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Smart Jacket for Cyclist

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Abstract: Cycling has become one of the most popular sports activities, especially after the lockdown phase. In fact, this activity also cheap and eco-friendly as it encourages people to be more active in promoting healthy lifestyle and well-being by individuals of all ages. While this trend appears to have many advantages, the issue of visibility and detection always be the key concerns for the cyclist since cyclist frequently struggle to stay safe among other vehicles. The most common safety gears for cyclists are side mirror, reflectors and lights. However, these gears have limitation and provide minimal road awareness. As the technology progressed, a smart jacket with an all-in-one system was developed to assist cyclist feel safe and enjoy their rides. The rear of the jacket has an arrow-shaped turn signal to show the turning direction and improve the cyclist's visibility. The turn signal was created using LED strip and controlled by a switch on the sleeve of the jacket. The turn signal is visible even at distance proximity 50 m. Besides that, a blind spot detection system was created using ultrasonic sensors to detect nearby obstacles in the blind spot area and alert the cyclist via a buzzer and LED. The system notifies the cyclist via LED for 10 m distance and via buzzer for 2 m distance. This gives them more time to avoid and prevent dangerous collisions. Despite its technical benefit, this smart jacket is capable to power up approximately 2 hours and 3 minutes before having the jacket to recharge its power as Smart Jacket. Other than that, this smart jacket is water-resistant, washable and keeps cyclist safe and comfortable when cycling.

Keywords: Smart Jacket, Bicycle, Safety, Obstacles, Wearable Electronic, Blind Spot

1. Introduction

Progressive reductions in the usage of motorized cars, as well as the promotion of more sustainable as an alternative modes of transportation are now an essential aspect of most transportation strategies across the world[1]. These significant changes in transportation dynamics will not only contribute to environmental advantages, but will also boost beneficial activities that support their health and well-

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being especially after the lockdown phase[2,3,4]. Diverse tactics for expanding the importance of exercise through this activity have been developed in order to attain these objectives, resulting in a significant increase in the number of bicycle users in most situations from adults to children[5].

Despite, this activity helps the people to keep fit and reduce stress during lockdown, safety has been a serious concern as cyclist are more vulnerable than other vehicle occupants to fatality and severe injury during road collisions. According to the World Health Organization (WHO), half of the world's road traffic deaths occur among vulnerable road users [6]. For example, in Canada, cycling accidents result in 2.20 % and 4.60 % of all road fatalities and injuries, respectively, despite the low proportion of cyclists on the road [7]. In Malaysia, number of cycling fatalities is ranked fourth in statistical records that obtained from the year 2017 to 2021 publication of Royal Malaysian Police with total 137 cases followed after motorcycle, car and pedestrian[8].

According to the statement, 90.00 % of pedestrian driver encountered they often look for cyclist but fail to see them in time due to bicycle's lack of conspicuity. Clearly, the issue of visibility, conspicuity and detection are the key concerns for the cyclist, since cyclist frequently struggle to stay safe among other vehicles. Other road users need to be alert to the existence of cyclist on the road and also the direction of the cyclist. Besides that, cyclist have limited sight view as blind spot even with the help of side mirrors, and accidents can easily occur due to this problem.

Nevertheless, with the growth of technology a smart jacket with turning direction indicator and blind spot safety assist was proposed in this project. To conclude, with all-in-one system of these two features the turning direction and blind spot system via Led and buzzer can help the cyclist to stay vigilant, while stay focus on the road. This jacket also water resistance and washable. In the next section, discuss the innovation of wearable technology for cyclist.

2. Materials and Methods

This section provides a thorough overview of the methods and materials used in this project. The information will include all aspects related to the work plan for each stage, namely block diagram, software and hardware used and overview of the system flowchart.

2.1 Materials

The design of this project was made based on its functionality as a smart safety jacket. Therefore, the physical will resemble a jacket. Since, this invention involves the cyclist there were many decisions to make with regard to the positioning the various of components on the jacket. However, it is made to be wearable technology that can alert and notify cyclist through the sensors to stay safe during the ride. In order to make smart jacket, which have the feature of turn direction and blind spot Led Buzzer detection system to provide immediate proximity detection to cyclists via buzzer and LED alert, allowing them more time to avoid and prevent collisions. The list of components and software used for this project are listed below:

- Arduino Uno Microcontroller
- HC-SR04 Ultrasonic Sensor
- LED WS2812 RGB
- Piezoelectric Buzzer
- Led
- Switch Button
- Lithium-Ion Battery 9V
- Arduino IDE
- Blynk Software

In Figure 1 and Figure 2, depicts the block diagram of this project. The system utilizes the Arduino Uno Microcontroller as the main control system. The microcontroller is programmed by Arduino Ide program to function as desired. The input and output of this project are representing through the general block diagram. This smart jacket consists of ultrasonic sensor and pushbutton as input. As the results, if left button is triggered, the flashing signal in left arrow shape will be blinking and if right button is triggered, the flashing signal to the right side will be blinking. As for ultrasonic sensor it used to detect near object that can detect based on pin Trig and Echo. This sensor can detect approximately around 10m. After data be collected, it sends the notify to the user through the Led and Buzzer. For instance, when the sensor is detecting an object within the distance, it notifies the user through the Led and Buzzer. On the other hand, all this system is programmed using the software Blynk Arduino IDE. Moreover, this prototype of Smart Jacket is uses 9.00 V Lithium-ion battery as a power supply. The Lithium-Ion battery is a rechargeable battery that is lightweight and has long battery life. Lastly, the reason uses the Arduino Uno as microcontroller instead Lilypad Arduino, aside from its capability the Arduino Uno is low cost and easy to find. Thus, this prototype of smart jacket is water-resistant, washable, and it keeps cyclists safe and comfortable when cycling.

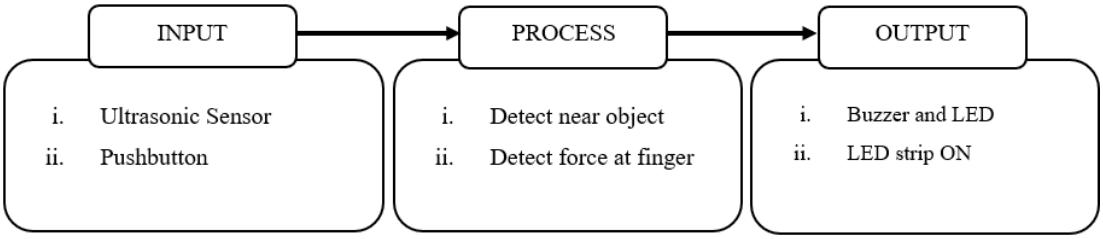

Figure 1:General Block Diagram

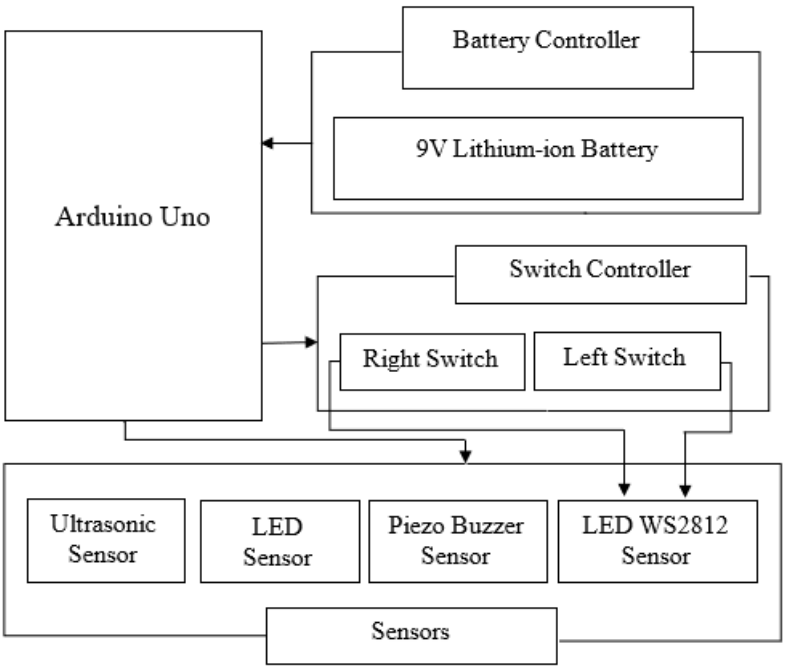

Figure 2:Block Diagram of The System

2.2 Methods

Generally, the two main function of this system are the turning direction and blind spot detection via Led Buzzer system. In Figure 3 and Figure 4, depicts an overview of how the system functions. The system starts by having the user check the battery level to determine if the power for the system is sufficient. Next, the user is required to check all the sensors to determine the functionality by pressing the right and left switch button to trigger the turn signal and wave to the ultrasonic sensor to trigger the led and buzzer detection. When cycling, if the user needs to determine their desired destination by pressing the switch button to trigger the flashing signal that resemble in arrow shape left and right. Despite the use of Led for turning direction it also helps to enhance the visibility of cyclist. For instance, if left button is triggered, the flashing signal in left arrow shape will be blinking for about 2.5s and if right button is triggered, the flashing signal to the right side will be blinking for about 2.5 s.

Once the user is start cycling, the Ultrasonic sensor initiate the pin Trig and Echo to read data. The ultrasonic sensor is used as blind spot detection to avoid and prevent dangerous crashes occurs with any obstacles. The sensor will detect and calculate the distance between the cyclist and the vehicles. If the vehicle is approaching within the distance of 10m, the Led will turned ON and if the distance of vehicles approaching is approximately in 2 m, both Led and buzzer will turn on to notify the cyclist as the object detected is too closed. Therefore, this blind spot Led Buzzer feature is to give as much awareness about road as possible, while allowing the cyclist to stay focus on the road. Another reason the system, is effective for cyclist due to bicycle have limited number of safeties, such as side mirror.

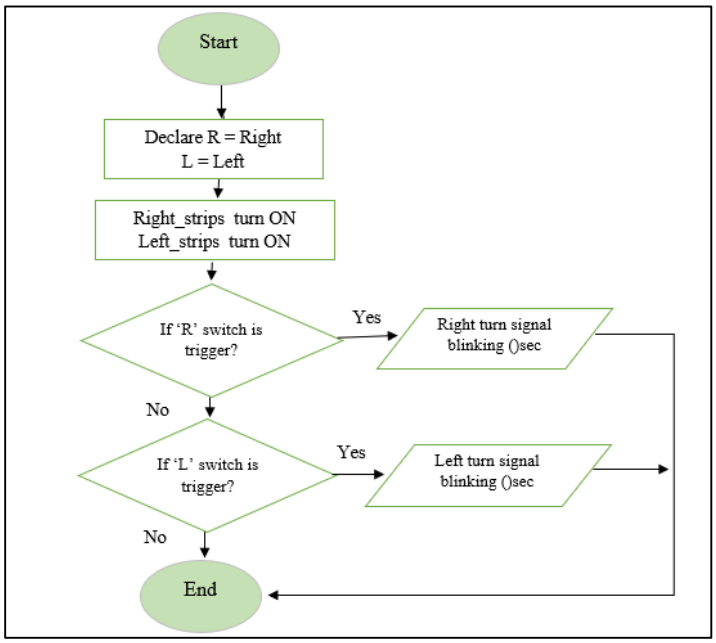

Figure 3: Flowchart for Turning Direction

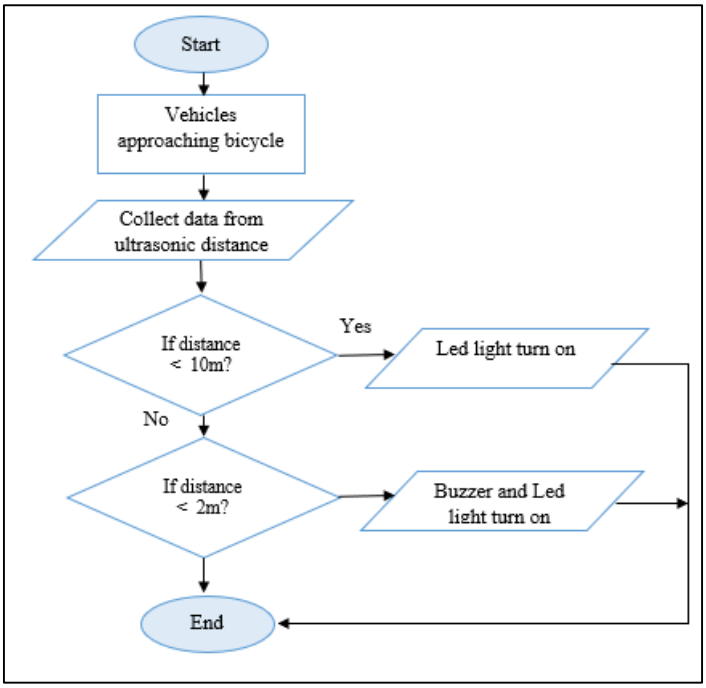

Figure 4:Flowchart for Blindspot Assist

3. Results and Discussion

This section focuses on the analysis and discussion of collected results and findings that was obtained from several experiments conducted with reference to the aims of the project. To recall, the purposes of the project are to invent safety Smart Jacket for cyclist that help to enhance the visibility of cyclist and notify the blind spot. In addition, this system provides immediate proximity detection to cyclists via buzzer and LED alert, giving them extra time to avoid and prevent dangerous crashes. This smart jacket also alerts the vehicle behind the cyclist through flashing turn signal which is part of the jacket safety feature. Lastly, this smart jacket that equipped with various sensors is control by microcontroller Arduino Uno and powered up by 9V battery. The experiment is performed under controlled environment during outdoor and indoor experiment to observe the effectiveness of Smart Jacket, to test the visibility of turn signal and functionality of blind spot system, to test the integration of circuit with jacket and durability of the smart jacket.

3.1 Smart Jacket Layout Design

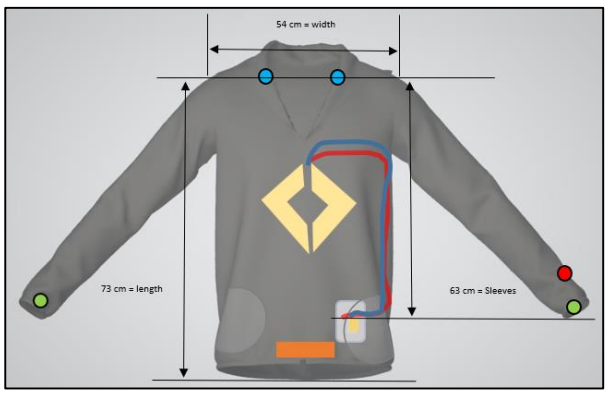

Figure 6:Jacket Design with sensors (Front View)

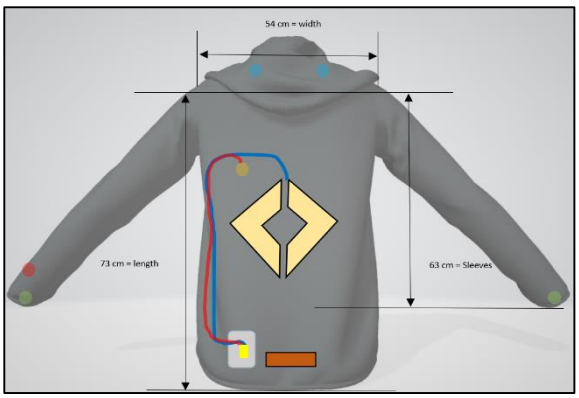

Figure 5: Jacket Design with sensors (Back View)

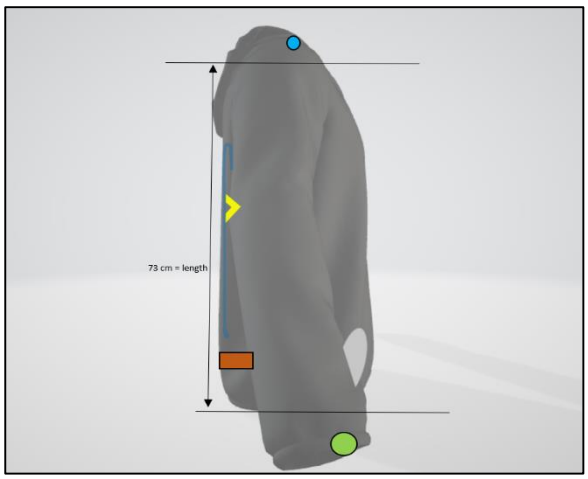

Figure 7:Jacket Design with Sensor (right Side View)

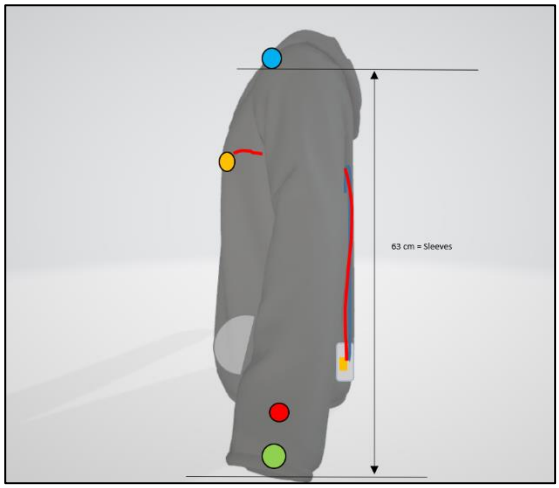

Figure 8: Jacket Design with sensors (left Side View)

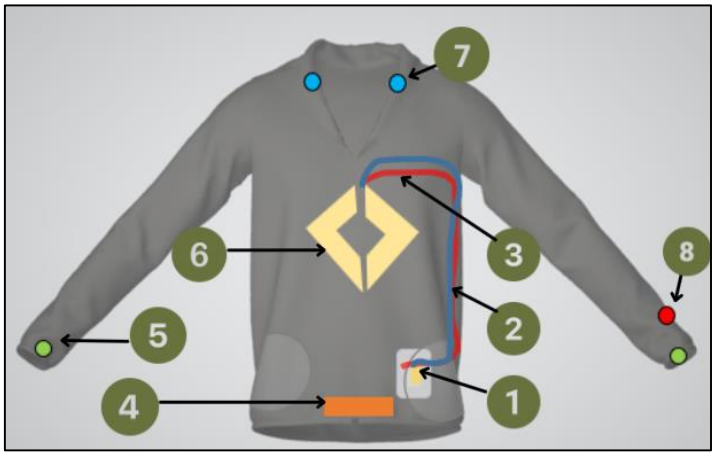

Figure 7:Jacket Design (Three-Dimensional View)

Table 1:Label of Component for Prototype Smart Jacket

Label Number	Part Name
1	Arduino Uno, battery
2	Wire cable
3	Wire cable
4	Ultrasonic Sensor
5	Pushbutton (turning signal)
6	Led Strips
7	Buzzer (blind spot detected)
8	Led Red (blind spot detected)

The layout design of Smart Jacket is shown in Figure 5 to Figure 9. As in Figure 5 and Figure 6, it depicts the front and back view of Smart Jacket prototype. Next, in Figure 7 and Figure 8, it represents the right and left side view of smart jacket prototype. Meanwhile in Figure 9 it shows the three-dimensional view of this smart jacket prototype whereas, Table 1 shows the name and label of each of components. The prototype is tested in two situations, namely outdoor and indoor experiment. For outdoor experiment, the test is carried out as designed in Figure 10 during night ride under control environment.

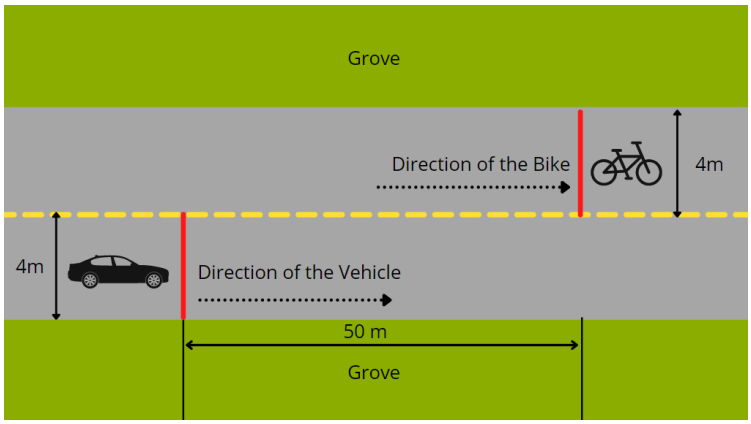

Figure 10: The Layout of Test-Driving Scenario

The experimental route was a straight along north-south direction with 50m distance between cyclist and the other vehicle The road width was 4m wide and the camera was placed at the initial line. For indoor experiment. The testing was related to the function of overall function of the smart jacket. The subject was a 25 years old male student from Universiti Tun Hussein Onn Malaysia (UTHM).

3.2 Results

This experiment was to observed the effectiveness of Smart Jacket under controlled environment during outdoor and indoor experiment. The finding shows, the difference visibility of cyclist wearing Smart Jacket compare to dark jacket as shown in Figure 11. From this observation, the Smart Jacket help to increase the detection and recognition especially during night ride compare to the dark jacket, which slightly creates a negative contrast with road.

Figure 11: Visibility of Cyclist using Smart Jacket and Dark Jacket

In the first experiment, the visibility of turning signal and functionality of blind spot detection were tested. The type of Led used for turning signal is WS2812 due to higher brightness and good performance. The visibility of turning signal was observed by setting the subject at several distance from 10m to 50m from the camera as in Figure 10. The result shows that all the flashing signal passed the requirement of being visible from distance of 50m, which also it can be ascertained by the fact that it could be visible and slightly visible as shown Table 2. Through the results of visibility, approximately below than 20m the flashing signal is visible, while the rest is slightly visible. This due to the driver's eye which not capable to focus equally when the subject at distance above than 30m as per Table 2[9].

Table 2:Results of Visibility Detection at Distance(m)

No.of Experiment	Types	Distances(m)	Visibilities
1	Flashing Signal	10m	Visible
2	Flashing Signal	20m	Visible

3	Flashing Signal	30m	Slightly Visible
4	Flashing Signal	40m	Slightly Visible
5	Flashing Signal	50m	Slightly Visible

Next, the blind spot detection functionality was tested through Led and Buzzer under two situations. For the first situation, the detection via Led are programmed to detect and alert incoming object within 10m proximity in range. This experiment was tested under controlled variable with standard lane change of a vehicle approaching the cyclist at distance between 1.5 m and 2.5 m at constant speeds up to 24 km/h relative to the stationary cyclist [10, 11]. From the finding, the effective range for blind spot is 10 m as it is well within the reason to set the cars to slow down between the time there are detected and when they overtake the cyclist.

For the second situation, the detection via Led and buzzer is programmed to detect and alert incoming object within 2 m proximity in range. Both tests have been conducted for 7 times with constant speed of 24 km/h as shown in Table 3. Through the finding, both sensors detected when vehicles are approaching within 2 m proximity, in range between 1.5 s and 2.5 s before the vehicle passes the cyclist. Hence, when the vehicles approach the bicycle at distance between 4 m and 10 m, only the Led is triggered, and when the vehicles approach within the distance of 2 m both sensors will be triggered and notify the cyclist. Figure 12 shows the raw data of blind spot detection below than 2 m. The data obtained for both situations were collected during cyclist's constant speed and the testing is invalid if the cyclist speed up.

Table 3:Results of Led and Buzzer Detection

No.of Experiment	Distances(m)	Led Detections	Buzzer Detections
1.	12m	Not Detected	Not Detected
2.	10m	Detected	Not Detected
3.	8m	Detected	Not Detected
4.	6m	Detected	Not Detected
5.	4m	Detected	Not Detected
6.	2m	Detected	Detected
7.	1m	Detected	Detected

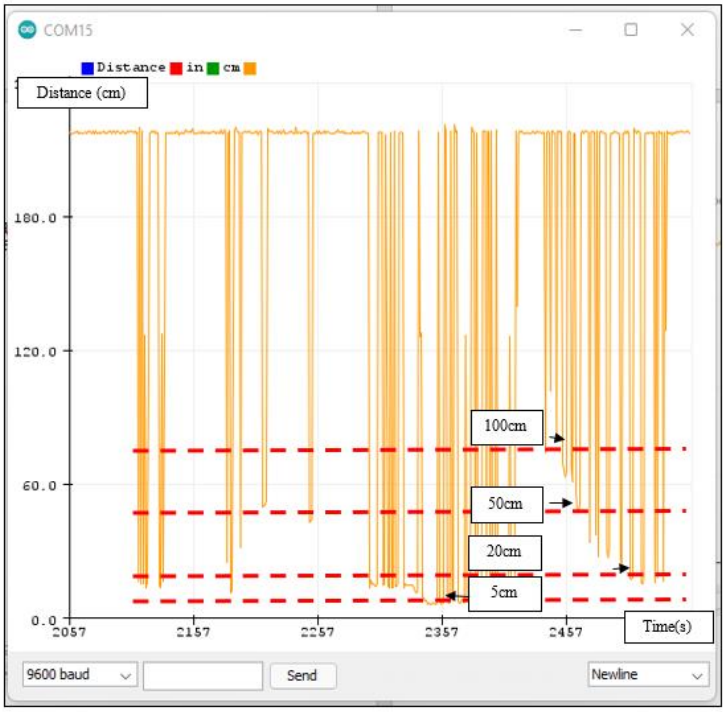

Figure 12: Blindspot Detection Below 2 m

In the second experiment, the test was carried out indoor to test the integration of circuit with jacket and durability of the Smart Jacket. The integration of circuit with jacket was tested along with the mechanism test and in each experiment the Smart Jacket was able to verify and function according to the programs as shown in Figure 13.

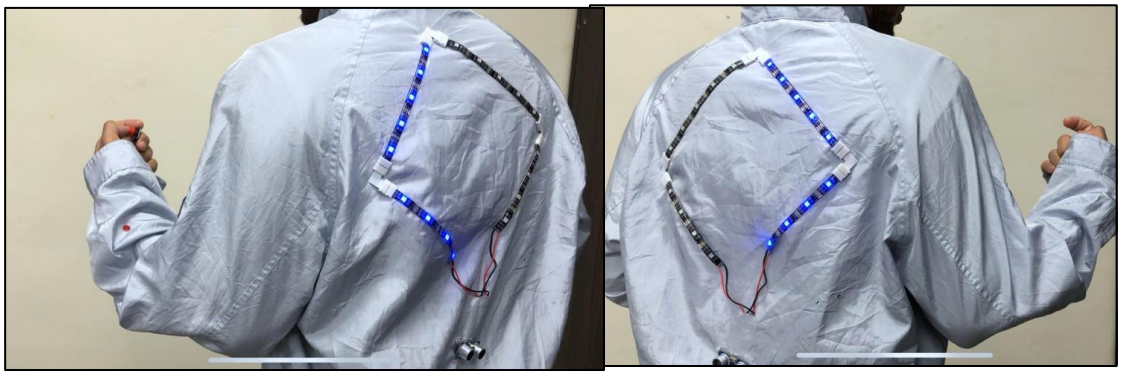

Figure 13: Circuit Integration with Jacket

In last experiment, the durability of jacket was tested by measuring the battery's voltage level during usage, for every 5 minutes. The purpose of this test is to observe and determine the amount of time this jacket can operate at maximum performance. Results in Figure 14 shows that the voltage level of battery decreases gradually, around 3.00 V– 5.00 V after each 3 minutes interval. With the initial standard charge state 8.77 V at 100.00 %, the battery is able to power the Smart Jacket for approximately 2 hours

and 3 minutes. This is an ideal operation time for the smart jacket before the battery need to be recharged.

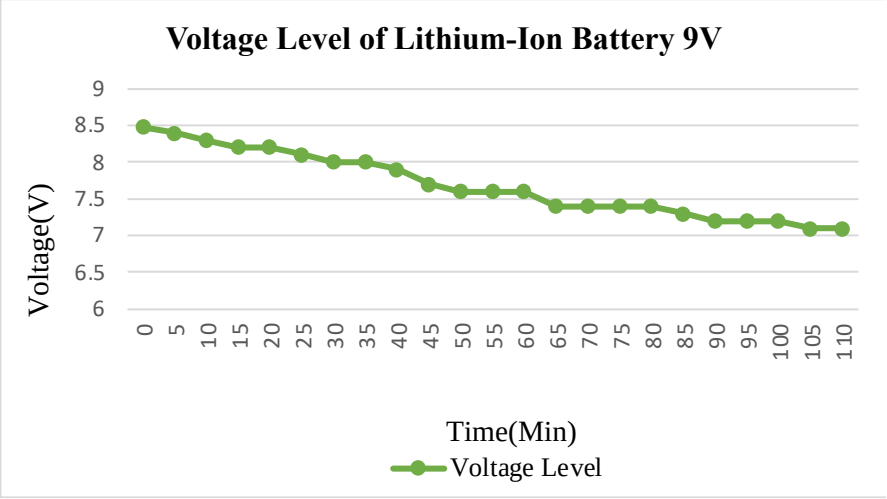

Figure 14: Results of Durability of Smart Jacket

4. Conclusion

Based on the finding of the experiments, it is apparent that the Smart Jacket is an effective wearable technology with optimizing its functionality especially during night ride. This is because, although most of the wearable technology project for cyclist are focus on safety, still not many of the them take serious attempt to build a full-scale cyclist safety system. This situation may result an increase the number of bicycle-car collisions, such as rear-end, angle, overtaking and turning left or right collisions. With that, this invention of cyclist Smart Jacket is to enhance the visibility of cyclist and notify the blind spot via Led and Buzzer alert. This feature is to give the cyclist as much awareness about road as possible, while allowing the cyclist to stay focus on the road. Another feature, this Smart Jacket has turn signal light that resembles as arrow shapes at the back of jacket. As the turn signal will blinking when cyclist trigger the switch button according to the desired destination. In fact, the reason of blinking is to help to distract driver's attention and allowing them more time to avoid and prevent collisions.

All the objectives that were initially set for this project was successfully achieved. The Smart Jacket is effective and visible even at distance proximity 50m as proven in Table 2. Next, the blind spot of Led buzzer system are effective as it can detect and notify cyclist within the distance of 10m for Led and 2m for buzzer showing the object detected is too closed. The 10m distance is well within the reason to set the cars to slow down between the time there are detected and when they overtake the cyclist as proven in Table 3. Additionally, the objective of developing the Smart Jacket with various sensor namely, ultrasonic sensor, Led and piezoelectric buzzer are successfully when all the sensors can be mount on the jacket and functioning as desired as shown in Figure 13. Thus, this Smart Jacket proved that it is able to integrate the smart jacket with the circuit as it allows to achieve as programs set and enhance the functionality in the system such as to avoid any obstacles from behind and be visible while on the road.

Although, all three objectives of this project were achieved, there are a several limitations and area of improvement to ensure the Smart Jacket for cyclist can further deliver optimal performance in safety during riding on the road. This will require further study on tailoring practicality and insertion of electronics into the textile to create better flexibility for cyclist through integration of all aspect of circuit into fully functional and practical smart jacket. Other than that, the motion control could be used to replace the pushbutton by controlling the smart jacket through body movements without self-activating. Lastly, to invent a wearable technology one of the key concerns is the weight. One of the techniques is

by replacing the microcontroller Arduino Uno to Arduino Nano which is lighter and smaller to attach on the jacket. Besides that, the weather effect on the smart jacket and impact upon the traffic safety through before-after comparison technique are recommended for future works.

Acknowledgement

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