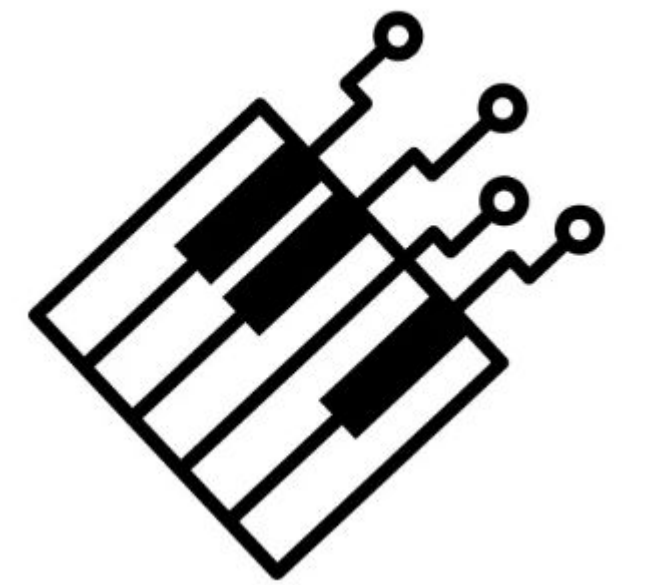


Anywhere Piano

Team B6: Lee Poirier, Nish Nilakantan, Caroline Liu
 18-500 Capstone Design, Spring 2023
 Electrical and Computer Engineering Department
 Carnegie Mellon University



Product Pitch

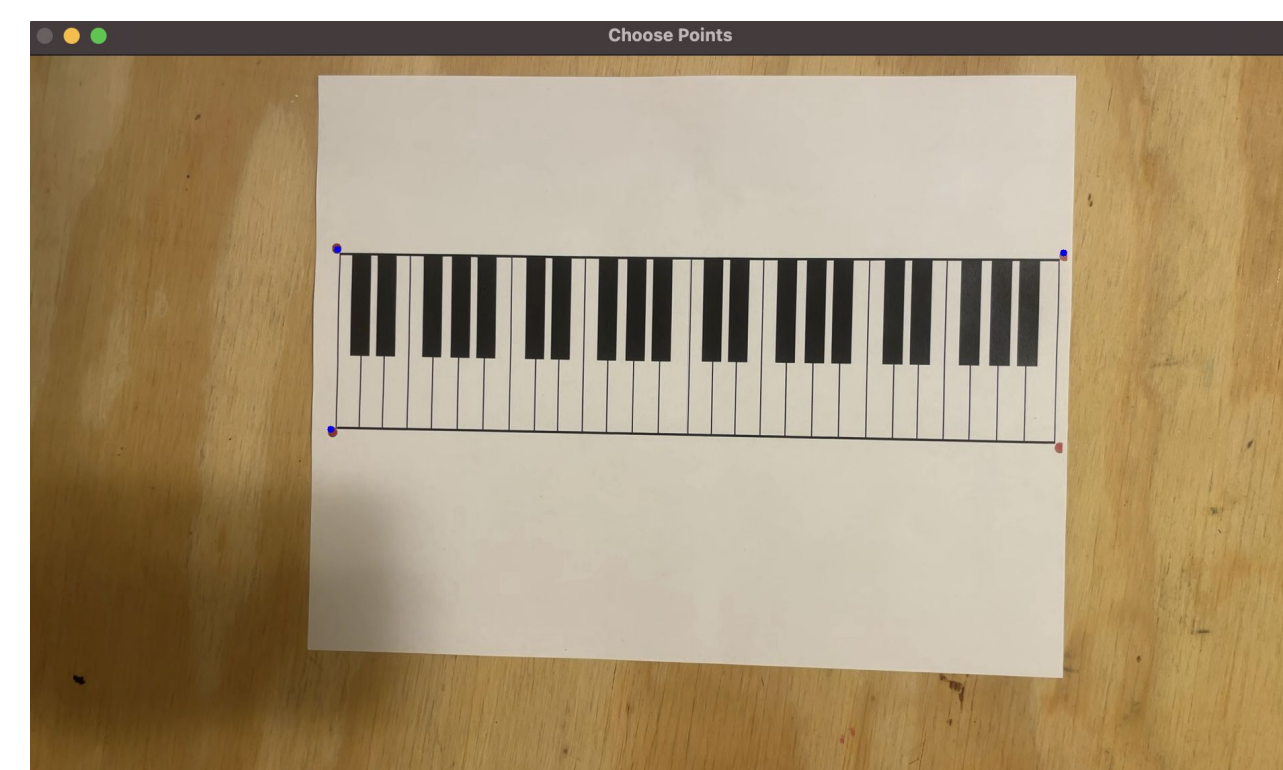
Problem

Music composition and arrangement requires using a piano (not portable & lacks accessibility). Online synthesizers are not user-friendly & robust, and lack pressure-controlled volume.

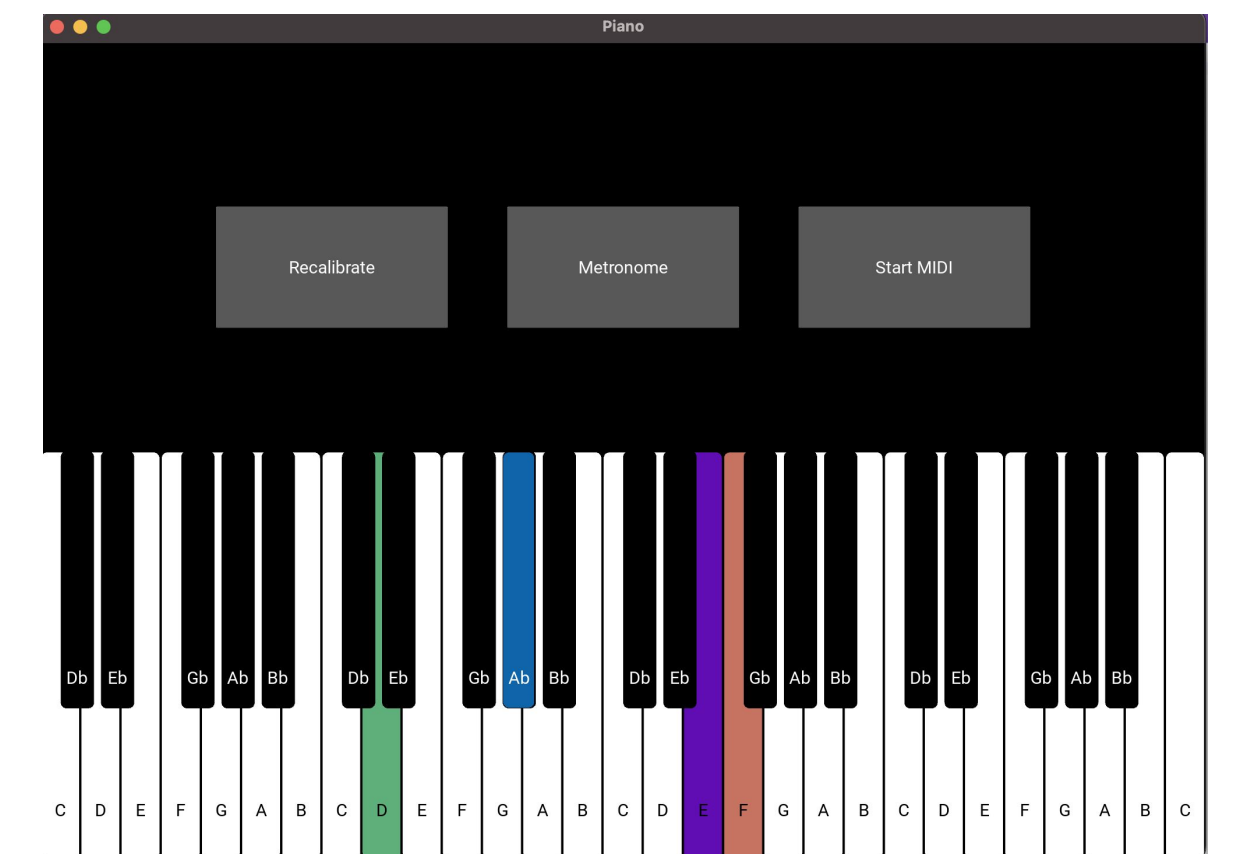
Solution

User will wear a glove of sensors, play notes on a printed piano key layout, use phone camera CV to detect notes, and desktop for UI.

System Description



Calibration screen, Camera view of Keyboard



Interface Subsystem

System Architecture

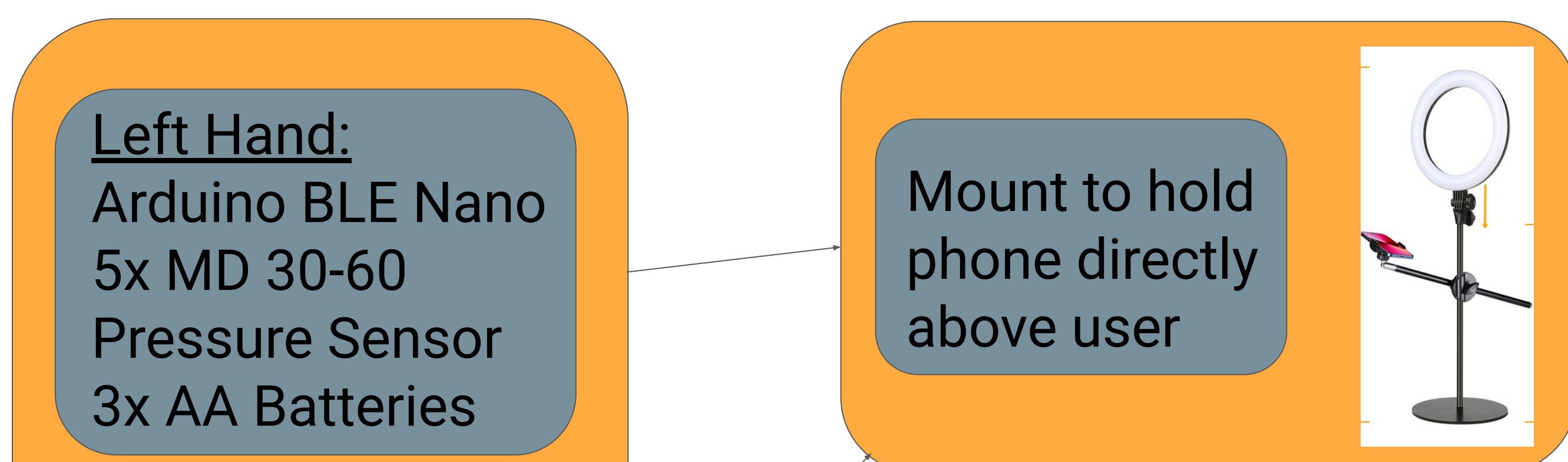


Fig 1: Phone+ Camera

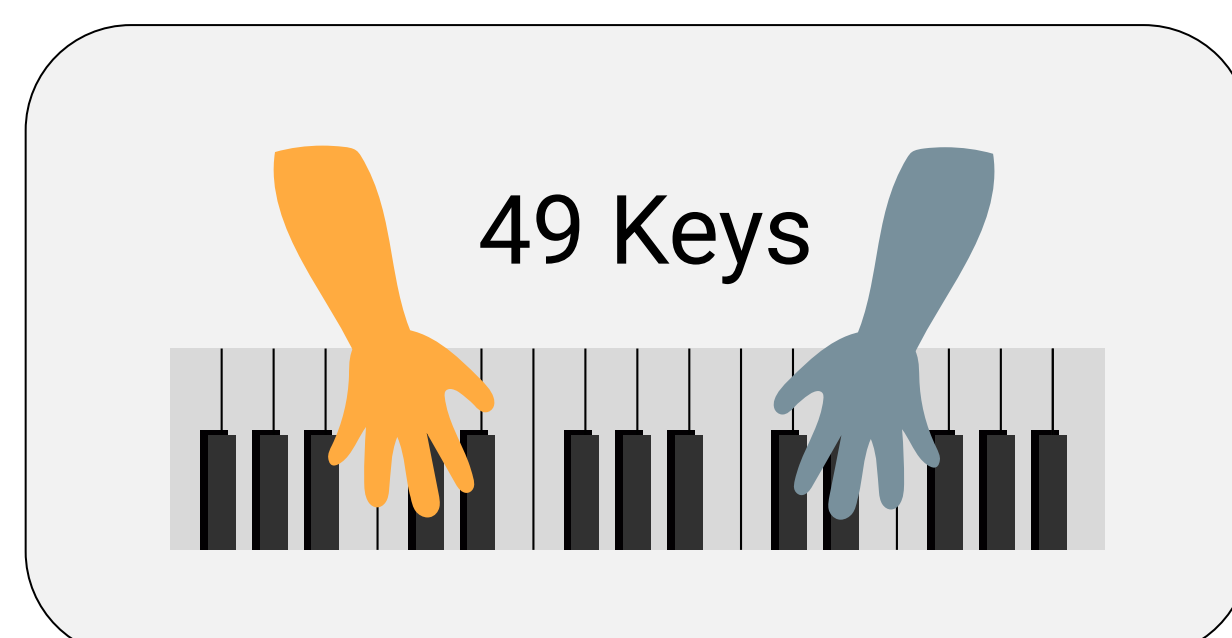


Fig 3: Paper Keyboard

Fig 2: Gloves

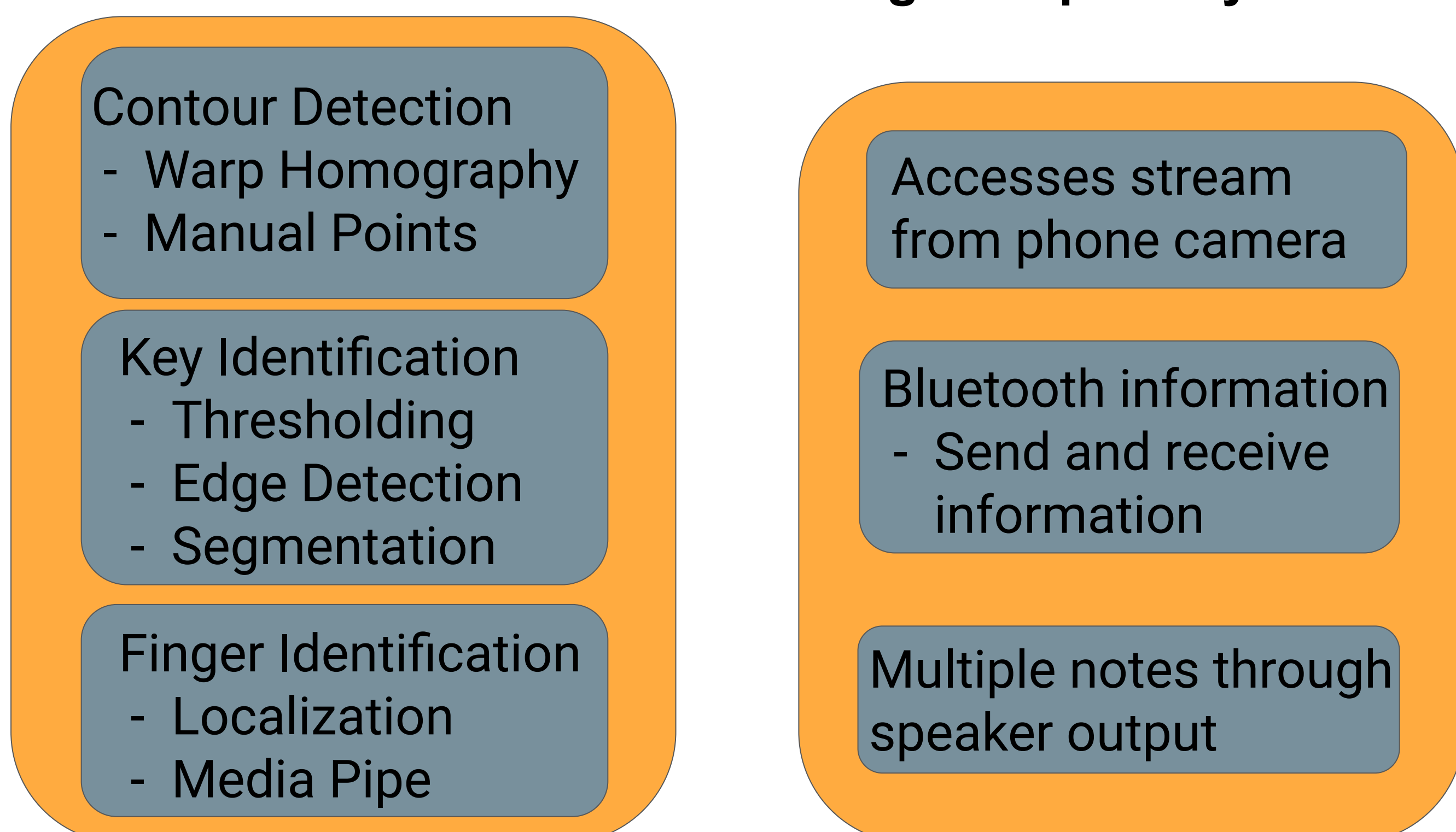
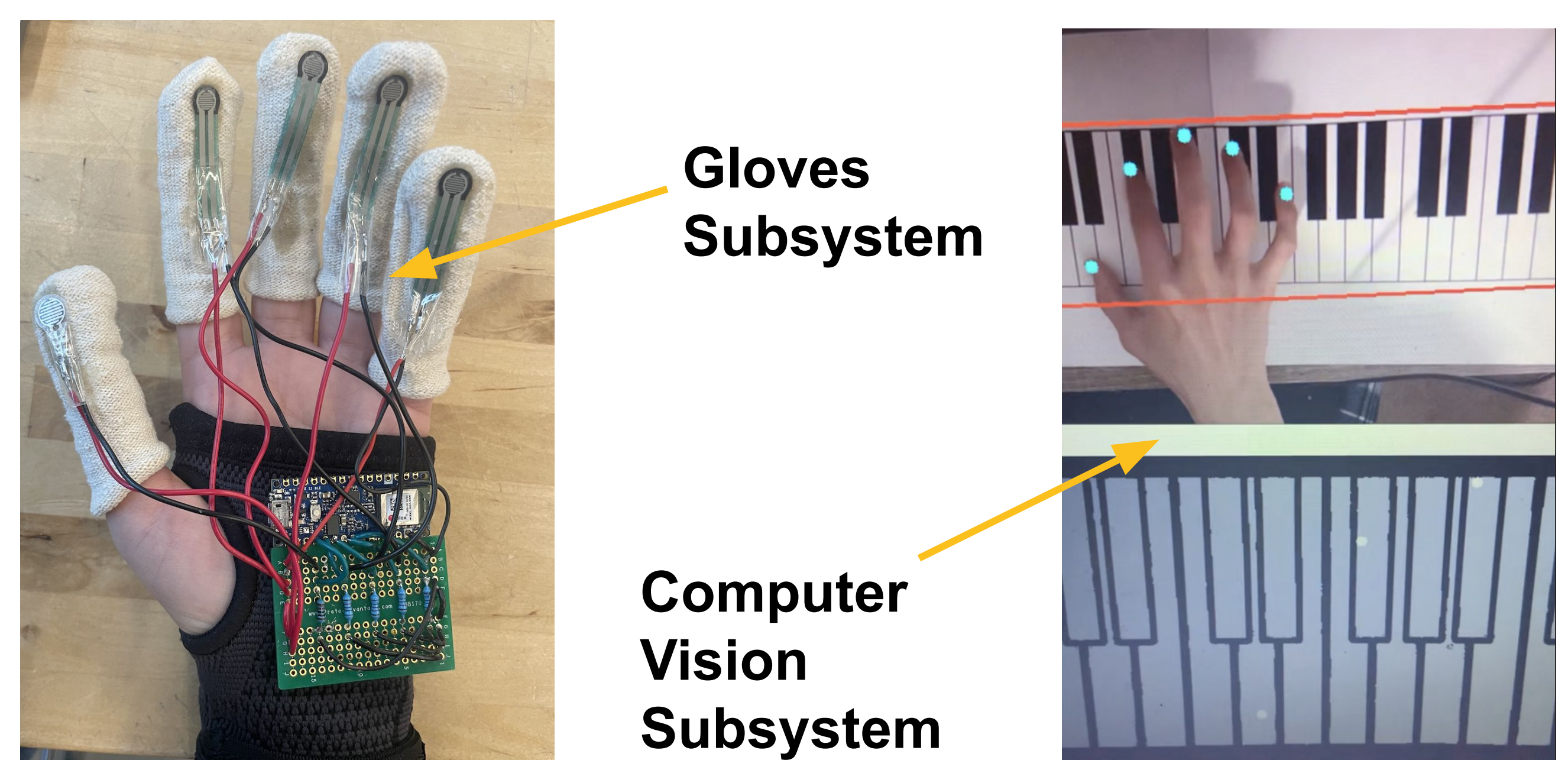


Fig 4: Computer Vision

Fig 5: App Interface



System Evaluation

Test	Method	Goal	Result
Warp Consistency	25 Test Images	95%	80%
Key Segmentation	25 Test Images, with successful warp	95%	84%
Key Identification	25 Test Images, with successful warp	100%	84%
Multi-Note Volume Comparison	Play 48 successive notes and compare decibel output <1-2 dB difference	9/10 notes -> 90% accuracy	100%
Multi-Note Volume Threshold	Play 48 "loud" notes and check they don't overpower the speaker (go above 70 dB)	9/10 notes -> 90% accuracy	100%
Note Accuracy	Play all notes and compare with tuner	48/49 notes -> 98% accuracy	100%
Edge Cases	Use one finger to play between two notes 10 times to make sure ties are correctly broken	9/10 notes -> 90% accuracy	100%

Table 1: Tests, verification, validation + results

Conclusions & Additional Information



Further Design Extensions

- Synth Engine
 - MIDI Capabilities
- More Volume Levels
 - Increase thresholding accuracy
- Interface
 - Pedal capabilities
 - More accurate resonance for loud + soft notes

<http://course.ece.cmu.edu/~ece500/projects/s23-teamb6/>

Design Tradeoff	Before	After	Rationale
Resistors	68K Ohm	10K Ohm	Wider range of volume outputs
Microcontroller	STM32 + HC-05	Arduino BLE Nano	Bluetooth already integrated
App UI	Phone	Desktop PC	Can't see user interface from phone. No need to convert code to C++ for apple phones.
Finger Identification	Colored Fiducials	Mediapipe	Faster, effective, and more reliable
Camera Angle	45 degrees	Top-Down view	Easier for warping and ring light more stable

Table 2: Design Trade-offs