



**Boston University**  
**Electrical & Computer Engineering**  
EC464 Capstone Senior Design Project

**Second Prototype Testing Plan**

**Halo Smart Drink Protector**



by

Team #23  
Halo

Team Members

Zirui Chen [zirui22@bu.edu](mailto:zirui22@bu.edu)  
Alan Dautov [dautal@bu.edu](mailto:dautal@bu.edu)  
Gabrielle Kuntz [kuntzg@bu.edu](mailto:kuntzg@bu.edu)  
Pengyu Wu [frankwu@bu.edu](mailto:frankwu@bu.edu)  
Chenyuan Zhao [zhaoc23@bu.edu](mailto:zhaoc23@bu.edu)

## **Required Materials**

Hardware:

- Arduino Nano 33 BLE
- Micro-USB cable
- Testing Cup
- Strain gauge
- Potentiometer
- Multimeter

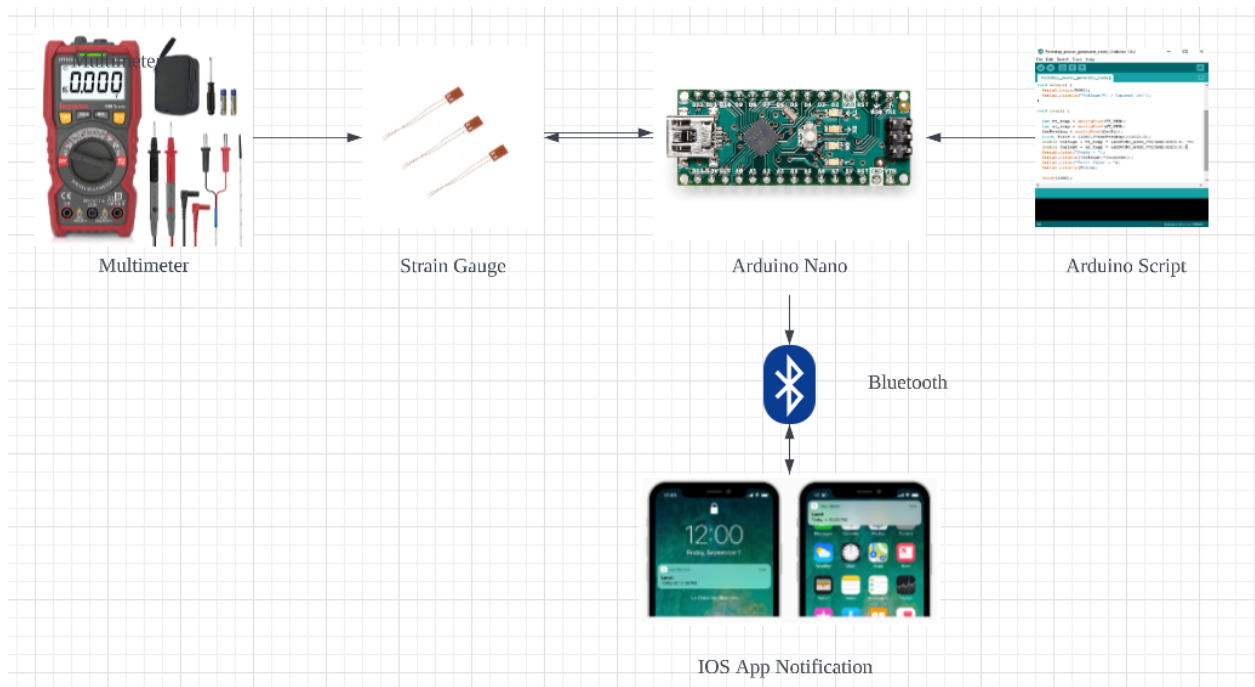
Software:

- Arduino script
  - Scans for compatible devices through Bluetooth
  - Connect Halo device to client's phone
  - Monitor the battery level of the device and deliver a notification to the client when the battery level is low.
  - Initialize the LED pin when the device is connected.
  - Stops the program and prints the warning message to warn the remote client when the cap is potentially taken off, continues when the reset button is pressed
- IOS Application
  - Scan for Halo devices with Bluetooth
  - Handle Bluetooth connection errors and check for compatibility of the device; print corresponding error messages when Bluetooth connection fails.
  - Display the functionalities including a connect button, an info button, and a battery level.

## Set Up

The prototype test consists of both software and hardware. We made an IOS app that has Bluetooth searching and connecting functions. We modified the program so it accurately finds our device without having many irrelevant signals. We have our strain gauge connected to a wheatbridge circuit to measure its resistance. We taped the strain gauge on a piece of cardboard. When the cardboard is bent, the resistance of the strain gauge changes depending on the direction and depth of bending. The change will be measured and recorded in Arduino Nano BLE 33. Our program in Arduino will detect significant changes in the strain gauge and determine whether there is a risk of our protector being taken off. If the program detects such a risk, it will communicate with our app and display the message showing the user that their drinks might be exposed.

## Block Diagram



### **Pre-test Set-Up Procedure**

1. Connect the Arduino computer/power source
2. Attach the strain gauge to cardboard on a flat surface
3. Open our IOS app on a cell phone
4. Search and connect the Arduino Nano BLE to the phone

### **Testing Procedure**

1. Disconnect the Arduino on the phone
2. Bend the strain gauge up from horizontal and check if the message shows up
3. Reconnect the Arduino on the phone to test if the IOS app and Arduino Nano Bluetooth connection are working
4. Bend the strain gauge up upward horizontally and check if the voltage changes
5. Bend the strain gauge downward horizontally and check if the voltage changes
6. Move the device left to right horizontally to check if any false alarm appears.
7. Move the device up and down vertically to check if any false alarm appears.

### **Measurable Criteria**

1. After disconnecting the Arduino on the phone, the app should no longer react to the change of the strain gauge
2. By scanning for Bluetooth devices and connecting to the Halo Device, the IOS app will display all the compatible devices and successfully connect when pressing the corresponding options listed.
3. When pressing the connect option on the app, it should display voltage level and refresh the last checked level.

4. Voltage should change differently when the bending the strain gauge upward and downward
5. There should not be message displayed on the app when moving around the strain gauge without bending it