To: Professor Pisano

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Subject: First Prototype Testing Report

Equipment

- Arduino Nano 33 BLE
- Traditional drink cover (*Nightcap*)
- Micro-USB cable
- Testing Cup
- Arduino script:
    - Checks and prints the accelerometer values of the x-axis, y-axis, and z-axis
    - Stops the program and prints the warning message when the cap is potentially taken off, continues when the reset button is pressed

Setup

There were two components of our prototype: The traditional cloth drink cover, and the Arduino. The Arduino Nano 33 BLE was attached onto the middle of the cloth drink cover using 3M tapes. The script uploaded to the Arduino constantly measured linear acceleration using its built-in accelerometer, and if the change in the z-axis value of the accelerometer was significant enough, the program halted and printed out the “Cap might have been taken off” message. Otherwise, when the cover remained on the cup the “Cap is on” message was continuously printed.

Measurements

Displacement Test

Try moving the cup in the direction of the x, y, and z-axis to test if false-positive cases will appear, such that moving the cup will trigger the warning. This is a critical function of the Halo device because the device should have the ability to distinguish the difference between cover displacement and cup displacement. Otherwise, the device could send incorrect messages to the users and cause misunderstandings. Therefore, ensuring that a false-positive case would not appear when moving the cup in different directions is the fundamental feature of this product.

- Move the cup horizontally on the x-axis to check if Alert Message shows up.
- Move the cup horizontally on the y-axis to check if Alert Message shows up.
- Move the cup vertically on the z-axis to check if Alert Message shows up.
- Randomly move the cup in the x, y, and z directions and check if Alert Message shows up.
- Knock the cup over and check if Alert Message shows up.

Rotation Test

In addition to the displacement test to check for the appearance of false-positive messages, a rotation test is also necessary. When drinks are being moved around, the cup may tilt in different directions and angles. The device should be able to remain inactive and not show any alert message when the cup is being rotated. By avoiding all forms of inaccurate detections when moving the cup, our product will achieve a higher success rate.

- Tilt the cup horizontally on the x-axis from 0 to 90 degrees to check if Alert Message shows up, then return to the original position and tilt to the opposite side from 0 to 90 degrees.
- Tilt the cup horizontally on the y-axis from 0 to 90 degrees to check if Alert Message shows up, then return to the original position and tilt to the opposite side from 0 to 90 degrees.
- Tilt the cup horizontally on the x-axis from 90 to180 degrees to check if Alert Message shows up, then return to the original position and tilt to the opposite side from 90 to180 degrees.
- Tilt the cup horizontally on the y-axis from 90 to180 degrees to check if Alert Message shows up, then return to the original position and tilt to the opposite side from 90 to 180 degrees.

Cover Removal Test

After clearing the possible false-positive conditions that alert messages may respond to, our product should be tested to check if the cover removal action will be detected successfully.

There should be no glitches or bugs that could potentially not trigger the device if the cover was removed.

- Gently remove the cover while making as little movement as possible.
- Quickly remove the cover and check if the alarm system is working.
- Two people cooperate and try removing the cover by avoiding the detection algorithm.
- Remove part of the cover from the cup.

Conclusion

After conducting our first prototype test, we realized that our design still has a few flaws. Fortunately, our algorithm has passed the displacement and rotation tests, and no alert message showed up when we conducted these tests. This is a large success of our prototype because we have achieved one of the main functionalities: no alert when the cup is simply being moved around. However, issues came up when we conducted some parts of the cover removal test. When the cover is removed normally, the alert message appears. However, when two people cooperated and when the cover was gently removed, the device did not pick up the signal and report an alert message. We realized that there is more to improve on both the hardware and the software part of the device. We would need to conduct more tests to determine a better threshold for the device to output alert messages. In addition, adding another sensor on the side of the cup may be helpful as well. Using both the displacement changes and the rotation changes of two sensors to determine if the device should output alert messages may provide a better result.