TeleTouch

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Product Pitch

The current state of tools for portable live presentation consists of devices such as laser pointers or remotes. However, these tools are not suitable for interacting with 3D entities as they lack the mechanisms to control the degree and intensity of actions such as zoom and rotation. TeleTouch enables the user to remotely interact with 3D schematics using hand gestures.

The product consists of a wearable glove outfitted with an array of flex sensors and accelerometers, and a compute module to be attached to a personal computer for gesture recognition. The system is able to recognize gestures corresponding to pan, zoom in, zoom out, and rotate, after which appropriate HID commands are dispatched to the computer. For a smooth user experience, the following key performance metrics were tested:

Latency: 126 ms end-to-end (sensor to HID dispatch)
Accuracy: 89.25% averaged across the four gestures
Portability: 91g
Cost of System: $218
Battery Life: 40 hours

System Architecture

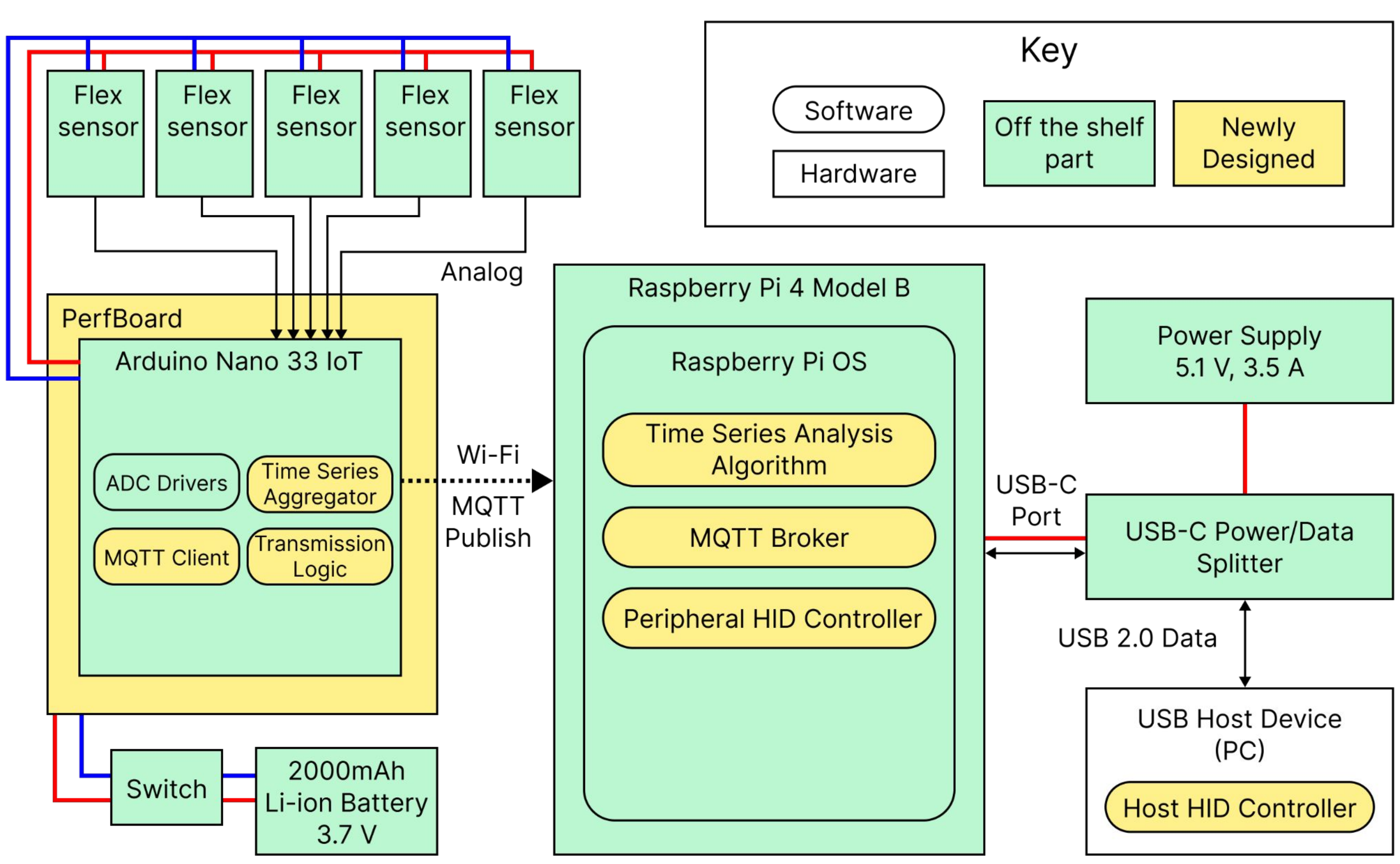

Figure 1. Full system block diagram

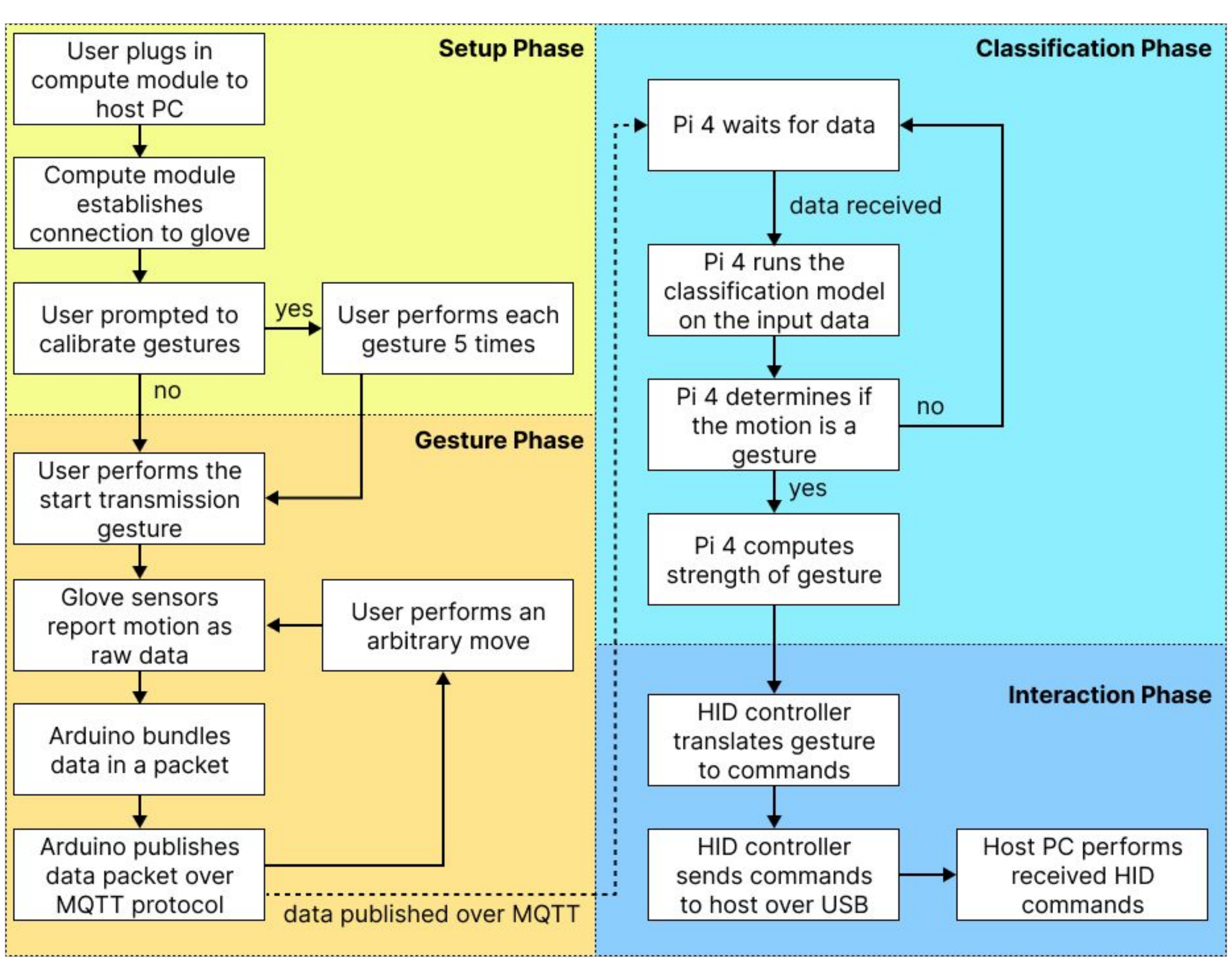

Figure 2. System operation flowchart

Conclusions & Additional Information

We achieved the basic functionality of the system. However, due to time constraints, we were not able to implement additional features such as seamless calibration or custom keybindings for different applications. Nevertheless, the product is able to fulfill the basic requirements of enabling a more intuitive method of presenting 3D models.

http://course.ece.cmu.edu/~ece500/projects/s23-teama4/

System Description

Glove Module	Collect flex, accelerometer, and gyroscope sensor data. Wirelessly transmit to compute module over WiFi using MQTT protocol. Single-board microcontroller: **Arduino Nano 33 IoT**
Compute Module	Listens for and aggregates data from glove module. Classifies raw sensor data into specific gestures. If gesture is detected, dispatches an HID report to the host computer over USB. Single-board computer (SBC): **Raspberry Pi 4**
HID Module	Application on host computer that listens for input HID reports from the compute module. When input is detected, dispatches this into mouse/keyboard inputs, depending on application configuration (GeoGebra, SolidWorks, etc.)

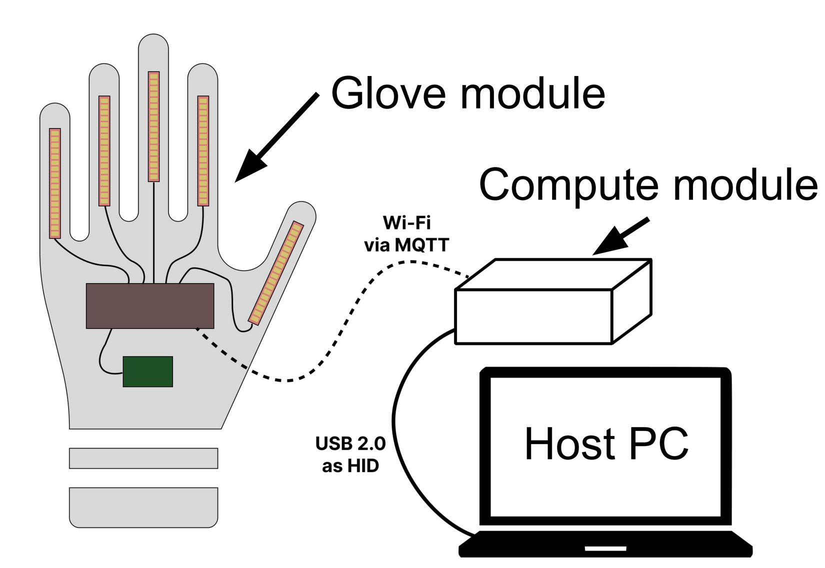

Figure 3. Physical system diagram

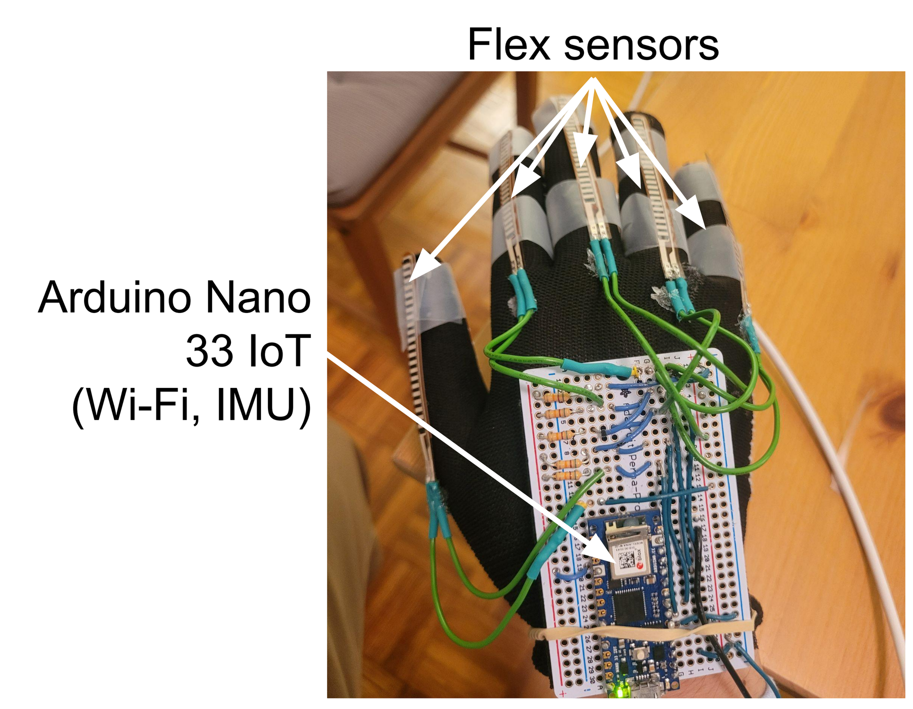

Figure 4. Glove module

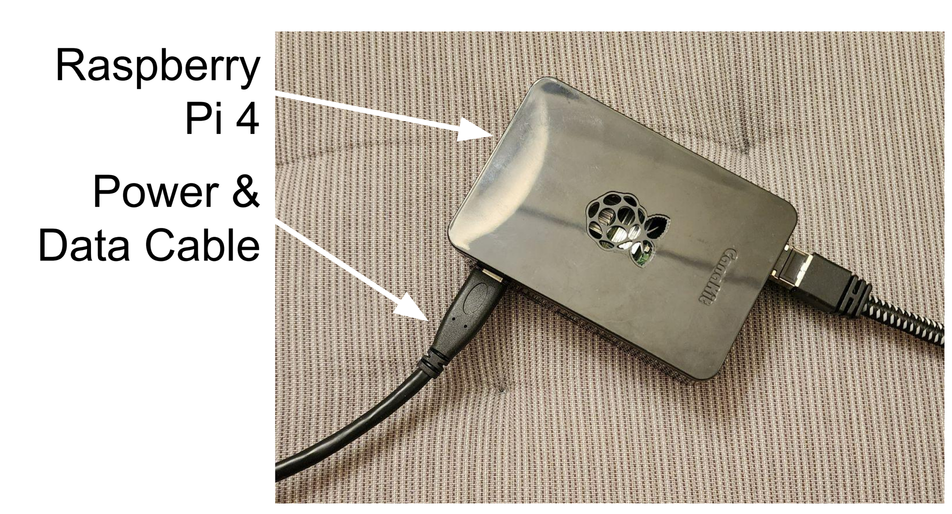

Figure 5. Compute module

System Evaluation

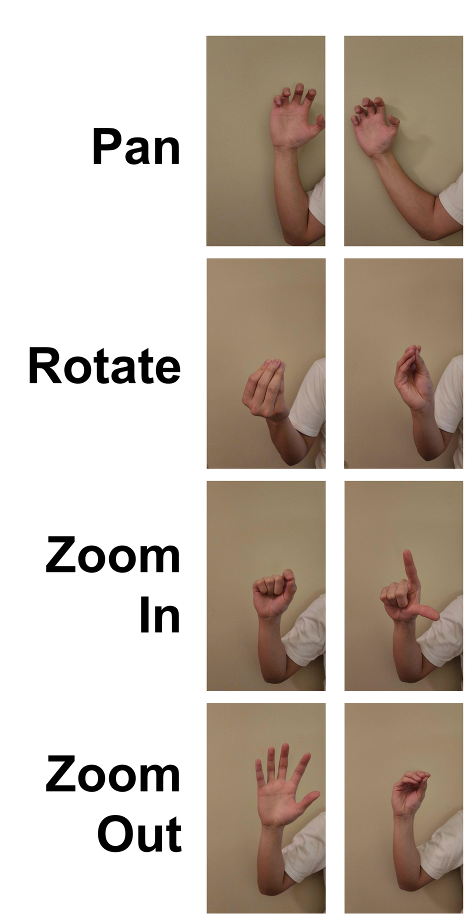

Figure 6. Supported gestures. Start (left) and end (right) of gestures shown

Gesture	Accuracy
Pan	97%
Rotate	90%
Zoom In	73%
Zoom Out	97%

Figure 7. Classification accuracy test results for each gesture

For the gesture classification tests, the gestures were performed a total of 30 times each in random order.

At each gesture, the test passes if a gesture was identified and the gesture was the correct one. The failure to detect any gesture is considered a failed test. The number of correct and incorrect classifications were counted and used to determine the overall accuracy for each gesture.

Measurement	Actual Value
Oscilloscope measurement of Pi 4 GPIO pin and sensor detection output (overall measurement)	~ 112ms
Sensor data collection	*~ 100ms*
Model classification time	*~ 5ms*
Wi-Fi transmission delay with ping tests	*~ 5ms*
HID dispatch time	~ 14ms
Total end-to-end latency	**~ 126ms**

Figure 8. System latency test results for each segment of data transmission

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