Smart Sock

1. Design

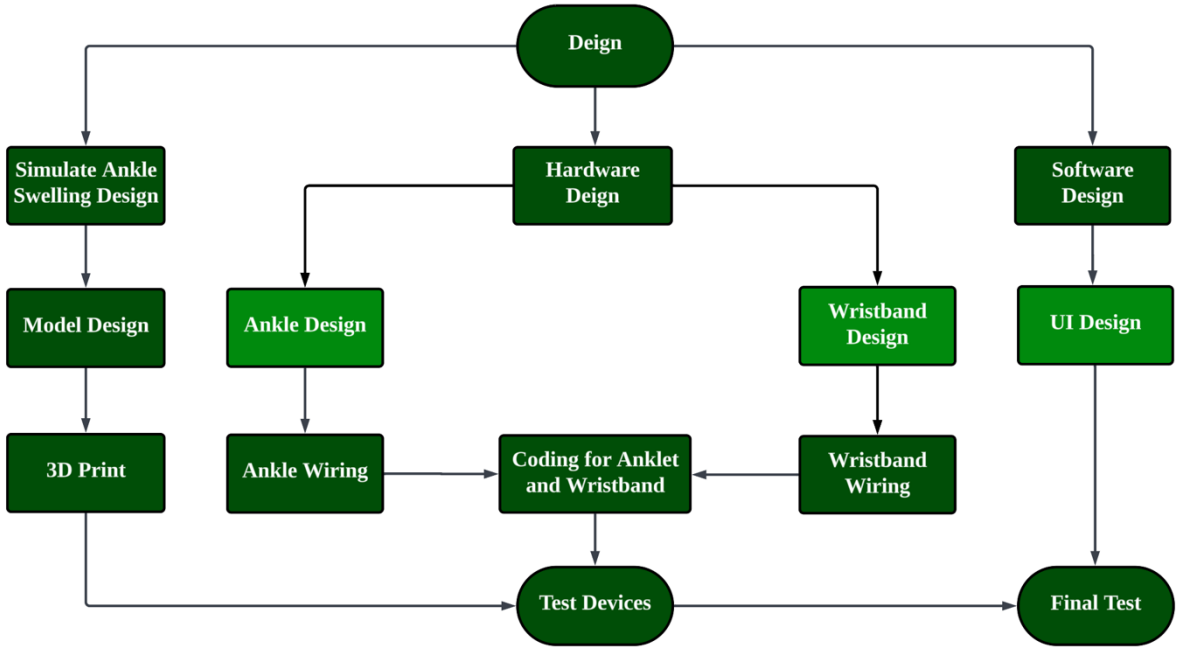

Figure 1: Overall project flow chart.

Figure 1 shows the overall flow of the project.

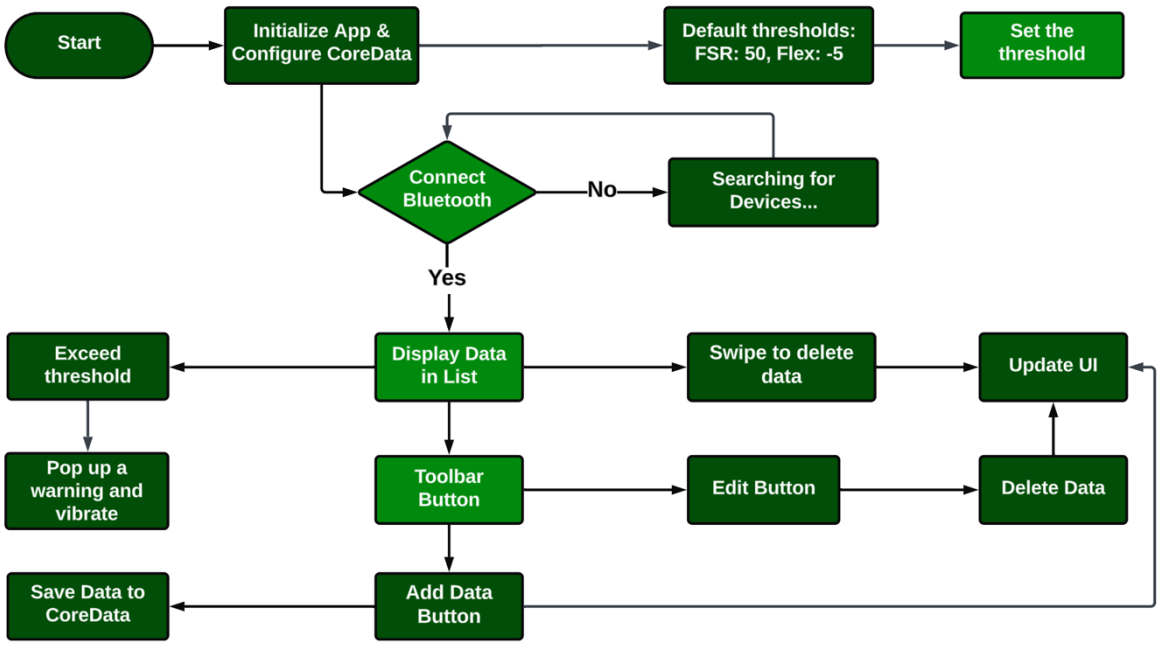

Figure 2: Application workflow flowchart.

Figure 2 presents the workflow of the 'Smart Sock' application.

Table 1: List of components for the anklet and wristband

Devices	Components	Number
Anklet	Arduino Nano 33 IoT (including BLE and IMU modules)	1
	Force Sensitive Resistors (FSR)	1
	Flex sensors	1
	TLV2462 operational amplifier (Op-Amp)	1
	10μF electrolytic capacitor	1
	100nF ceramic capacitor	1
	LED Light	3
	10 $k\Omega$ resistance	2
	220 Ω resistance	3
	Mini breadboard	1
Wristband	Arduino Nano 33 IoT	1
	Gravity: MAX30102 Heart Rate and Oximeter Sensor	1
	0.91" OLED Display Module	1
	LED Light	1
	220 Ω resistance	1
	Mini breadboard	1

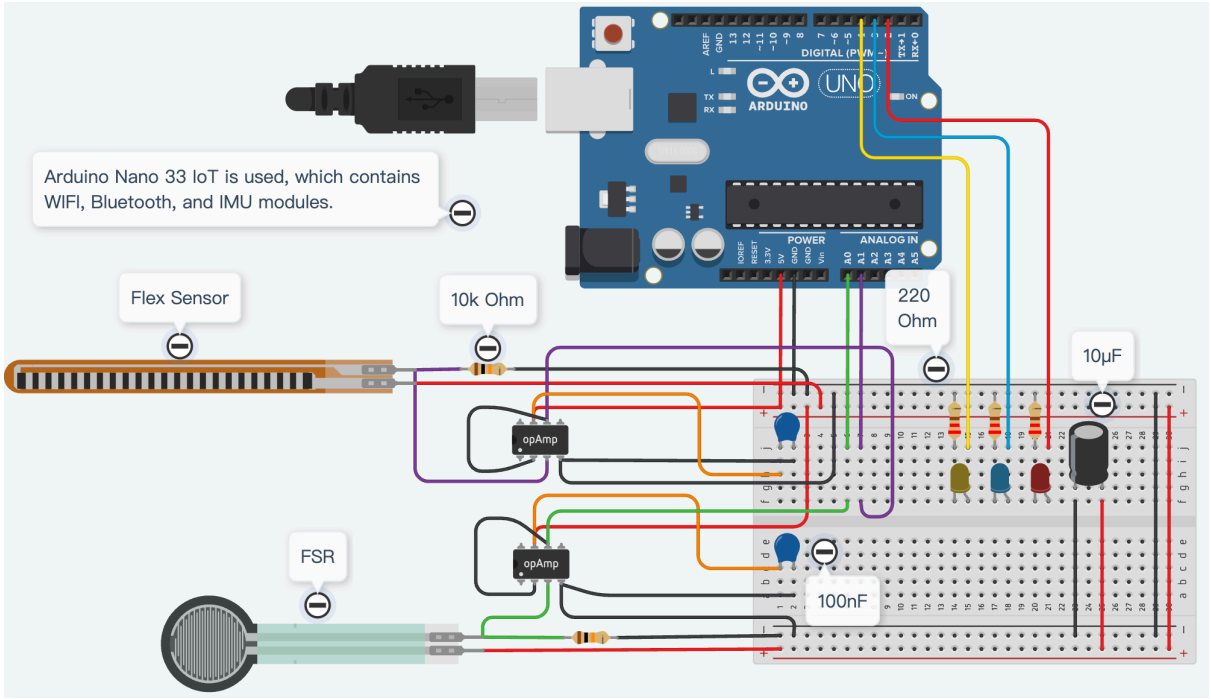

Figure 3: Circuit design of Anklet.

Figure 3 is a simulation experiment conducted on the Thinkercad website, clearly displaying the circuit of the anklet.

2. Wiring

The specific wiring steps for the anklet and wristband are as follows:

a) Connection of the FSR to the Arduino Nano 33 IoT

One end of the FSR is connected to the 5V power supply of the Arduino. The other end of the FSR is connected to a 10kΩ resistor (R1) and the non-inverting input pin (Pin 3) of the first channel of the TLV2462. The other end of R1 is connected to the GND of the Arduino. The output pin of the first channel of the TLV2462 operational amplifier (Pin 1) is connected to the analog input A0 of the Arduino.

b) Connection of the Flex Sensor to the Arduino Nano 33 IoT

One end of the Flex Sensor is connected to the 5V power supply of the Arduino. The other end of the Flex Sensor is connected to a 10kΩ resistor (R2) and the non-inverting input pin (Pin 5) of the second channel of the TLV2462. The other end of R2 is connected to the GND of the Arduino. The output pin of the second channel of the TLV2462 operational amplifier (Pin 7) is connected to the analog input A1 of the Arduino.

c) Power supply and negative feedback connection of the TLV2462 Op-Amp

The V+ pin (Pin 8) of the TLV2462 is connected to the 5V of the Arduino, and the V- pin (Pin 4) is connected to the GND of the Arduino. For the FSR channel, the inverting input pin (Pin 2) of the first channel of the TLV2462 is connected to its output pin (Pin 1). For the Flex Sensor channel, the inverting input pin (Pin 6) of the second channel of the TLV2462 is connected to its output pin (Pin 7).

d) Connection of LED lights

The long leg of the LED is positive, the short one is negative. The positive poles of the red, blue, and yellow lights are connected to D2, D3, and D4, respectively, and the negative poles are connected to the ground after a 220-ohm resistor.

e) Improving the stability and performance of the circuit

Connect the positive pole (long leg) of a 10μF electrolytic capacitor to the 5V pin of the Arduino Nano 33 IoT and the negative pole (short leg) to the GND pin. Then connect a 100nF ceramic capacitor between the V+ (Pin 8) and GND (Pin 4) of the TLV2462.

f) Wristband Wiring:

Connect the 3.3V, GND, A4, and A5 of another Arduino Nano 33 IoT to the VCC, GND, SDA, and SCL of the MAX30102 and OLED screen, respectively. The positive pole of a yellow LED is connected to D4, and the negative pole is connected to the ground after a 220-ohm resistor. Finally, organize all the wires and wrap the circuit with electrical tape.

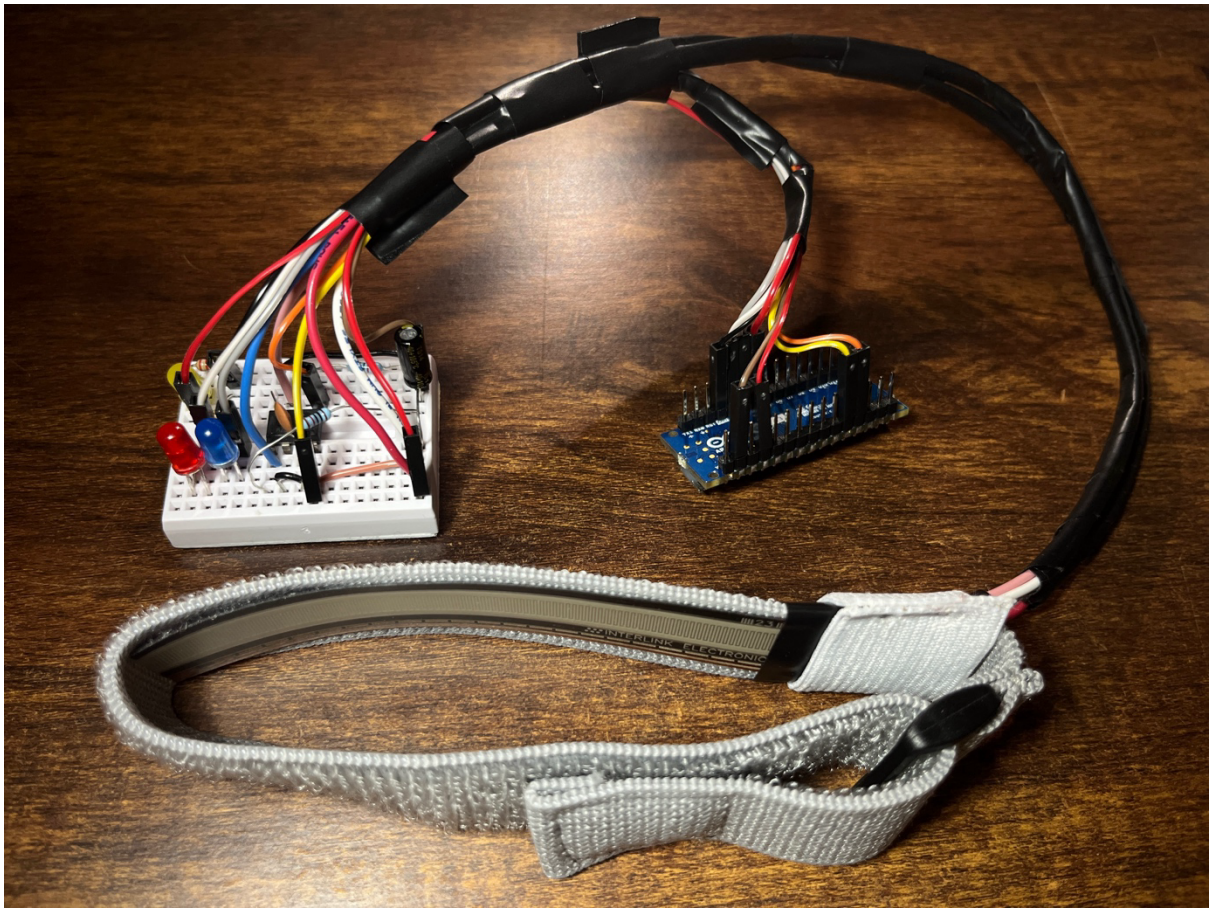

Figure 4: Anklet wiring.

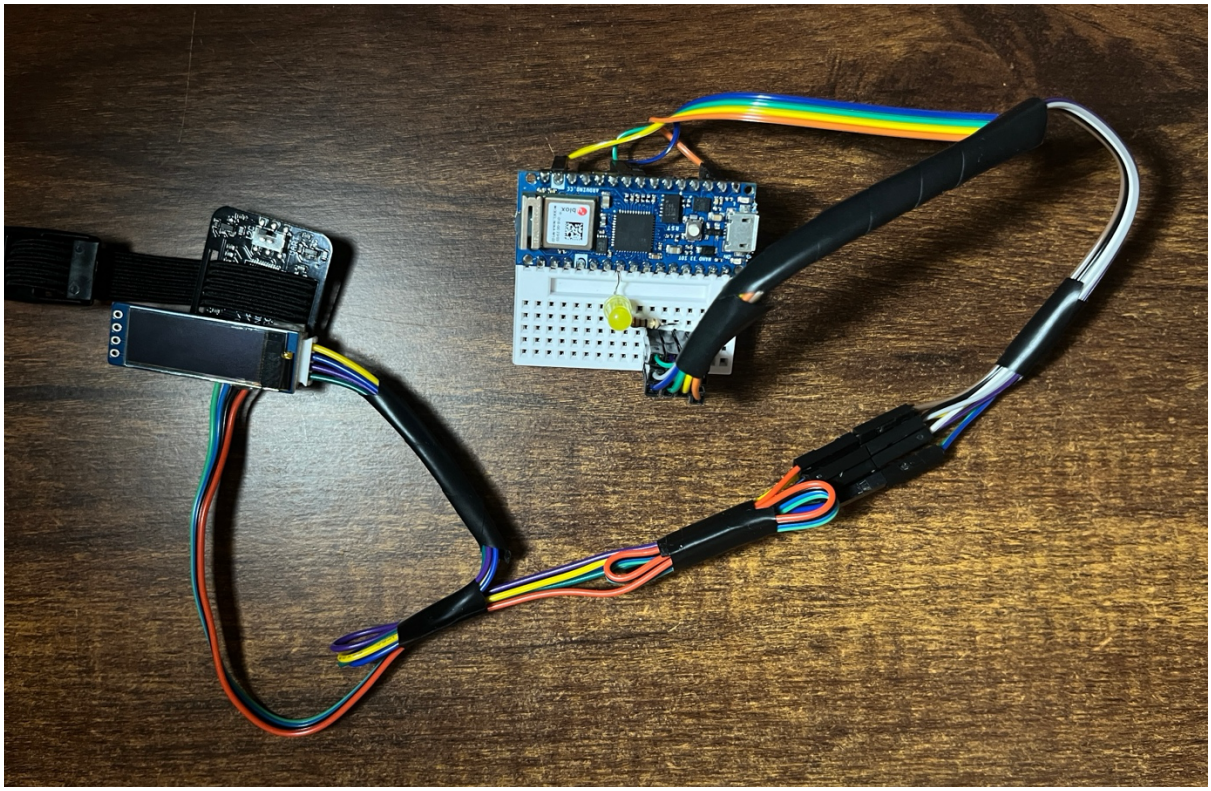

Figure 5: Wristband wiring.

3. Result

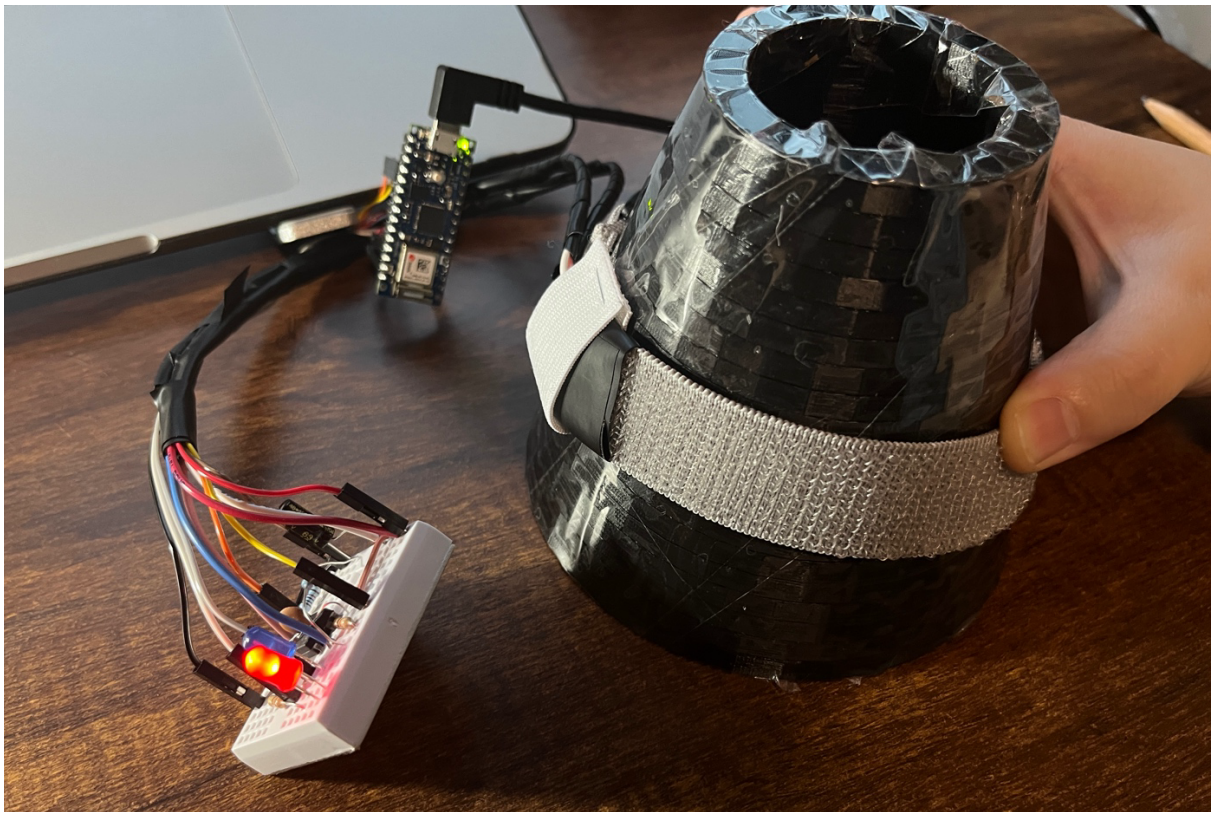

Figure 6: The result of simulates anklet swelling.

Figure 7: Final test.

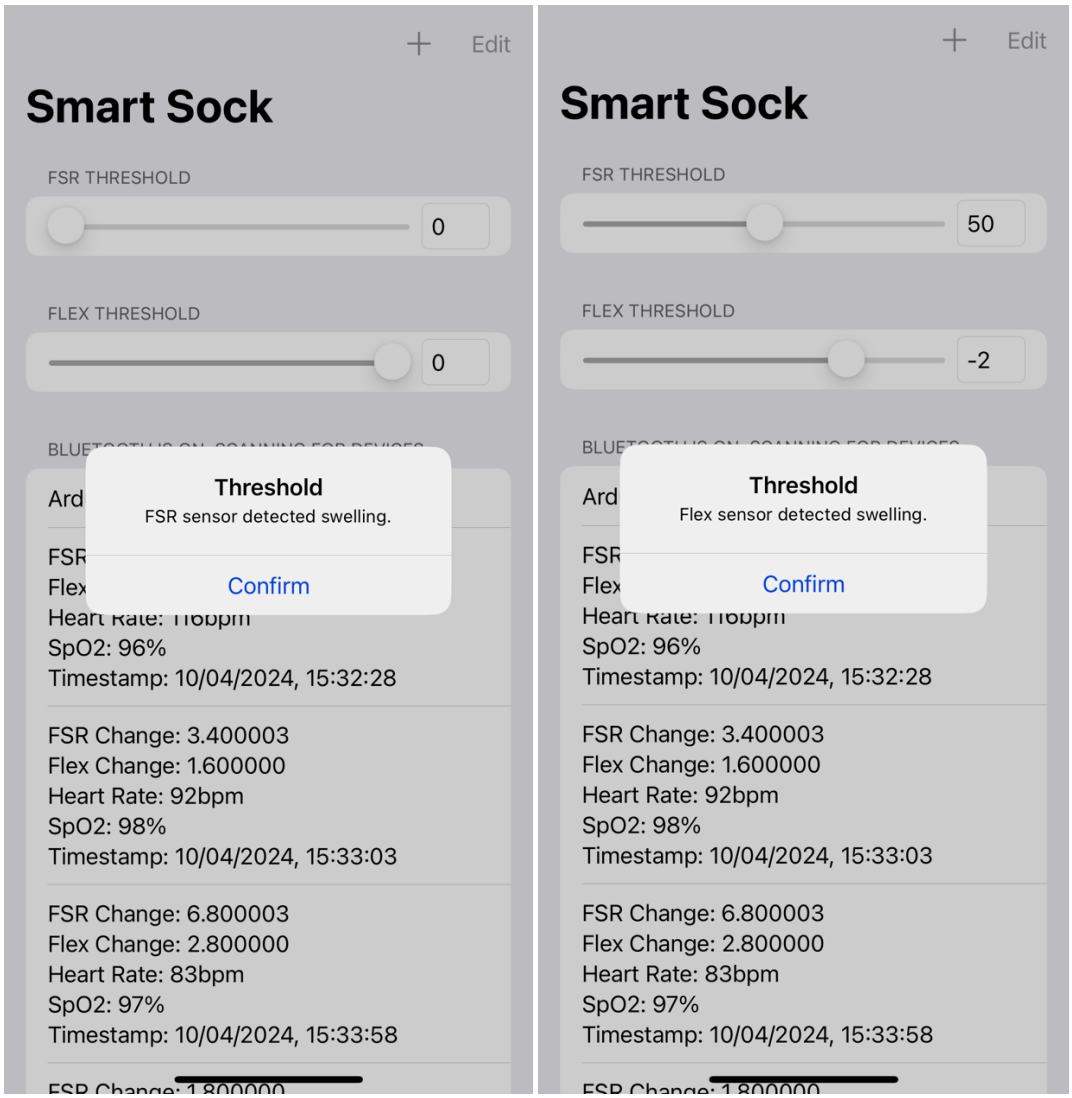

Figure 8: Alert displayed by FSR sensor.

Figure 9: Alert displayed by Flex sensor.

As current devices do not allow for testing on patients, a truncated cone was designed and 3D printed to simulate ankle swelling and verify whether the anklet can detect ankle swelling. The test results show that the anklet, wristband, and application function normally, the Bluetooth maintains a stable connection, transmits data reliably, and accurately represents sensor data and alarm information on the application interface.