Senior Design
ENG EC 463

To: Professor Pisano

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Team: Team 23

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Subject: Final Prototype Testing Report

Equipment

- Arduino Nano 33 BLE
- Strain Gauge
- Strain Gauge Module BF350
- 2 CR2032 3V Lithium Coin Cell Batteries
- Battery Holder
- iOS App
    - Connects to the Arduino
    - Outputs whether cover is still on
- Arduino script:
    - Establishes bluetooth connection with the iOS App

- Analyzes the voltage from the strain gauge
- The voltage combined with the Arduino's accelerometer dictates whether cover is still on

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 strain gauge amplification module, which measures the gauge's resistance and outputs the amplified voltage. The strain gauge, arduino, and battery are placed inside a 3D printed part. This part sits on top of the cover. The strain gauge is placed on the elastic that goes around the cover. We developed an algorithm that combines the strain gauge's voltage with the Arduino Nano BLE 33's accelerometer. 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 sends a notification to alert the user that their drink might be exposed.

Measurements

The key objective of the final prototype was to make sure that the Arduino could accurately detect when the cover has been removed and is able to sense forces applied to the cover from different angles. In addition to the testing of the hardware, the mobile iOS app is also a fundamental component. Ensuring the mobile app is able to successfully connect to Bluetooth

and send notifications when it senses potential cover removal to users are also significant parts of the final product.

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 whether the cover is still on or off via green and red color.
- Send a notification if the cover has been removed
- Users can press the info button to learn more about the product and how to use it
- Direct users to the website when pressing the website button

Movement Test

Move and rotate the cup in different directions 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. The requirements are:

- The iOS app should show the cover is on when moving the cup left to right horizontally.
- The iOS app should show the cover is on when moving the cup top to bottom vertically.

- The iOS app should show the cover is on when rotating the cup from different angles.
- The iOS app should show the cover is on when holding the cup upside down.

Conclusion

The final prototype testing can be considered successful since our team achieved the set goals of accurately detecting whether the cover had been removed and displaying this information on the iOS app. When tampering with the cup, the strain gauge sensor will detect voltage and transmit the voltage data to the arduino in real time. The result will be processed by arduino and notify users through their device connected to Bluetooth. The testing allowed our team to realize that the strain gauge design is successful and is able to accurately detect forces and distinguish between random movement and drink spiking. However, we need to make certain changes to the outer cover and reduce the overall size and design that are more suitable for users. We also need to continue calibrating the strain gauge to eliminate any possible false positives miniscule strain changes may create since incidents such of movement, rotation, flipping are all possible causes of false positive results. Rearranging the whole setup on the cloth cover seems to be the next goal of our project as it will make the design more organized and a lot less heavy. We also need to make sure the cover is safe and design a cover that protects the wires and sensors exposed outside.

Appendix

Table 1: Final Prototype Test Result

Test	Pass/Fail
Arduino established bluetooth connection with iOS app	Pass
Arduino transmits whether the cover is on to the iOS app	Pass
Direct users to the website when pressing the website button	Pass
Users can press the info button to learn more about the product and how to use it	Pass
The Arduino does not send out a cover off signal when the strain gauge is moved left to right horizontally.	Pass
The Arduino does not send out a cover off signal when the strain gauge is moved top to bottom vertically.	Pass
The Arduino does not send out a cover off signal when rotating the cup from different angles.	Pass
The Arduino does not send out a cover off signal when the cup is flipped upside down.	Pass
When the cover is removed for any angle the app alerts the user	Pass
Success rate	=100%