HALO

To: Professor Pisano

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Subject: Second Prototype Testing Report

Equipment

- Arduino Nano 33 BLE

- Strain Gauge

- Strain Gauge Module BF350

- iOS App

  - Connects to the Arduino

  - Outputs the voltage of the Strain gauge

- Arduino script:

  - Connects to the iOS App

  - Transmits the voltage data

Setup

The prototype test involves both hardware and software components. We have developed an iOS application that features Bluetooth searching and connecting functions. To ensure accurate device detection, we modified the program to filter out irrelevant signals effectively. Our hardware setup involves a strain gauge connected to a Wheatstone bridge circuit, which measures the gauge's resistance. We attached the strain gauge to a cardboard piece and observed changes in its resistance when the cardboard was bent, with the direction and depth of bending affecting the changes. We used an Arduino Nano BLE 33 to record and measure the changes and programmed it to detect significant changes in the strain gauge. This detection capability allows the Arduino to determine if there is a risk of our protector being taken off. If such a risk is detected, the Arduino communicates with our iOS app, which then displays a message to alert the user that their drink might be exposed.

Measurements

The key objective of the second prototype was to make sure that the first prototype test's movement false alarm is being eliminated and the new strain gauge module reacts accordingly when force is applied. In addition to the testing of the hardware, the mobile iOS app is also a fundamental component of the final product. Ensuring the mobile app correctly displays the correct voltage change and capable of connecting to the Bluetooth is significant in the testing.

iOS App Test

Open the Halo app and test if all the functionalities of the software works and the Halo device can be detected and connected by the mobile app. The app should display the options of connect, info, and website buttons and be able to respond when you interact with it. The requirements are:

- Have the ability to search for Bluetooth devices and successfully connect to it.
- Display the voltage change when interacting with the strain gauge.
- Direct users to the website when pressing the website button.

Movement Test

Move and rotate the strain gauge in the direction of the x, y, and z-axis to test if false-positive cases will appear. This will test if Halo device strain gauge module is sensitive to movement and rotation and have the ability to distinguish the incidences of people trying to temper the drink from potential outside influence on the cup and cover such as external forces and movement caused by accident. Therefore, ensuring that a false-positive case would not appear when moving the cup in different directions is the fundamental feature of this product.

Conclusion

The second prototype testing can be considered successful, since our team achieved the set goals of making the strain gauge voltage change when bent and transmitting the voltage data to the iOS app in real time. The testing allowed our team to realize that the strain gauge design is less likely to have the false positives due the casual movement of the device compared to the accelerometer design only. However, we need to link the bending of the strain gauge to a certain

change of the cover during the action of taking the protector off. We will need to find the best spot on the cloth cover itself to attach the strain gauge and calibrate the strain gauge to eliminate the false positives miniscule strain changes may create. Putting the whole set up on the cloth cover seems to be the most important task that the team has to accomplish since the spot for the strain gauge should be flexible enough for it to sense the changes yet not too flexible so that it does not break the strain gauge.

Appendix

Table 1: Second Prototype Test Result

Test	Pass/Fail
Display the voltage change when interacting with the strain gauge.	Pass
Direct users to the website when pressing the website button	Pass
Arduino established bluetooth connection with iOS app	Pass
Arduino transmits correct voltage values to the iOS app	Pass
Voltage should change differently when the bending the strain gauge upward and downward	Pass
The Voltage displayed on the app does not change when the strain gauge is moved around	Pass
Success rate	=100%