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Personal Load Carrier Vehicle With Automatic Following Capability

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Abstract: Every supermarket has shopping carts to help customers choose their desired products. There are a lot of bustles in the mall during festivals and special offers. In shopping malls or supermarkets, trolleys are frequently used. It will usually cause a collision with the trolleys or the shelves around it. Trolleys are also frequently changed by the users, which is very dangerous for the current situation plagued by this COVID-19 situation. This condition will cause the virus to spread if there is no immediate action taken. To avoid this issue, we propose a solution which is the design capable to replace the trolley. This invention is able to carry goods and follow the user automatically to overcome this problem. It is built with sensors that will help to detect its owner and move as directed. The presence of this product will also reduce the risk of COVID-19 virus transmission among consumers as they will no longer have to share their carts with other customers. Moreover, this new invention is not limited to shopping; it can also be used anywhere by consumers according to their wishes.

Keywords: Trolleys, Arduino UNO, Object detection

1. Introduction

Nowadays, shopping in big malls has become a daily habit of many people. During holidays or weekends, the mall is quite busy. People buy a variety of products and put them into carts. There are more and more stores, so the need for shopping carts is increasing. As the need for shopping carts increases in the coming years, supermarkets will become more dependent on them.

Furthermore, the demand for trolleys has increased, and the steady market demand for supermarkets has increased yearly. Is this to say that when the need for trolleys increases, more stores will leave requests than usual. With more and more shopping carts in the market, it has become the mainstream market [1].

This shopping cart can reach peak season. Sales will also be successful as more and more customers open supermarkets, so shopping cart sales often get a high response [2]. Over the years, the shopping

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cart market penetration rate has maintained rapid growth. Although the price has not changed much before, the price/performance ratio is getting higher and higher than traditional shopping carts. Shopping carts are the most sophisticated. This technology is produced and used very quickly. With the development of increasingly sophisticated technology, shopping carts are now occupying the market at high speed, and it is expected that there will be better development.

Many modern shopping carts are made of metal or a mixture of metal and plastic. They are intended to compete to allow the collection and transportation of multiple items at once while saving storage space. Trolleys come in various sizes, with larger trolleys capable of transporting children. Shopping carts usually have four wheels, but they will be difficult to operate if one of them breaks down. Most trolleys generally have a rotating front wheel while the rear wheel remains stationary, but four rotating wheels are more prevalent in Europe [3]-[5].

While shopping, the consumer will need a lot of energy to push the trolley manually. This situation will have a more severe impact on the elderly and pregnant mothers. In addition, there are also safety issues with shopping carts, such as slipping down escalators. Customers who are in a rush to discover the product in the supermarket are known to find it inconvenient and time-consuming. Meanwhile, in the current situation of the COVID-19 virus spreading around the world, it is very worrying for all parties, especially in shopping malls, because there is a places where people from various places come to buy the necessities of life. In this project, a personal load carrier vehicle (PLCV) has been proposed to provide an alternative to the conventional trolley. The purpose of the PLCV system which can move on its own according to the user's needs while shopping. This PLCV will follow behind the consumer while shopping and will be seen to be very useful in the future. Next, the PLCV prototype was fabricated with an acrylic material and an Arduino UNO microcontroller.

2. Material and Methods

Our project aims to implement a prototype to detect and track people using ultrasonic sensors. Ultrasonic sensors have low voltage and low current devices. An Arduino Uno converts data into digital form and sends it to the microcontroller in real time. The microcontroller compares the data from the three sensors and decides the movement of the PLCV. It is more suitable because it is faster and more accurate than other systems.

2.1 Hardware component

Figure 1 shows the PLCV controller system that has been developed. The main component of this PLCV is the Arduino. It is used in conjunction with other components to make this operational system successful.

i. Arduino UNO: Act to process input to the fundamental component.
ii. Ultrasonic Sensor: The ultrasonic sensor recognizes an object and estimates the distance. We only need one sensor for this project
iii. Infrared Sensor: Used to sense specific characteristics of its surroundings to detect motion by measuring the heat generated by an object nearby.
iv. Motor Driver shield: The efficiency improves because the driver and the motor are better matched. In this operation, the motor driver uses to control four dc motors.
v. DC Motors: A DC motor is a machine that turns any energy into mechanical energy or moves anything. An engine plays a crucial part in the construction of a robot since it allows the robot to move. Four DC motors drive the robot.

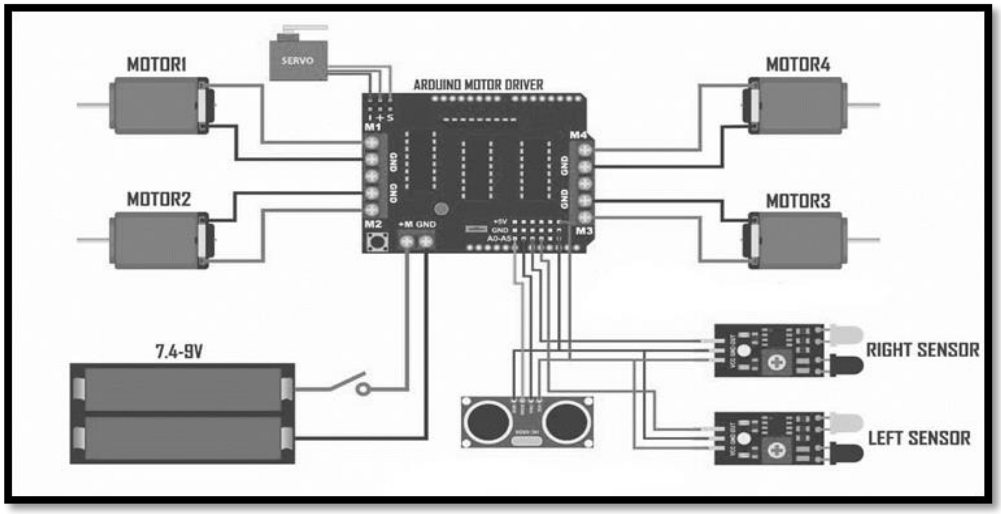

Figure 1: Hardware component connection

2.2 Electronic Circuit system

The simulation circuit diagram is shown in Figure 2. When the ultrasonic sensor does not detect any object, PLCV does not move, and when placing the object in front of the ultrasonic sensor, the PLCV moves. When set value one at the left IR sensor and 0 at the right IR sensor, PLCV will move to the left.

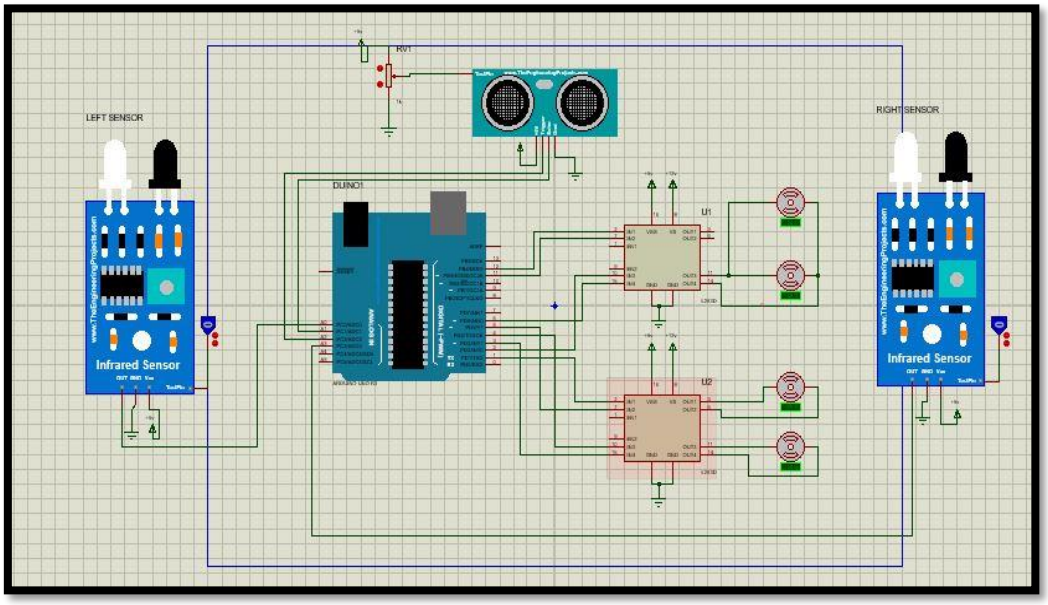

Figure 2: The schematic diagram of this system

2.3 Flowchart Overall PLCV Development

Figure 3 shows a flowchart of overall PLCV development. The project is underway to build and design a simple-to-use controlled PLCV that an Arduino Mega microcontroller will control as the system's brain. The PLCV development process will involve thorough research and study to ensure that all PLCV components function correctly.

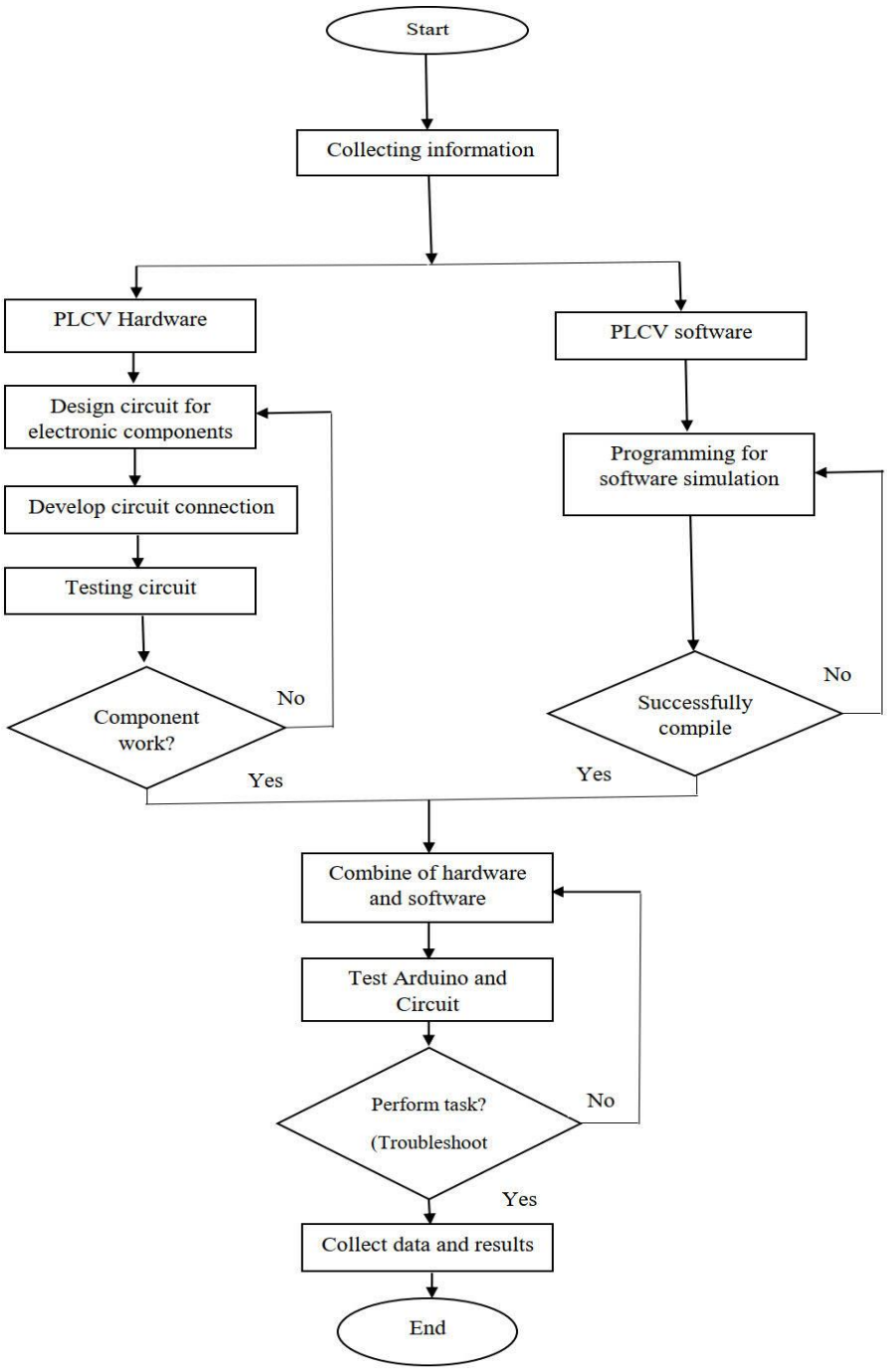

Figure 3: Flowchart Overall PLCV Development

2.4 PLCV Operation Flowchart

Figure 4 shows a flowchart PLCV operation, Arduino board is connected to an external power supply at 7.4V, and each component starts by itself unless there is a power failure. The infrared sensor will check the movement of the object. If no object is in the vicinity of the ultrasonic sensor, the motor that moves the wheel will stop, and the movement will stop until there is an object in its area. Once the sensor senses the adjacent object based on a set value of 30 cm, the wheel begins moving.

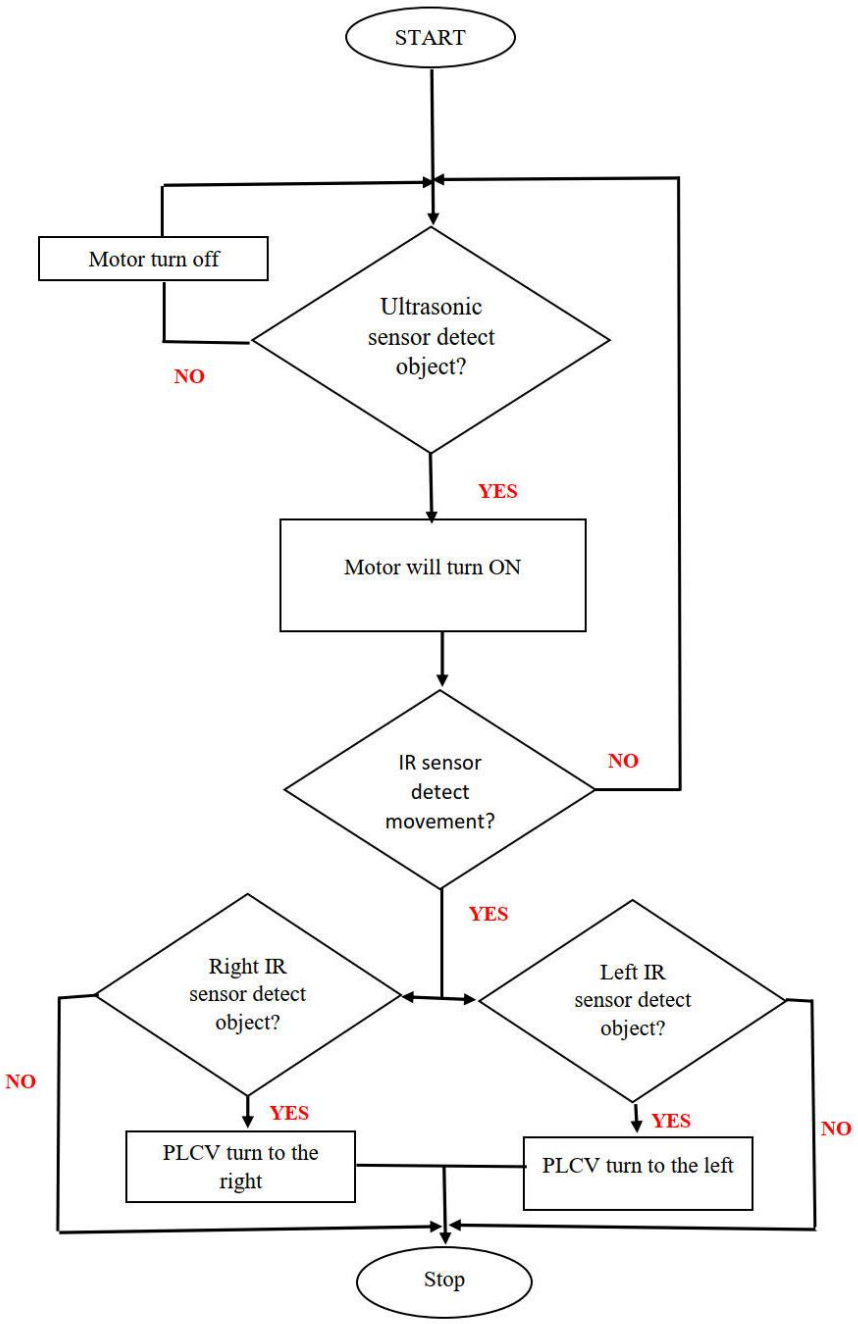

Figure 4: Flowchart PLCV operation

3. Results and Discussion

Three tests have been carried out to see if all of the system's components are working correctly and without any issues. The electrical and mechanical components and the relevant challenges and issues encountered during the development process are all part of the study. The findings of each investigation are compared to the theoretical values derived through simulation or calculations.

3.1 PLCV Prototype

The PLCV is supported by wheels and actuated by four DC motors with a microcontroller. Sensors play a crucial role in moving or stopping the PLCV. Therefore, the area that the sensor can detect has been defined. Figure 5 shows the Ultrasonic sensor principle in this system.

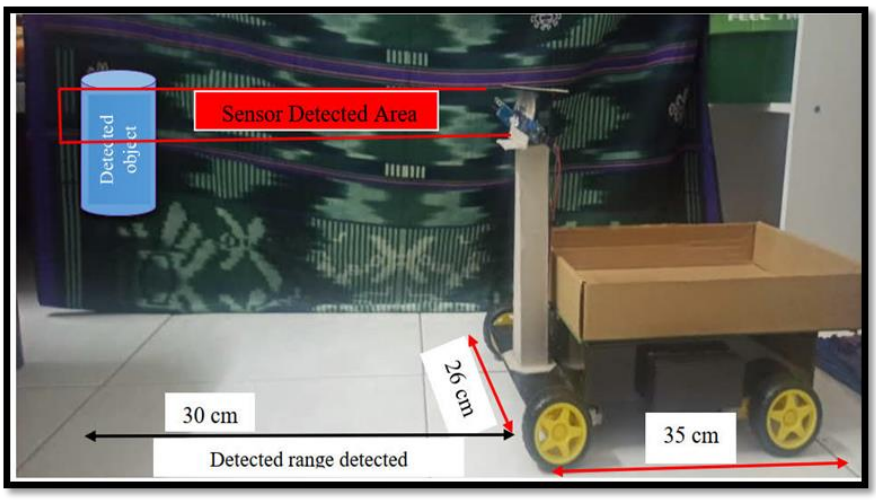

Figure 5: Ultrasonic sensor principle

3.2 Speed testing of PLCV for DC motor function in 2m range

The capability of the ultrasonic sensor is essential to enable the DC motor to function well in this project, especially when trying to get the best input for this Personal Load Carrier (PLCV) project. A distance of 2m is set to test the capability and speed that the PLCV can achieve without carrying any load. Generally, humans walk 1.4 meters per second if no external factors occur. In this experiment, the PLVC was allowed to move on a set path of 2m, and the time required to reach its destination was recorded. In this test, the object's distance from the sensor was placed 15 cm from the front of the PLCV. For the sake of fair and accurate results, this experiment was repeated ten times, and the results obtained are recorded in Table 1.

Table 1: Data for speed testing

No of test	Time(Second)	Speed (cm/s)
1	8.77	22.81
2	8.71	22.96
3	8.65	23.12
4	8.70	22.99
5	8.39	23.84
6	7.81	25.61
7	7.58	26.39
8	7.41	26.99
9	7.41	26.99
10	7.50	26.67

The PLCV requires an average of 7.35 seconds to move within a distance of 2 m. The average speed recorded is 24.84 cm/s. This is because the shorter the time to reach the finish point, the greater the speed released. The analysis also found that if the object were within a range of less than 5 cm in front of the ultrasonic sensor, it would not be detectable, and the automatic system would not work. This situation is due to the object's position in front of the sensor at different distances while performing the test. Although the object distance of 30 cm from the front of the sensor is set, there is a high

probability of human error, which causes a slight mistake in the value obtained. In this case, the message will be sent quickly to the DC motor, and the movement will increase speed. The analysis also found that if the object were within a range of less than 5 cm in front of the ultrasonic sensor, it would not be detectable, and the automatic system would not work.

3.3 Testing the range of Ultrasonic Sensor Detect Object

This analysis process will determine the success of the PLCV and the ability to detect and move following the detected object in front of the sensor. For this test, using four objects having different surface widths were performed. The widths used in this test are 1 cm, 3 cm, 13 cm, and 23 cm. The sensor was programmed to follow objects within a range of 2 cm height and 4 cm width in front of the sensor. It will be tested on four objects of different widths. Table 2 shows the performance results of each other objects. Each assignment tested approximately three tests.

Based on the result in Table 2, after performing three tests on all objects, it was found that no failure occurred. The sensor successfully detects all objects with different widths as long as they are within 2 cm high and 4 cm wide in front of the sensor. The analysis also clarifies that the ultrasonic sensor works by sending waves to the object in a straight line. When the object is successfully detected, it will reflect the frequency to the sensor, and the sensor will then receive information to be sent to the microcontroller to move the motor on this PLCV. Therefore, each object detected in a predetermined area will be able to reflect the frequency regardless of the object's width.

Table 2: Result performance of 4 difference widths detect by the sensor

Width object (cm)	Test 1	Test 2	Test 3
1	√	√	√
3	√	√	√
13	√	√	√
23	√	√	√

3.4 Testing load capacity carrier by PLCV

The ability of the PLCV project is further tested by testing its ability to carry the load in the prescribed direction. The ability to carry this load is shown in Figure 6 most important aspect of this project. In this test, five load weights were used, and the time to reach the destination was recorded. The distance the PLCV will travel is 200 cm, including the ability to turn left and right. This test will be performed for each load to get the best output.

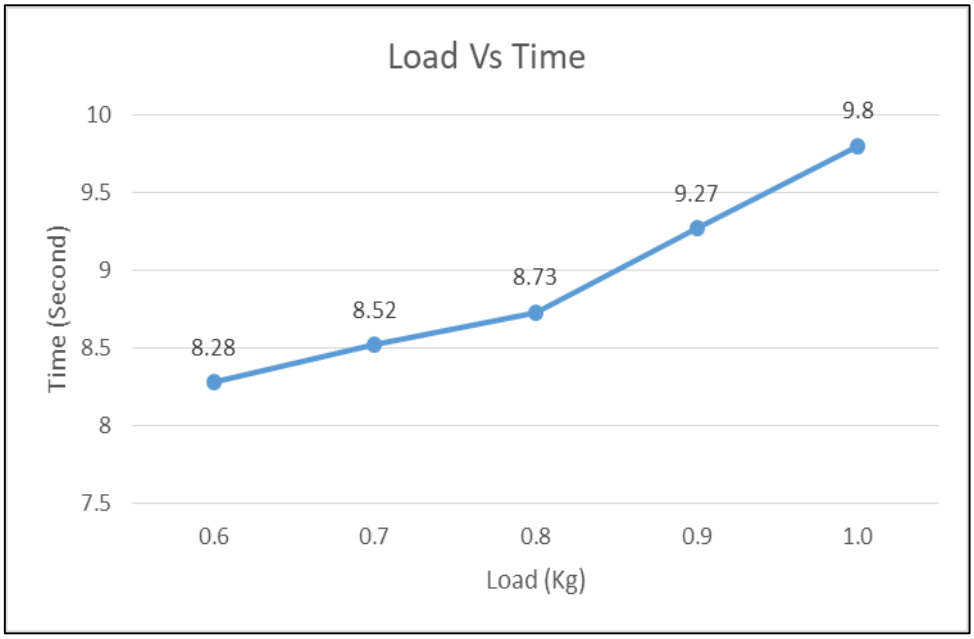

Figure 6: Result of load capacity testing

PLCV that carries the heavier load carries, the greater the time taken to reach the destination. This test can be seen when the load is carried at 0.60kg. The time taken to pass a distance of 2m is 8.28 seconds. Next, in the second test, the load was added to 0.70kg and the time to reach was 8.52 seconds. On the fifth test, using a load of 1kg, the time added to pass 2m is getting longer, which is 9.80 seconds. In this test, it was also found that there is a little problem with the PLCV turning left or right when carrying an excessive load because the motor only has an output speed of 100RPM. Overall, it can be stated that the more the load carried by this PLCV, the slower its movement, and cause the power supply runs out faster.

3.5 The Battery Power

The voltage supply is essential to turn on the circuit. The amount of supply voltage will affect the system's effectiveness. In this project, a PLCV prototype uses two batteries as a power supply. Lithium-ion batteries generate 7.4 volts of output and a current of 7000 mAh (milliamp-hours). DC motors currently used in this PLCV are controlled by the L293D and Arduino UNO motor drivers. The battery is rechargeable. However, the power generated during PLCV operation only lasts a short time. The issue develops when the ultrasonic sensor is configured with a motor driver shield. The battery is charged for extended periods to store more energy to address the problem. However, battery performance has an impact on the PLCV's usefulness.

The battery also affects the speed of the motor. This problem has a massive impact on programming. For example, the delay used in programming to control the rotation of the motor will change completely, and it will cause the robot to not work as programmed. To solve this problem, the battery must be constantly monitored or checked to ensure that the voltage does not drop below 5 volts during robot operation. If the voltage has dropped below 5 volts, the program session must be stopped, and the battery must be recharged to its optimum capacity.

4. Conclusion

In conclusion, the successful implementation of the following PLCV prototype is illustrated in this paper. This PLCV has detection capability and the ability to carry loads. While making this prototype, it should also be kept in mind that the functionality of the PLCV should be as efficient as possible. Tests were performed under different conditions to pinpoint errors in the algorithm and correct them. Various

sensors integrated with PLCV provide additional advantages. A PLCV is an automobile system that can recognize obstacles and move and change its original position towards the subject in the best way to stay on track. The project uses Arduino to move various sensors to achieve its goals. The project challenges you to collaborate, communicate, and develop an understanding of electronics, mechanical systems, and design integration with programming.

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