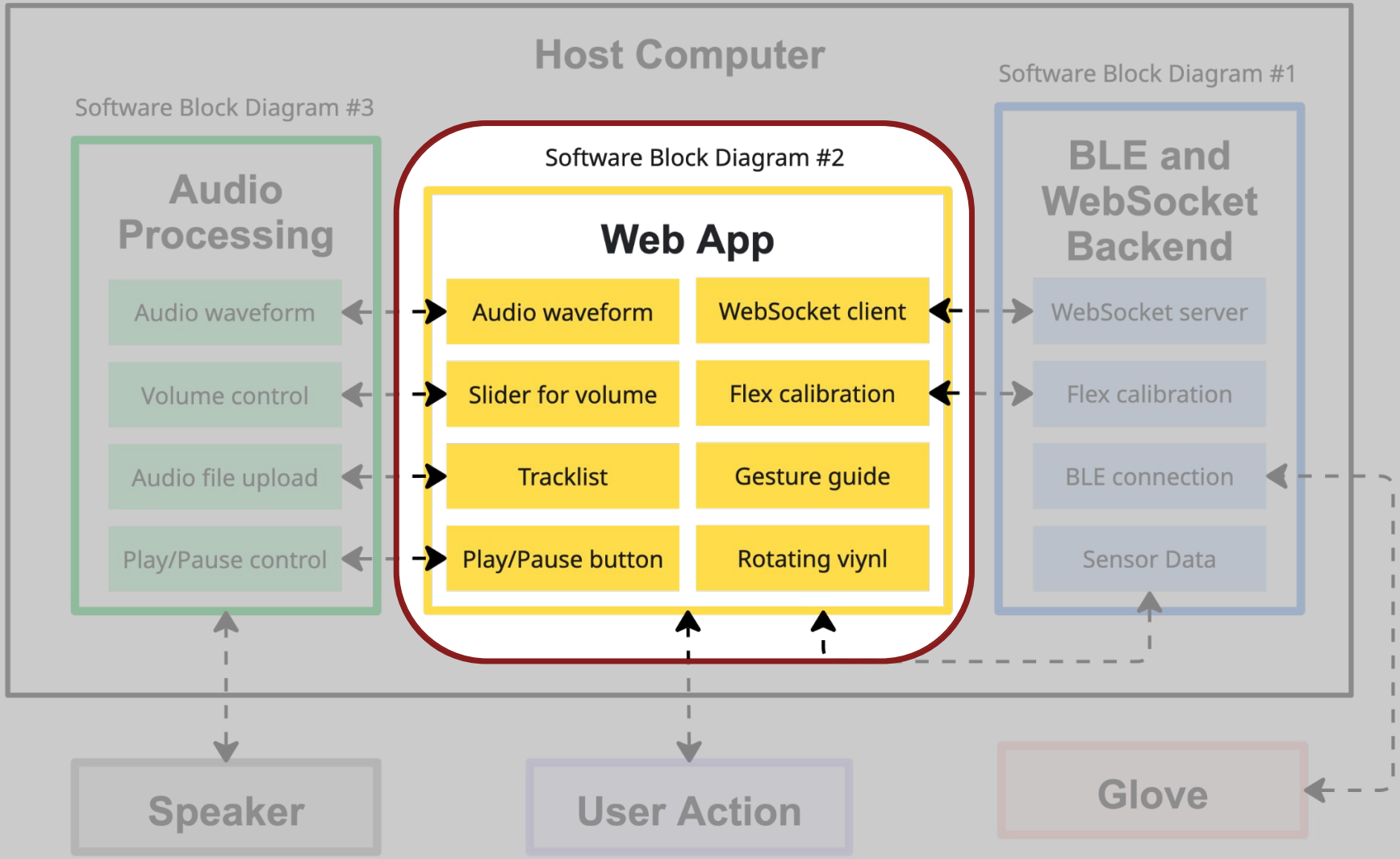
Software Block Diagram



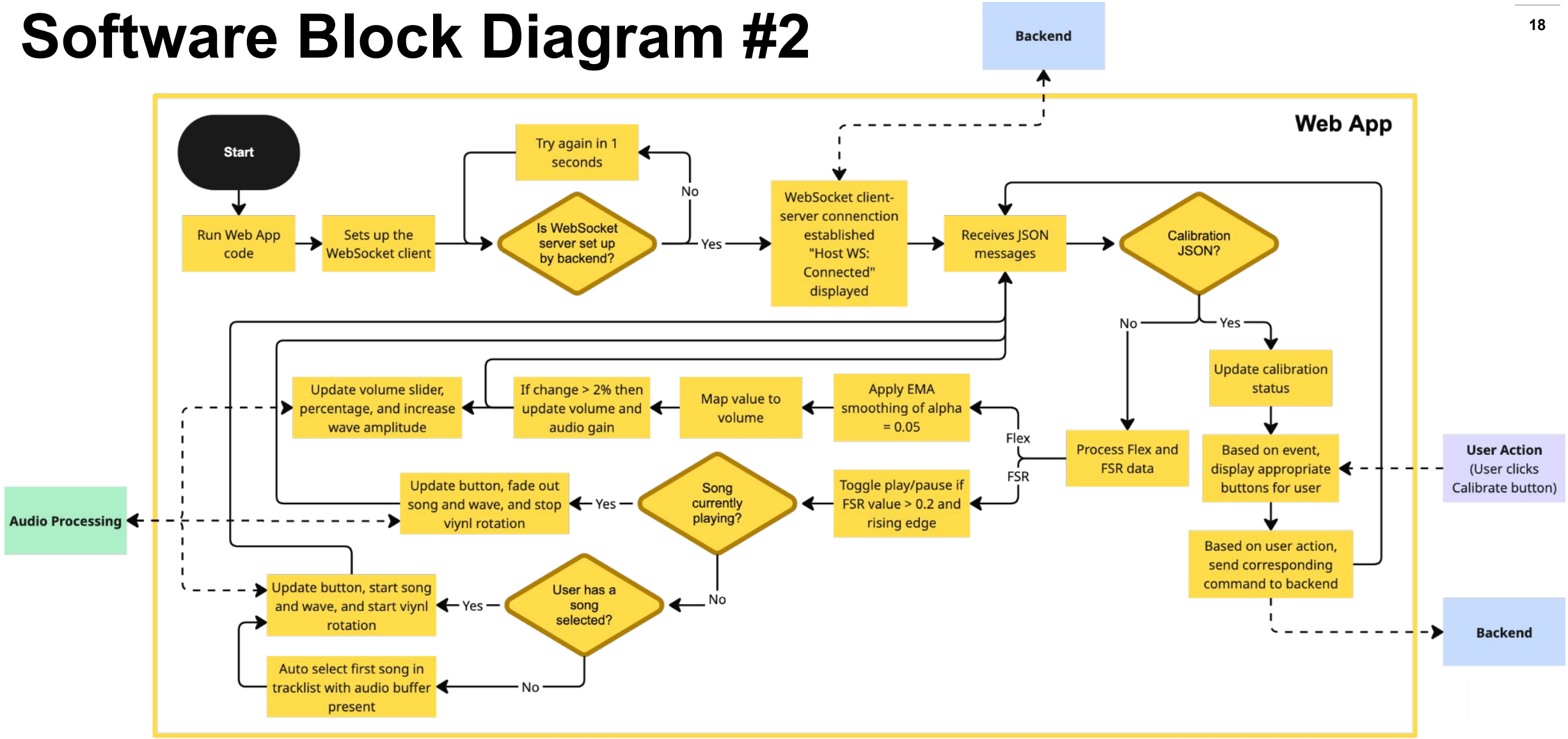
Software Block Diagram #1



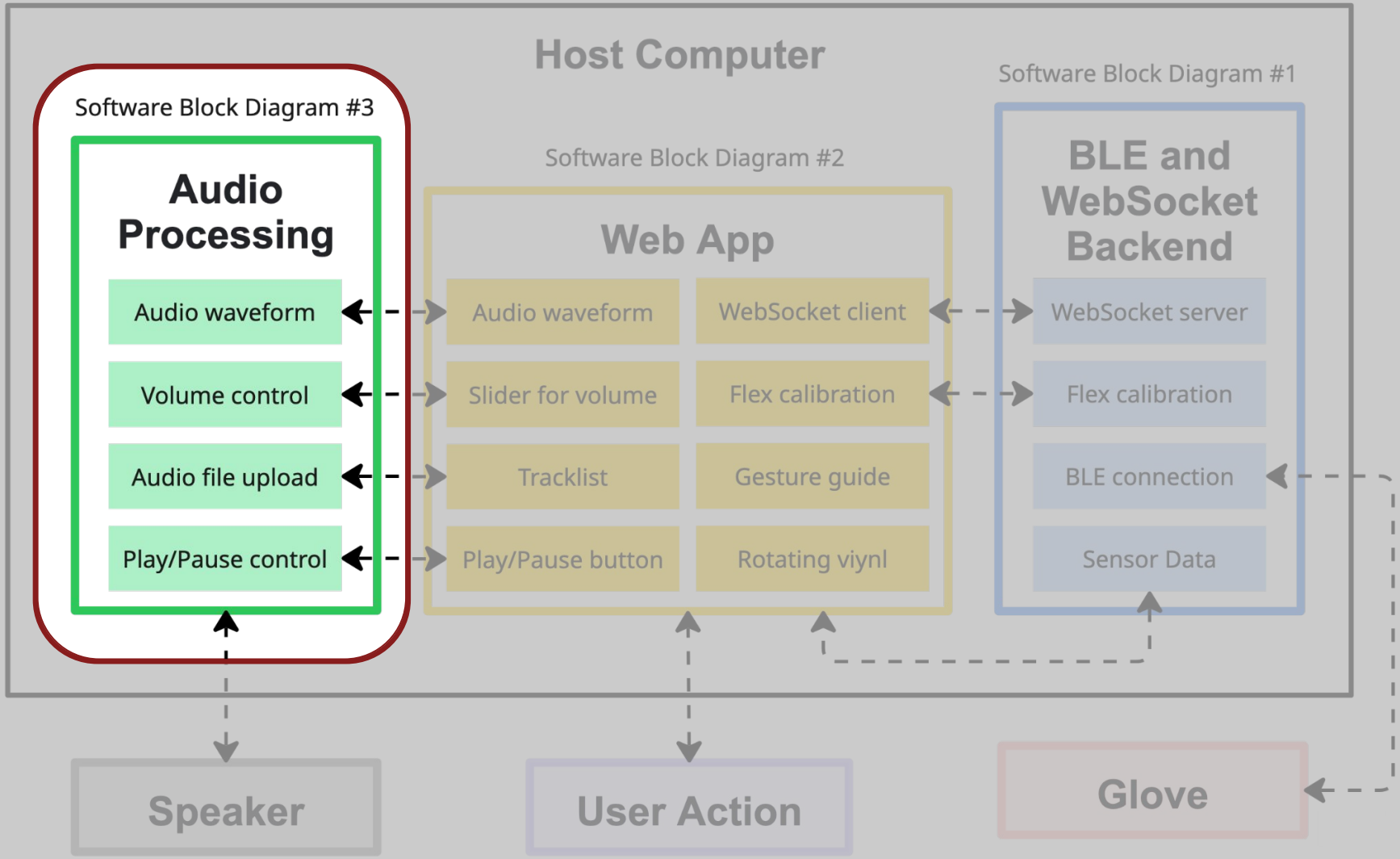
Software Block Diagram



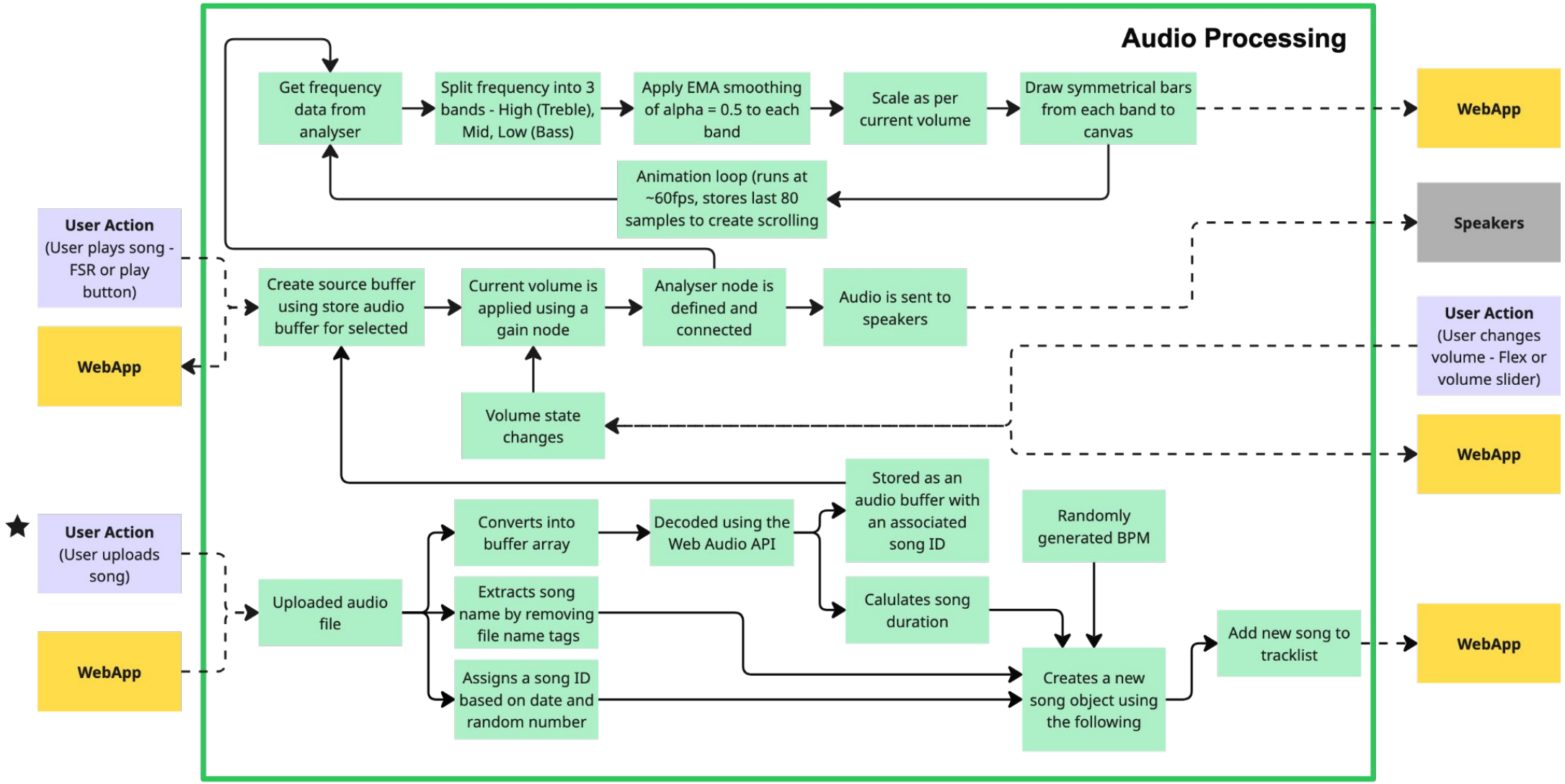
Software Block Diagram #2



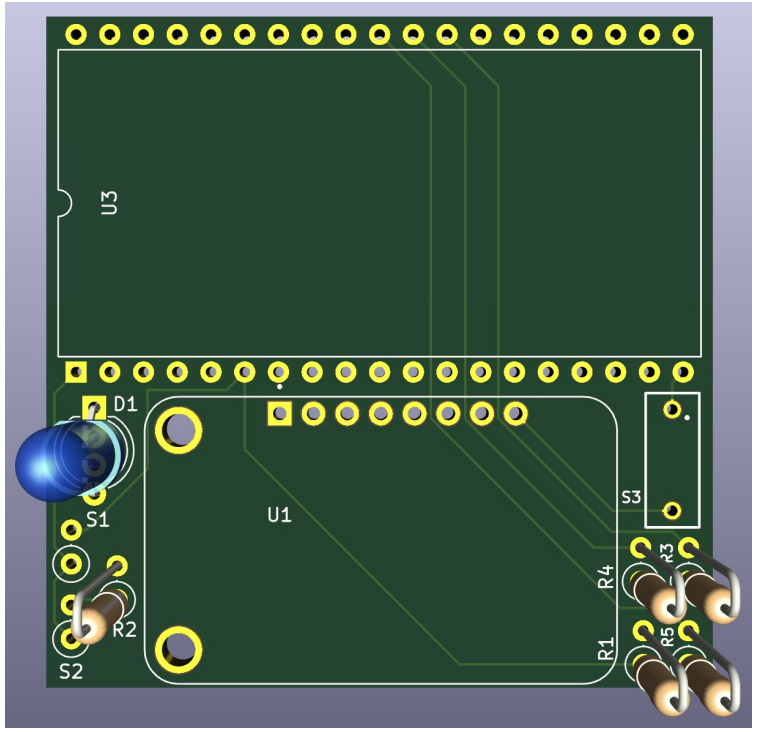
Software Block Diagram



Software Block Diagram #3

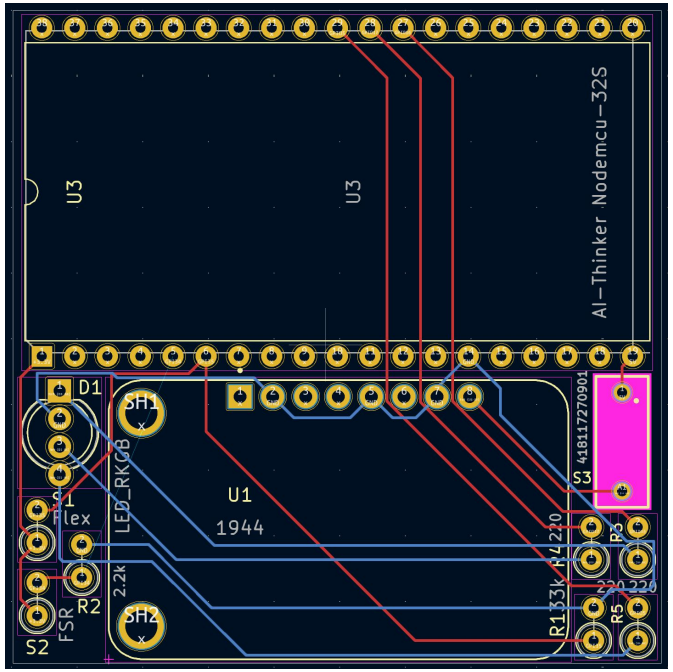


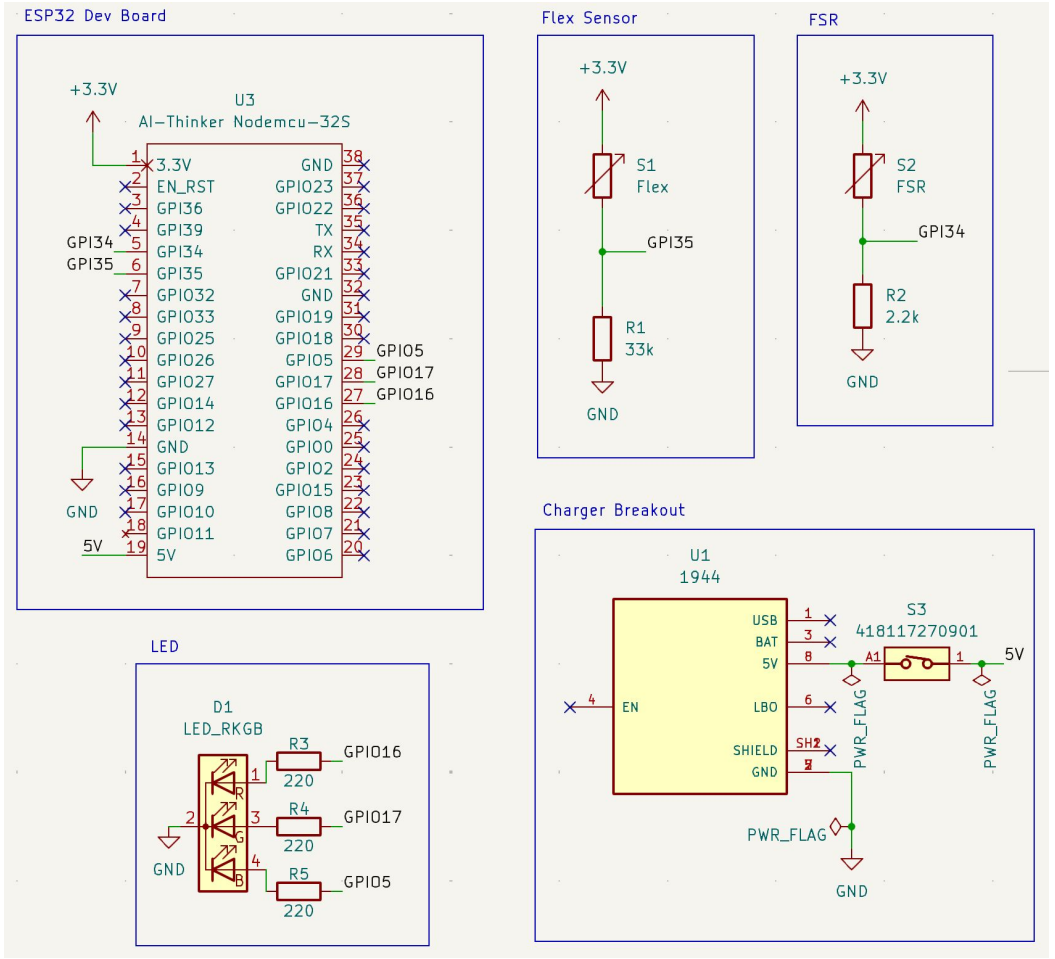
Current PCB Plan



3D Viewer

Layout





Schematic

MDR Deliverables

Proposed MDR Prototype

Glove System:

- ESP32 Development Board
- Inertial Measurement Unit
  - Detects hand position and gestures (up/down → volume control)
  - Maps IMU sensor data to control signals
- Power Switch
- Power supply (Battery + Charger Breakout)
- BLE connection to host computer

DJ Software Interface:

- Real-time visualization of current song as a waveform
- Volume Slider
  - Highlights when controlled by glove
  - Updates percentage in real-time with low latency
- Play/Pause button (manual on computer)

Proposed MDR Prototype

Glove System:

- ✅ ESP32 Development Board
- ❌ Inertial Measurement Unit
  - ↳ **Implemented Flex sensor instead**
- ✅ Power Switch
- ✅ Power supply (Battery + Charger Breakout)
- ✅ BLE connection to host computer

DJ Software Interface:

- ✅ Real-time visualization of current song as a waveform
- ✅ Volume Slider ⇒ Gesture: bending wrist up and down
  - ❌ Highlights when controlled by glove
  - ✅ Updates percentage in real-time with low latency
- ✅ Play/Pause button (manual on computer)

Additional Features in MDR Prototype

Glove System:

- Force Sensitive Resistor (FSR)
- LED to indicate BLE connection and FSR use

DJ Software Interface:

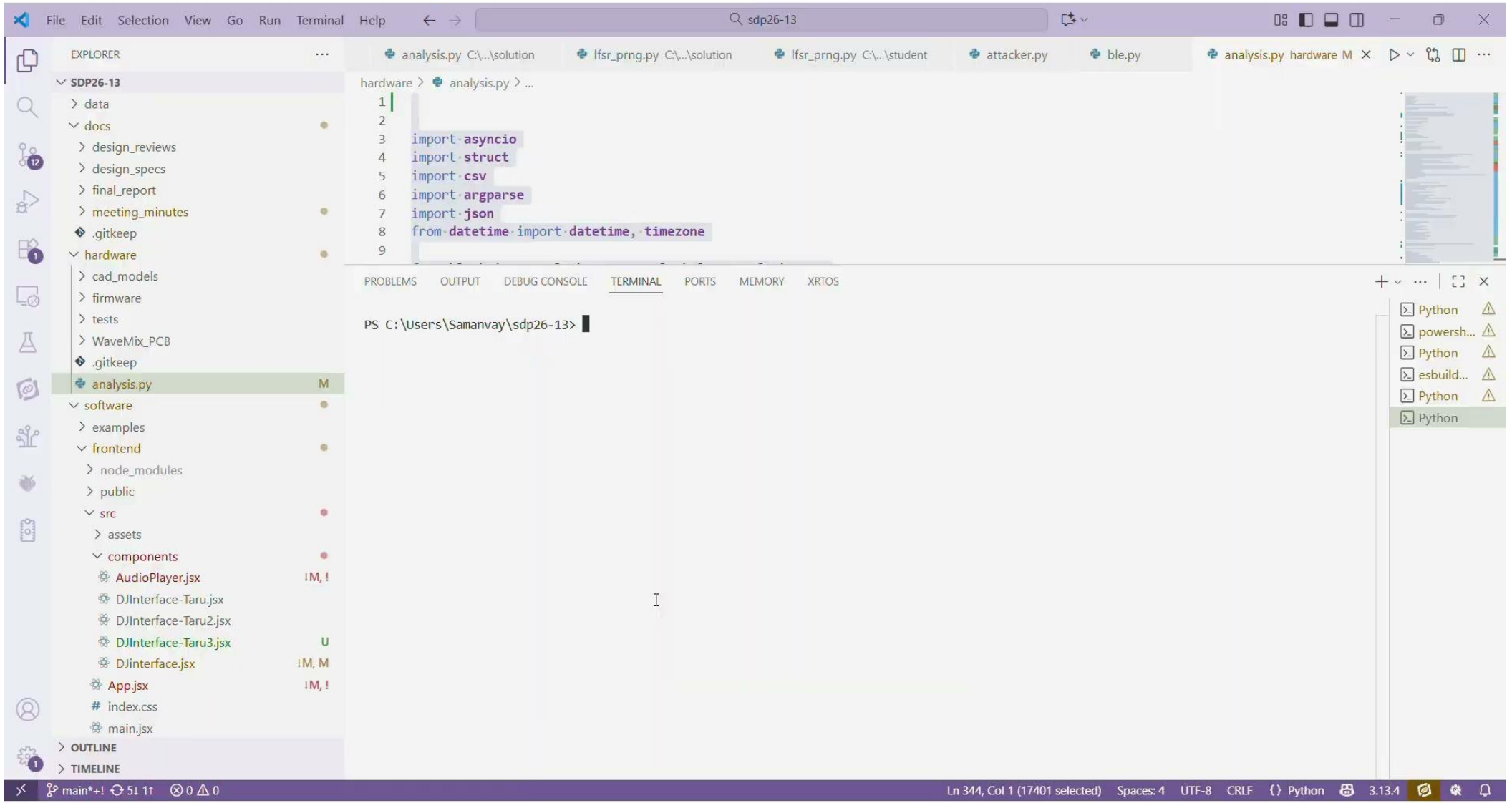
- Volume slider box glows with brightness proportional to volume
- Ability to upload user's own audio files
- Rotating vinyl as visual cue

Integration:

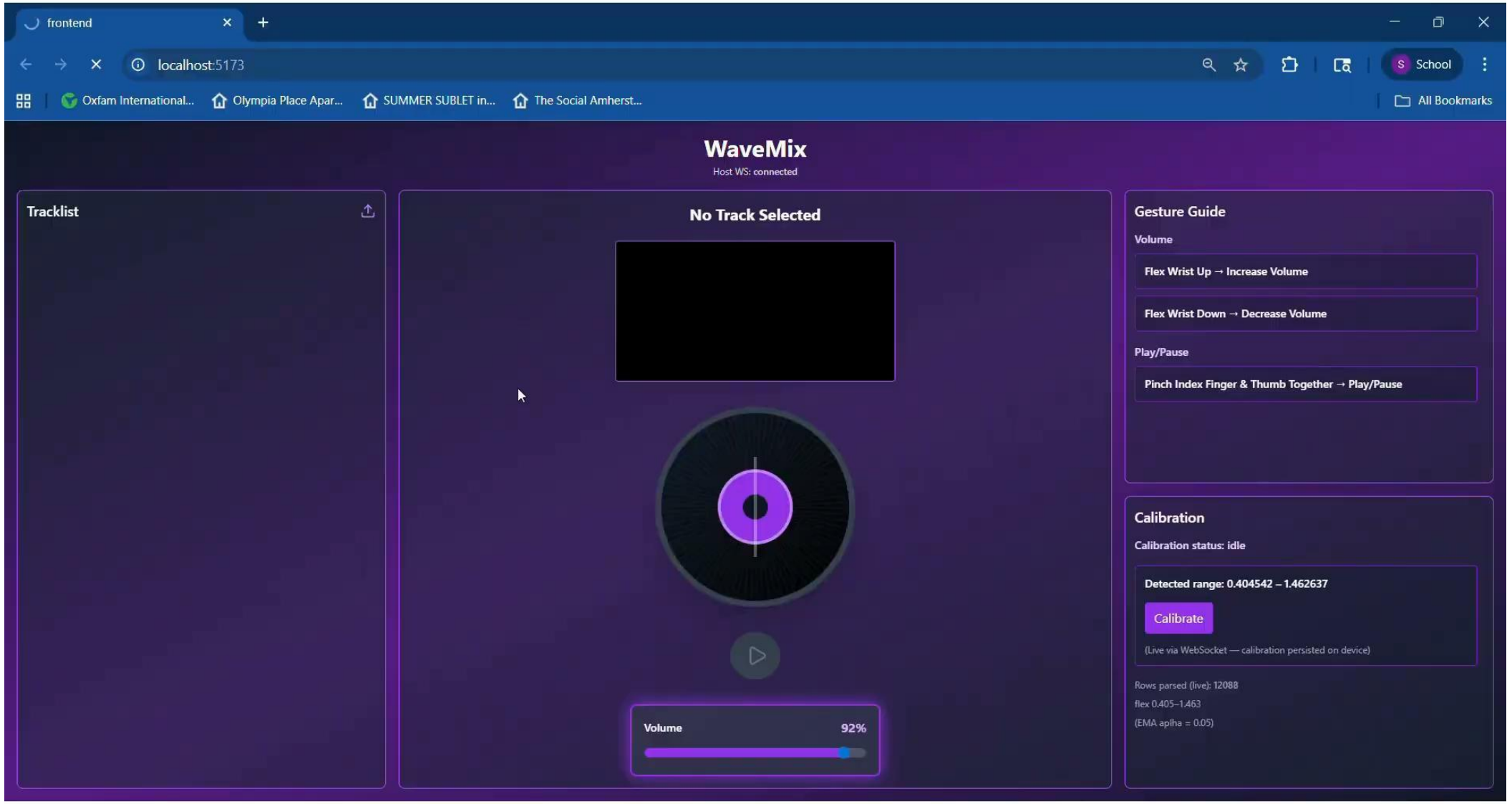
- Data flow across different parts of the system managed in real-time
- Play/Pause button controlled using index and thumb pinching gesture (uses FSR)

MDR
Live Demo

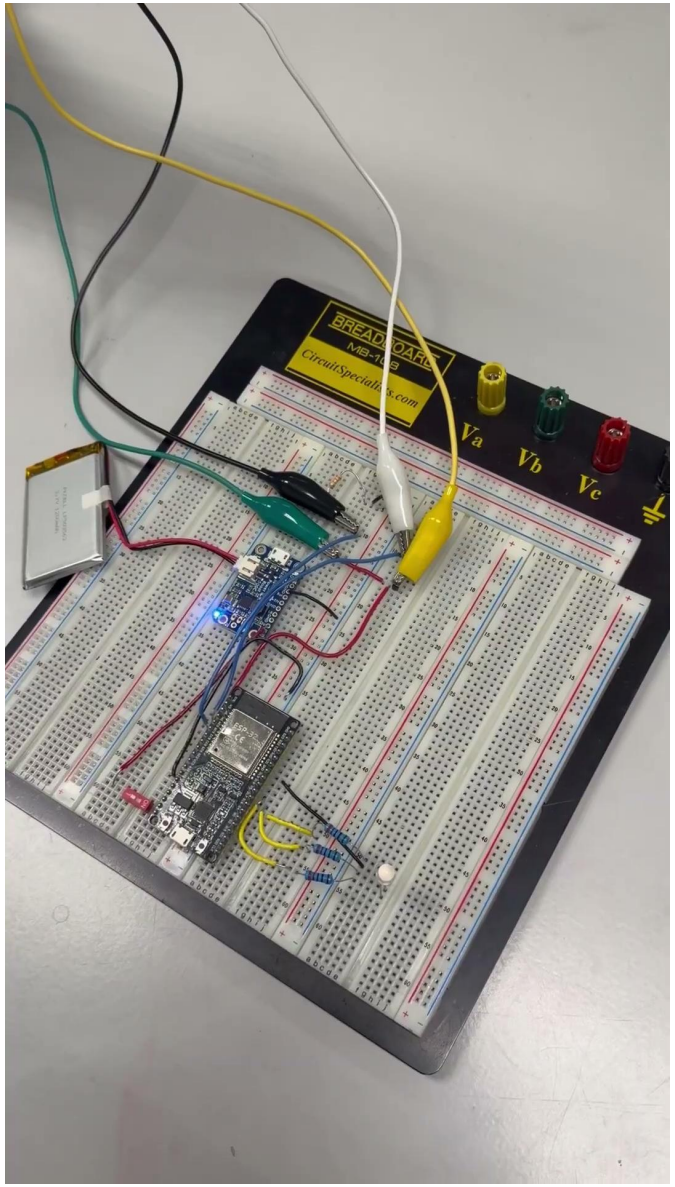
Demo videos #1 (BLE and WebSocket)

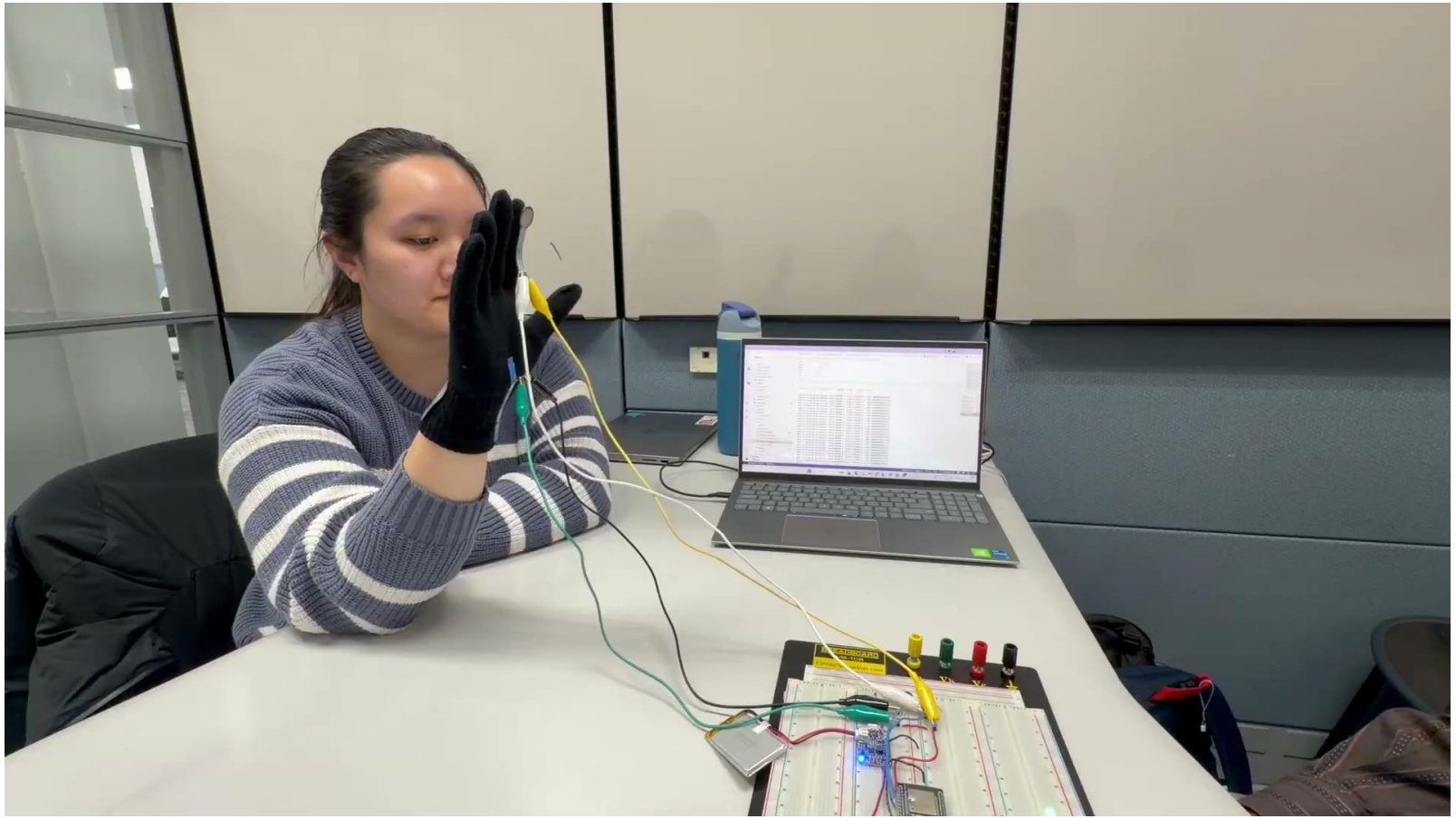


Demo videos #2 (Web App)



Demo videos #3 (Hardware and Integration)





CDR Deliverables

Proposed CDR Prototype

Glove System:

- ESP32 Development Board → ESP32-WROVER-B Module
- 1 Flex sensor and 3 FSRs (2 addition FSRs)
- Power Switch
- Power supply (Battery + Charger Breakout)
- BLE connection to host computer
- LED to indicate BLE connection, FSR use → Add LED indication for different sensor uses

Integration:

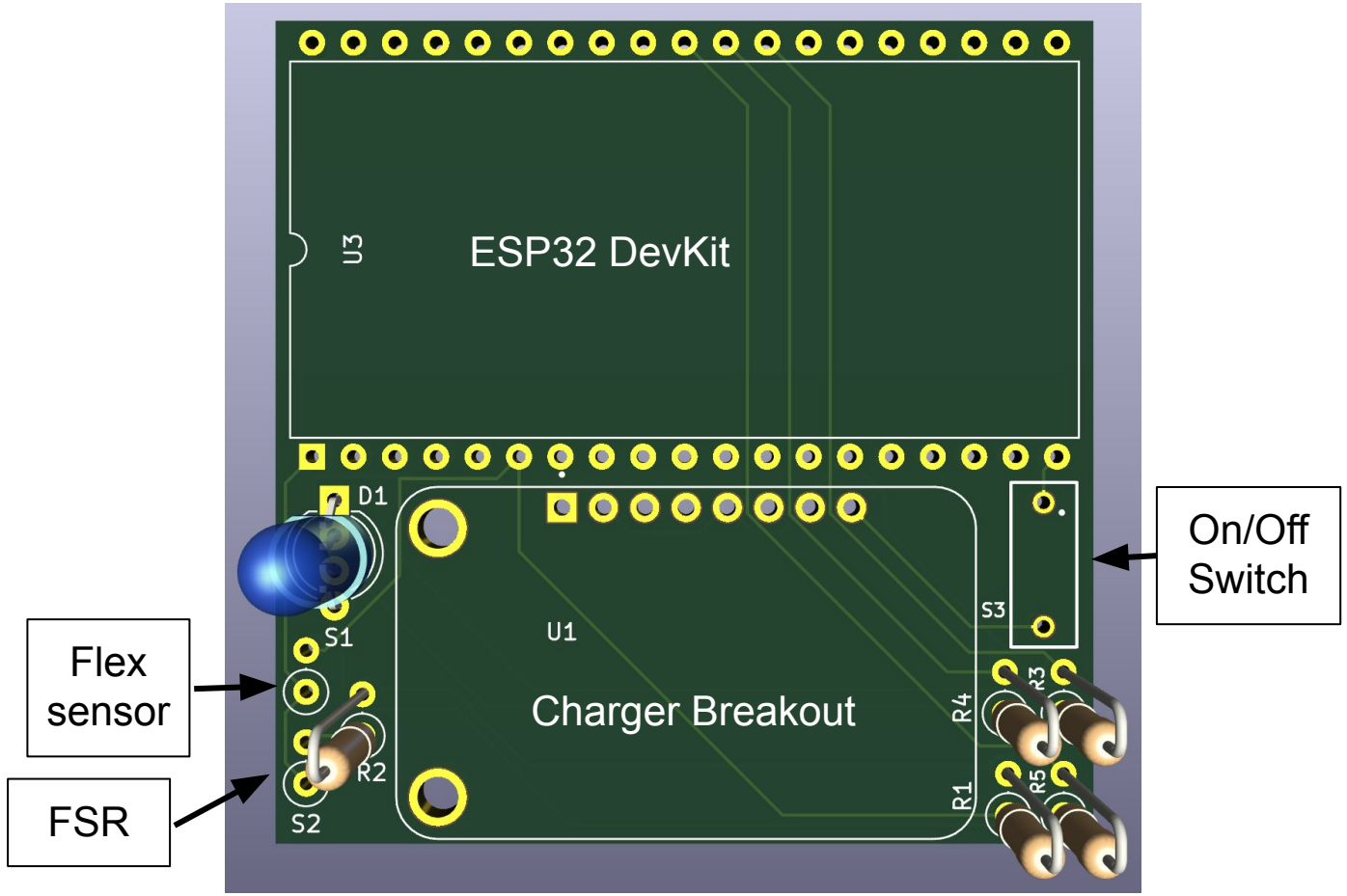
- Data flow across different parts of the system managed in real-time
- Play/Pause button controlled using pinching gesture (uses FSR)
- Potential consideration - implementing 2 gloves

DJ Software Interface:

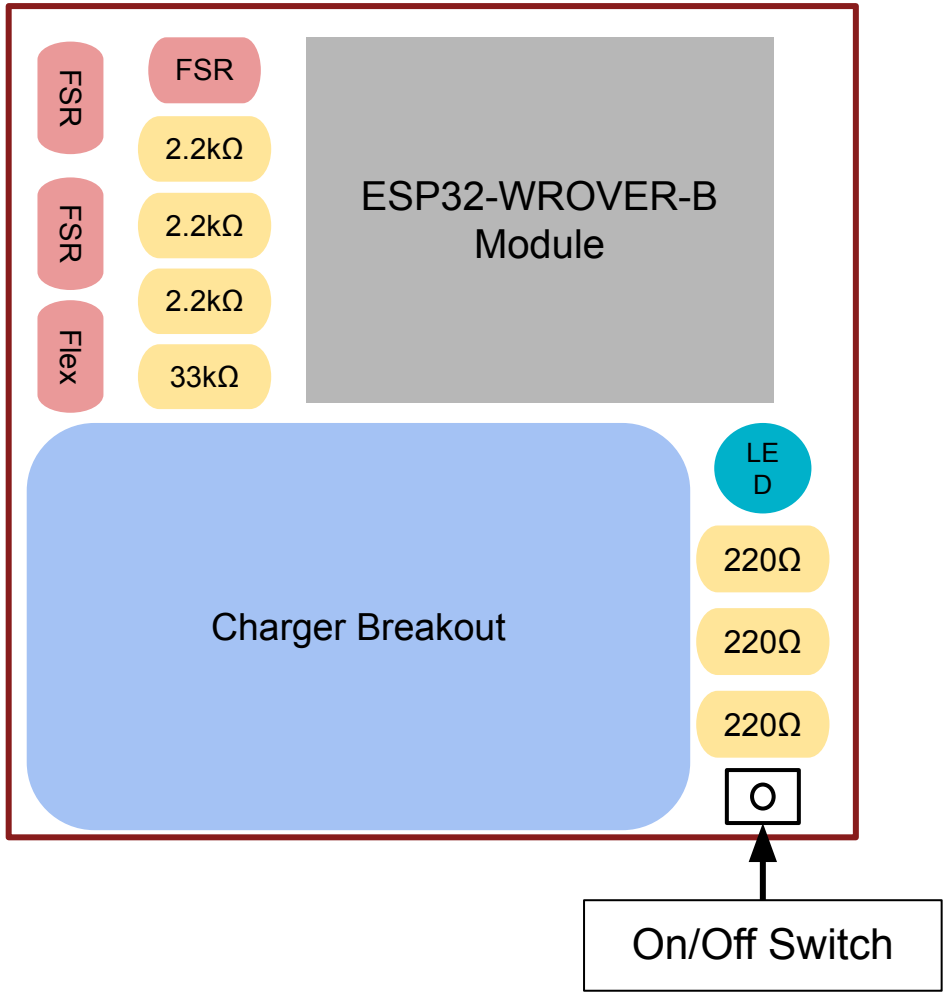
- Real-time visualization of current song as a waveform
- Volume Slider - Updates percentage in real-time with low latency
- Volume slider box glows with brightness proportional to volume → A certain feature box glows when corresponding gesture is activated
- Ability to upload user's own audio files
- Rotating vinyl as visual cue of song playing/not playing
- Pitch slider - Increases or decreases tempo and frequency
- Echo effect - when activated, the sound repeats until it's deactivated

CDR PCB Plan

Current PCB Plan



Revised PCB Plan for CDR



Demonstration Plan

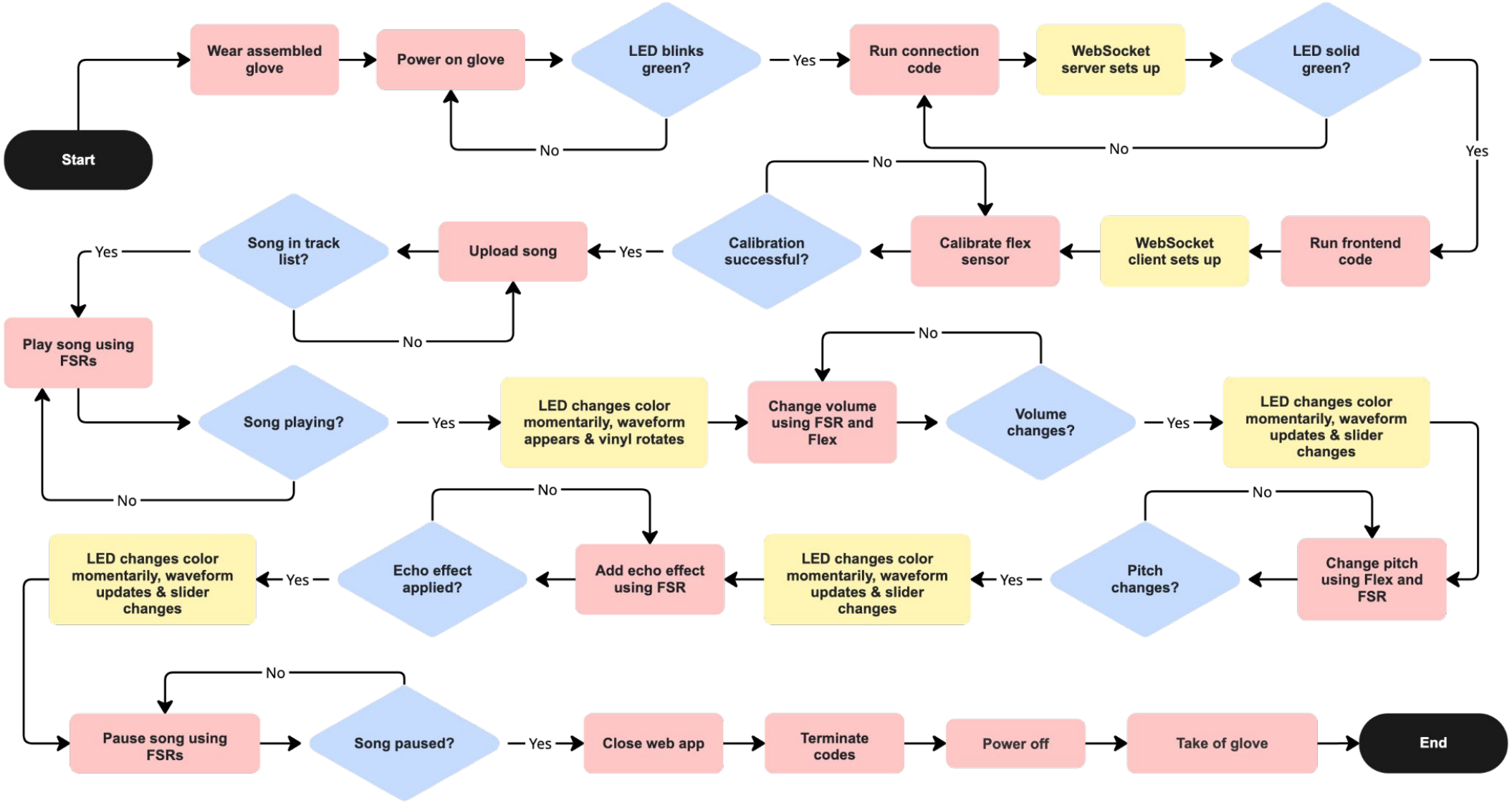
MDR Demo:

- **BLE Connection:** Glove wirelessly connects to computer
- **Upload Song:** Load custom audio files into interface
- **Play/Pause Control:** Pinch gesture (FSR) to play/pause
- **Volume Control:** Wrist flex gesture adjusts volume in real-time
- **Visual Feedback:** Waveform display, rotating vinyl, glowing volume slider
- **LED Indicators:** BLE status and FSR activation
- **Robustness:** Flex calibration to user's wrist bending range

CDR Demo:

- **Modified Volume Control:** Combine current FSR with flex sensor on wrist adjusts volume
- **Modified Play/Pause Control**
- **Pitch Control:** Second FSR sensor combined with flex sensor on wrist adjusts pitch
- **Echo Effect:** Third FSR to activate audio echo effect
- **Multi-Color LED Feedback:** Different LED colors associated with different FSR (different gestures)
- **Additional Visual Feedback:** Pitch slider, echo effect button both UI features glow when active
- **Assembled System:** Use populated PCB and battery housing for glove instead of breadboard

Demonstration Plan



Logistics & Management

Current Project Expenditures

Item	Unit Price (estimate)	Quantity	Total	Actual Amount Spent
ESP32 DevKit	$15	2 (1 backup)	$30.00	$0*
Spectra Flex Sensors	$7.95	3 (2 backup)	$23.8	$0*
FSR-402	$3.95	5 (4 backup)	$19.75	$19.75
3.7V LiPo 1200mAh	$9.95	2 (1 backup)	$19.90	$19.90
Charger Breakout	$14.95	2 (1 backup)	$29.90	$29.90
RGB LED	$2.30	3 (2 backup)	$6.90	$0*
2.2k ohm Resistor	$0.10	3 (2 backup)	$0.30	$0*
33k ohm Resistor	$0.10	3 (2 backup)	$0.30	$0*
220 ohm Resistor	$0.10	5 (2 backup)	$0.50	$0*
SPST Switch	$0.85	2 (1 backup)	$1.70	$0*
Gloves	$1.10	3 (2 backup)	$3.30	$3.30
Shipping	-	-	$10.13	$10.13
Total			**$136.40**	**$82.98**

*A member already has ESP32 DevKits. Flex sensors are from M5. LEDs, resistors, and switches are from All Campus Makerspace.

Predicted Project Expenditures

Item	Unit Price (estimate)	Quantity	Total
Spent so far (MDR)	-	-	$82.98
ESP32-WROVER-B Module	$9.95	3	$29.85
FSR-402	$3.95	5	$19.75
3.7V LiPo 1200mAh	$9.95	1	$9.95
LiPo Charger/Breakout	$14.95	1	$14.95
Gaming Gloves and Finger Covers	$14.99	2	$29.98
PCB	$7.00	3	$21.00
Miscellaneous	-	-	$10.00
Total			**$218.46**

Gantt Chart

TASK	ASSIGNED TO	December		February				March	
		12/1 - 12/5	12/8 - 12/12	2/2 - 2/6	2/9 - 2/13	2/16 - 2/20	2/23 - 2/27	3/2 - 3/6	3/9 - 3/13
Hardware									
Finalize PCB Schematic and Layout (w/ ESP32 Module and new sensors)	Sophia, Samanvay								
Order PCB	Sophia								
MCU programming and testing for additional FSR	Samanvay								
MCU programming for sensor(s) LED indicator	Samanvay								
Implement and test BLE on ESP32 Module	Samanvay, Ananya								
Design battery housing	Samanvay, Sophia								
Software									
Implement Pitch feature (WebApp UI and process audio)	Sreeniyathi, Samanvay								
Edit waveform to work with new features	Sreeniyathi								
Implement Echo effect	Sreeniyathi								
Implement a feature where users can scroll and select a track with a gesture	Ananya, Sreeniyathi								
Update gesture guide	Ananya								
Refine WebApp UI	Ananya, Sreeniyathi								
Implementation in UI where feature will light up when corresponding gesture is activated	Ananya								
Integration									
Assemble full system, breadboard prototype	All								
Test breadboard protoype and debug any issues	All								
Populate PCB with hardware	Sophia								
Test PCB integration	Sophia, Samanvay								
Assemble glove with all sensors, PCB, and battery	Sophia, Ananya								
Test assembled glove while connected to WebApp	All								
CDR Slides & Deliverables	All								

Thank you!

Questions & Answers

References

[1] “File:M-Audio DJ Blax.jpg - Wikimedia Commons.” Accessed: Oct. 03, 2025. [Online]. Available: https://commons.wikimedia.org/wiki/File:M-Audio_DJ_Blax.jpg