GIANO:
Guided Assistive Piano Learning Gloves

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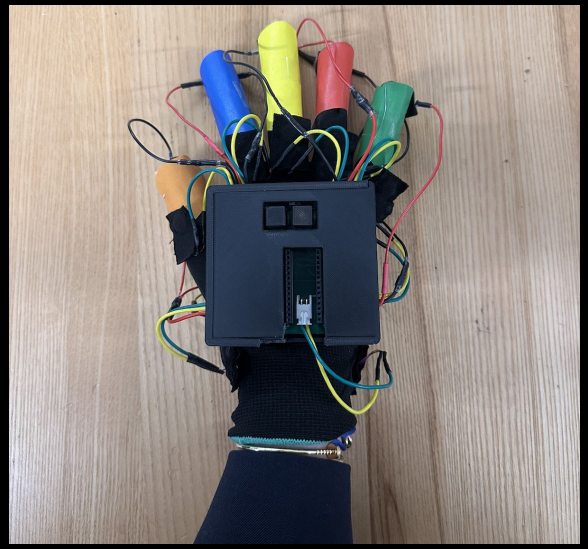
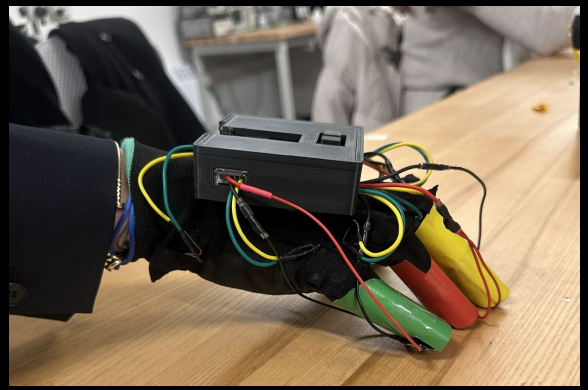
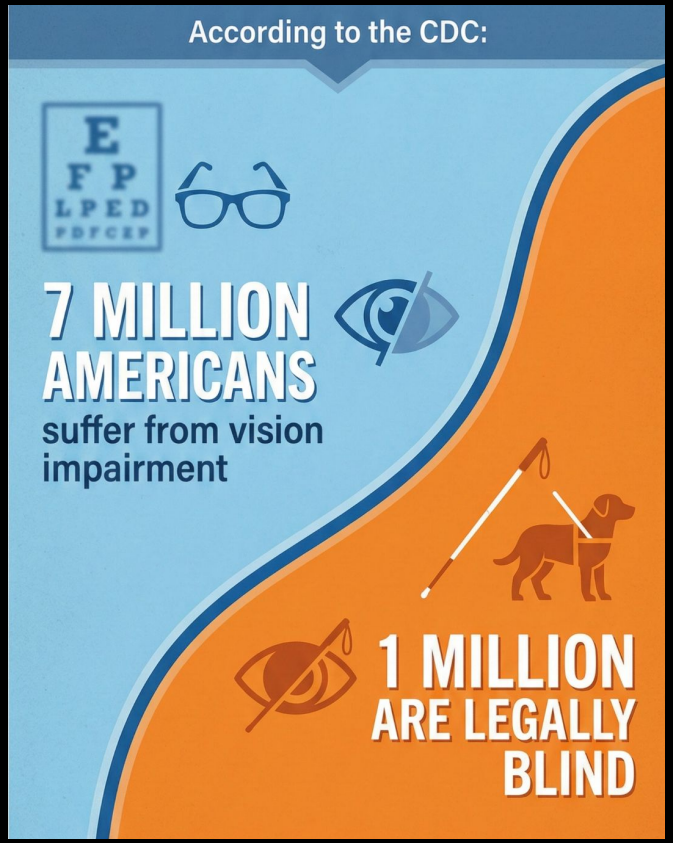




Background/ Motivation

- Motor skill development, memory, concentration skills, and social/emotional regulation
- Barriers: Expensive and space-limited and relies heavily on visual cues
- Inaccessible for low-vision or beginner users

A portable, affordable, and inclusive tool can open music education to many more people



Current Market Solutions & Limitations

Lessons

- $30–75/lesson
- Requires visual demos
- No tactile guidance

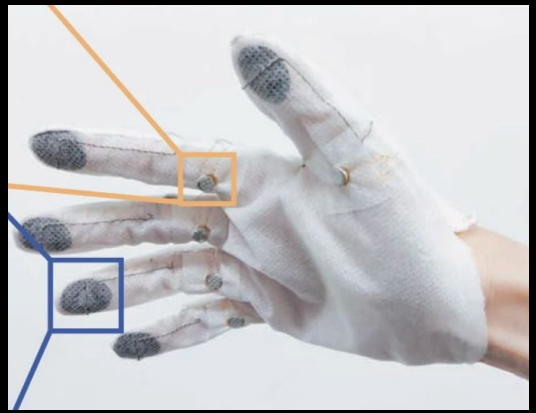
CDs/ Audio-Only Methods

- ‘By-ear’ learning only
- No real-time feedback
- Limited progression support

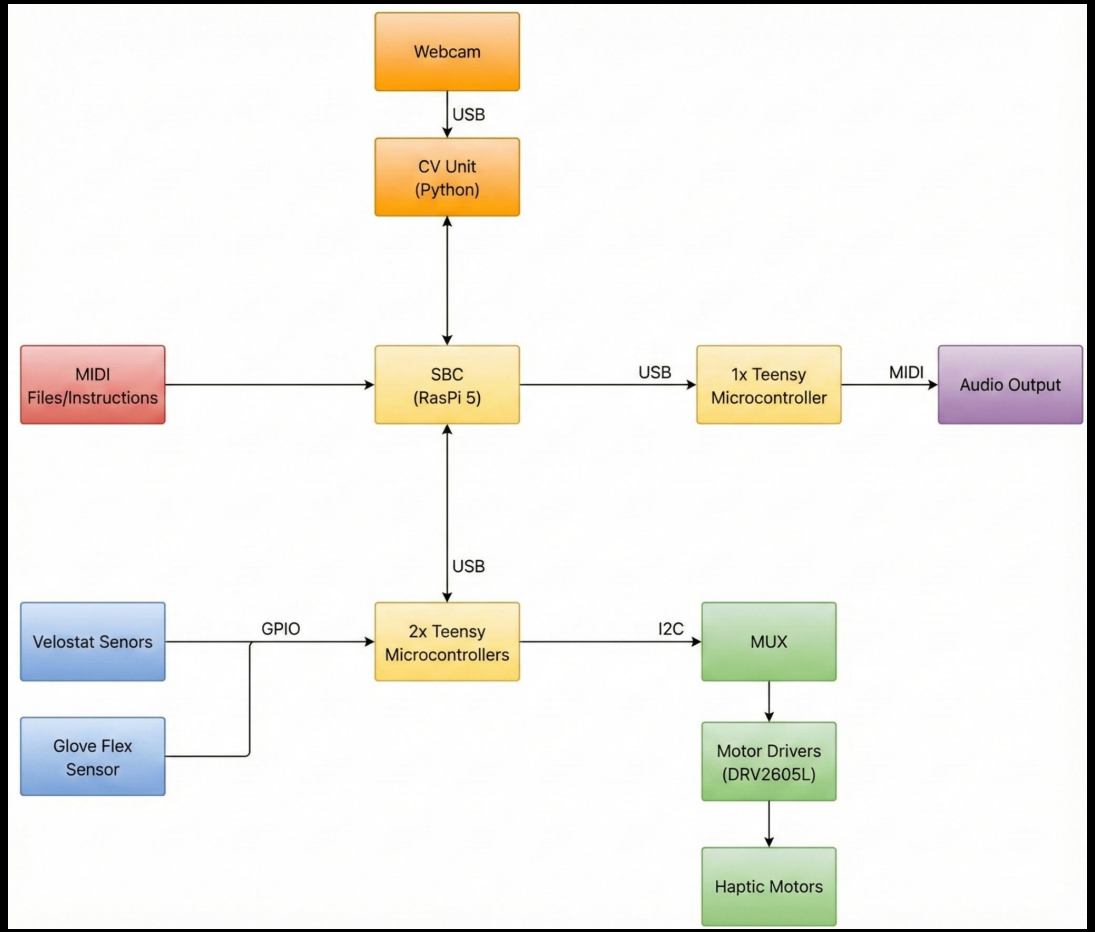
Previous Projects

Digitally embroidered haptic gloves

- Provide finger-specific vibration cues
- Not designed for music learning
- Complex fabrication
- No accessible learning path



GIANO: Solution Overview



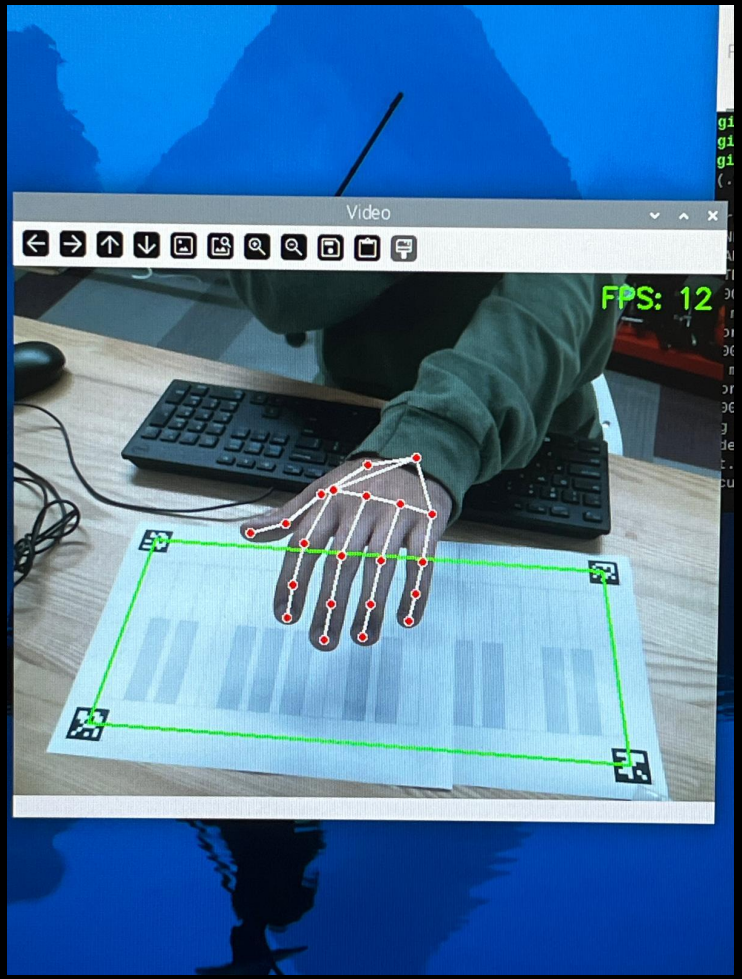
SBC (Raspi 5):

- System “brain”
- Works with CV Stack, maps hands to audio output
- Guides instructions for gloves
- Sends audio output commands

Teensy 4.0:

- Gloves → Receives and executes instructions using sensors
- Audio → Receives MIDI notes, outputs sound

Subsystems: CV Unit



Project Piano (Aruco Pose Estimation)

Ridge ximgProc OpenCV method

Generate Binary Mask

Filter out small shape image noise

Vertical and horizontal kernel to clean/ connect keys

Uses contours to find key shapes

Generate Piano Mask

Reproject to Normal Image

MediaPipe

Track Finger/Hand Position

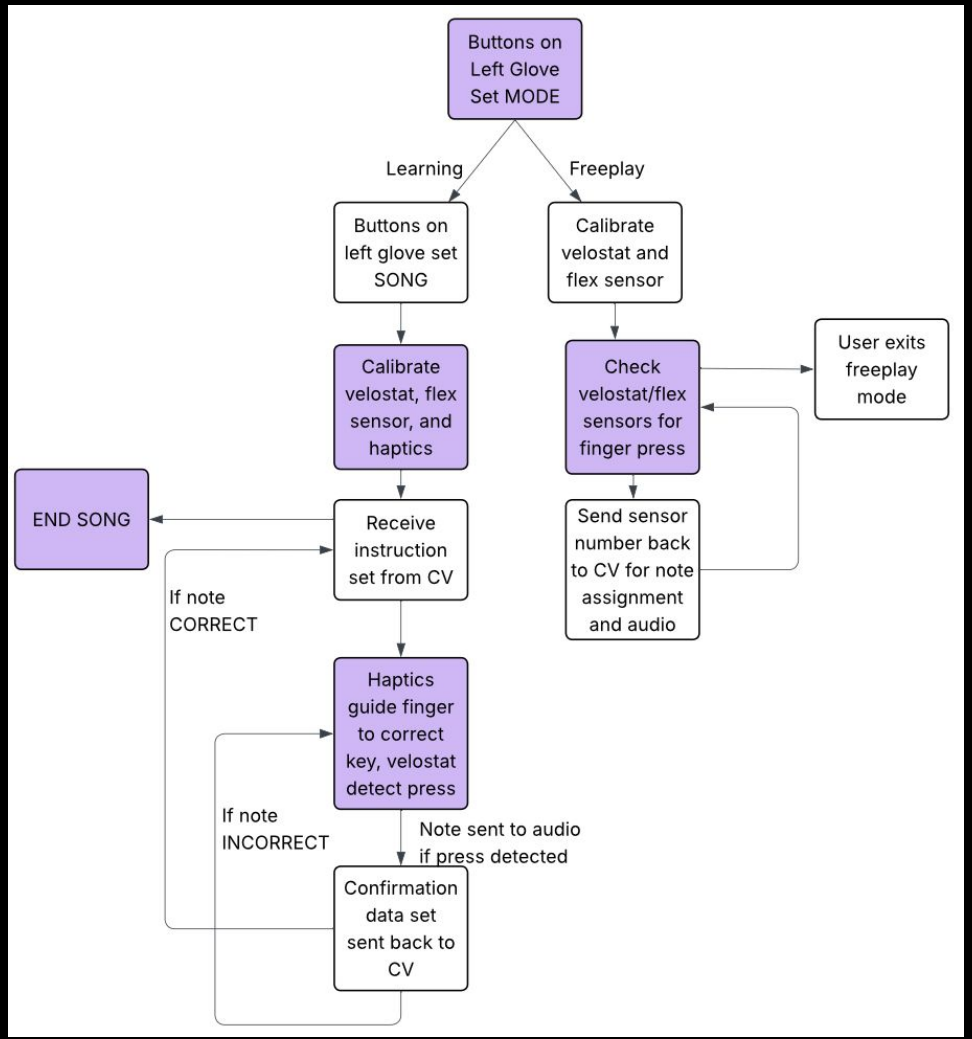
Freeplay Mode

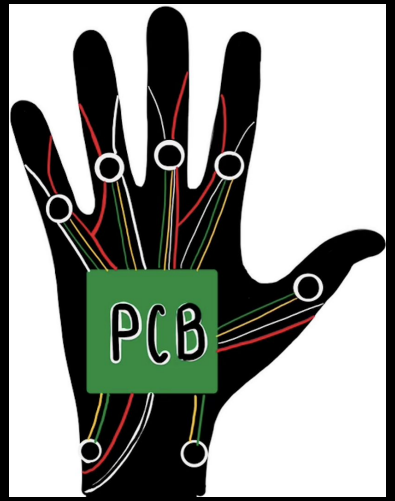
Learning Mode

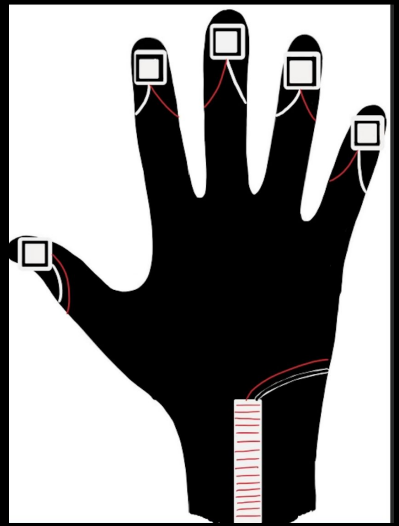
Verify MIDI note upon press detection

Verifies instructions by detecting nearest key

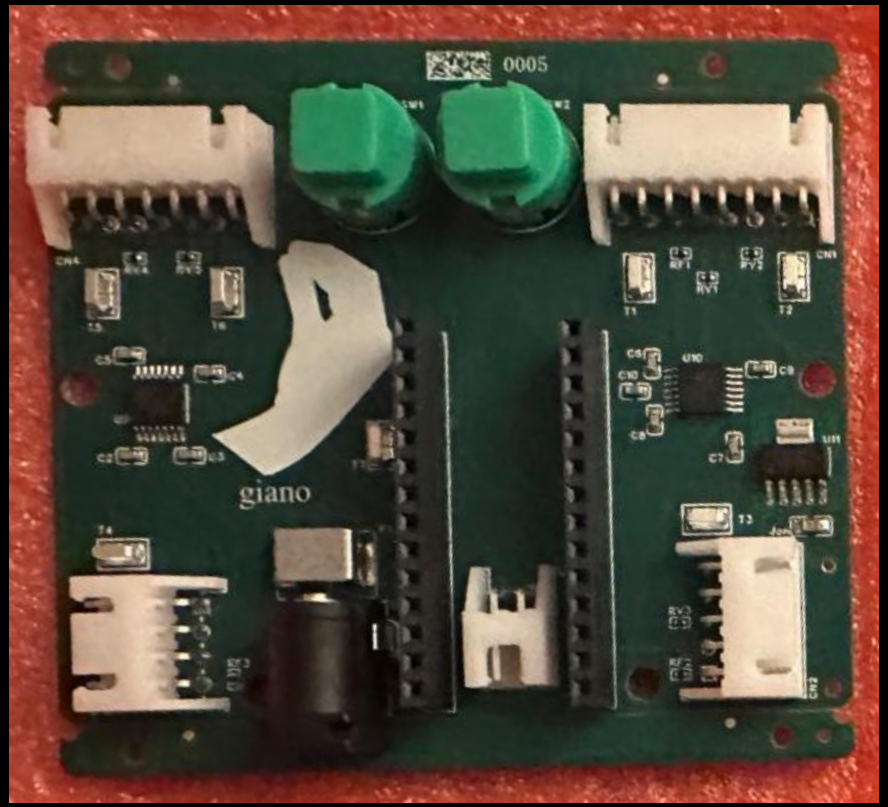
Subsystems: Gloves and Firmware


Buttons on Left Glove Set MODE
Learning
Freeplay
Buttons on left glove set SONG
Calibrate velostat and flex sensor
Calibrate velostat, flex sensor, and haptics
Check velostat/flex sensors for finger press
User exits freeplay mode
END SONG
Receive instruction set from CV
Send sensor number back to CV for note assignment and audio
If note CORRECT
Haptics guide finger to correct key, velostat detect press
If note INCORRECT
Note sent to audio if press detected
Confirmation data set sent back to CV


PCB



GIANO'S PCB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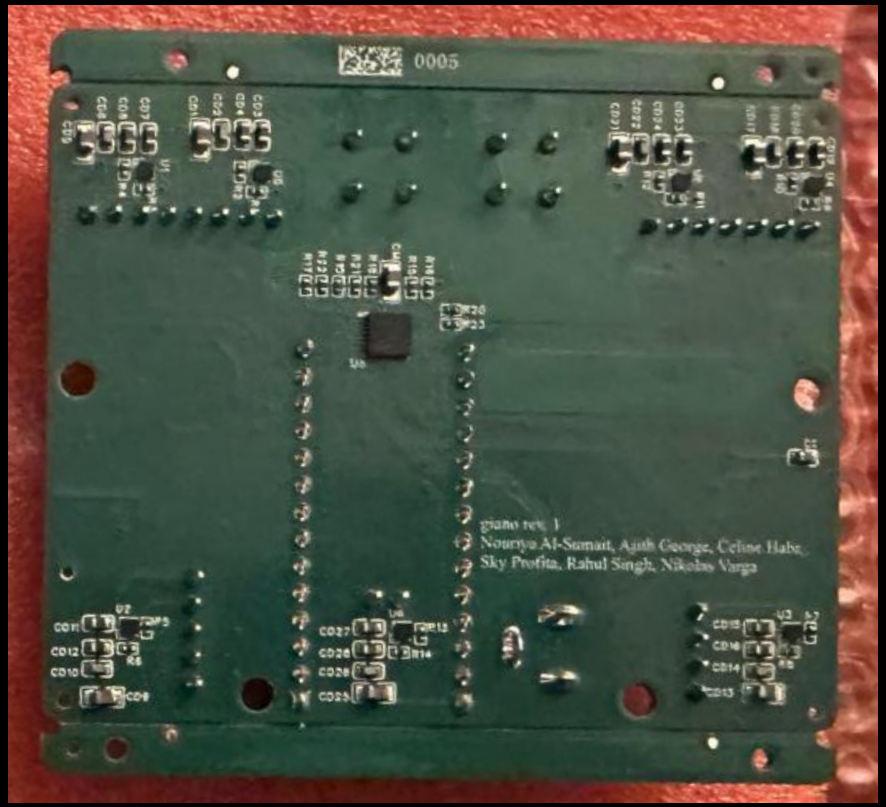
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Subsystems: Audio Output

KEY PRESS **KEY RELEASE**

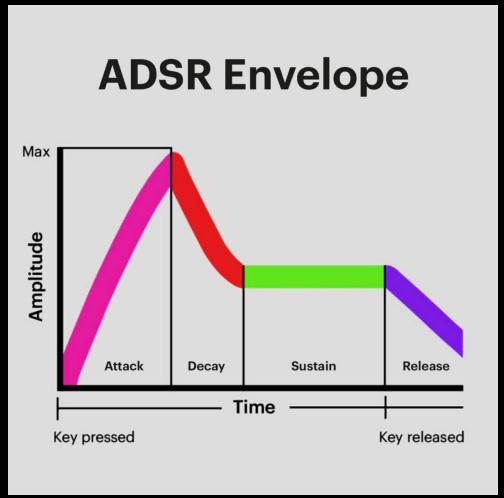
MIDI note converted to frequency → Velocity converted to amplitude → noteOn() begins (ADS part of envelopes) → noteOff() begins (R part of envelopes)

AUDIO SCRIPT

Frequency Modulation (FM) -> Carrier + modulator signals to create characteristic FM sound

Harmonic Enhancement -> Additional harmonics to extend frequency content

Additive Synthesis -> Attack, Decay, Sustain, Release (ADSR) envelopes to control amplitude and sound timing



GIANO in Action

Cost Summary

Part Name	Manufacturer	Price ($)
Haptic Motors (x15)	Adafruit	26.40
DRVL20605L Haptic Motor Driver (x1)*	Adafruit	7.95
Short Flex Sensor (x10)	Adafruit	71.60
Teensy Audio Adapter Rev D (x1)	Digikey	9.80
Teensy 4.0 (x2)	Digikey	47.60
Teensy Stackable Header Kit (x1)*	Digikey	1.80
Raspberry pi 5b 8 Gig (x1)*	Microcenter	79.99
Adafruit TCA9548A I2C Multiplexer (x1)	Microcenter	10.99
SPI ADC (x2)*	Digikey	12.42
Velostat (x2)	Digikey	9.90
CMOS Op-amp (x2)*	Digikey	7.00
Camera (x1)	Amazon	21.98
PCBA (x1)	JLBPCB	295.59
Tariffs of PCBA	N/A	57.11
Shipping	Digikey	7.00

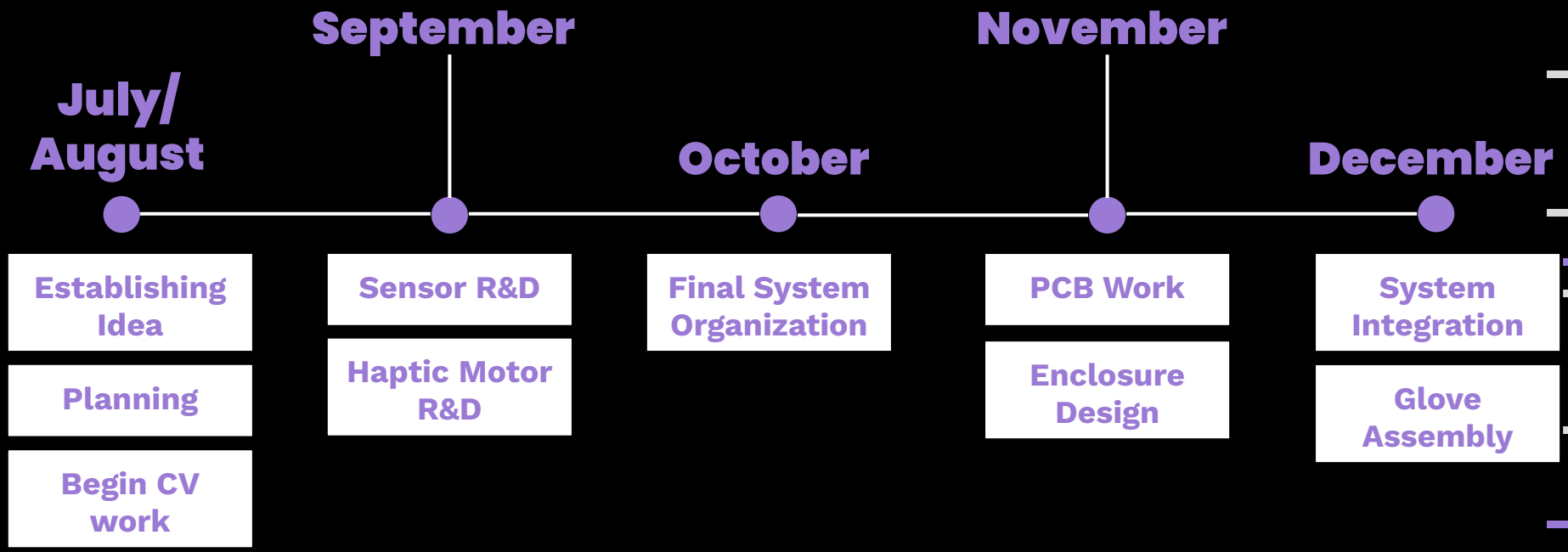
** not used in final product*

Total Price (R&D)
$663.09

Total Price (manufacture)
$586.78

x14 haptics, x2 flex sensors, x1 audio hat, x3 teensys, x1 raspi, x1 velostat sheet, x1 camera

Work Timeline and Breakdown



Future Work & Stretch Goals

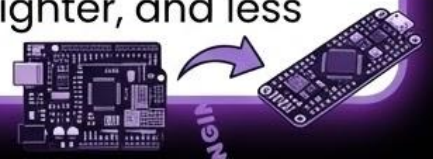
1. **Multi-finger chord support**
   Reduce haptic latency when multiple motors activate together

2. **Accurate simultaneous press detection**
   Improve sensor processing so chords register as one combined event

3. **Fully hands-free, visual-free setup**
   Expand audio-guided calibration for complete non-visual operation

4. **Wireless glove system**
   Replace wired connections with Bluetooth or other low-latency wireless links.

5. **Smaller, more ergonomic PCBs**
   Redesign glove-mounted boards to be smaller in size, lighter, and less bulky



Overall Impact and Accomplishments

- ✔ Detects multi-finger presses
- ✔ Hand position tracking
- ✔ Real-time audio output
- ✔ Visual-free glove setup

THANK YOU

Questions?