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Smart Bag Carrier with Human Detection System

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Abstract: In recent years, robot technology has developed significantly. This project is worked to carry a bag by following humans without any touch. This robot is by upgrading the trolley to a smart bag carrier with a human detection system, there will be a reduction in the risk for the virus to spread. It is because the bag carrier will automatically move without any touching. Furthermore, with the smart bag carrier, it will again ease the burden of hotel workers. Moreover, the worker will not feel any pain because it does not have to use energy to push the trolley. The main objective of this project is to design a smart luggage bag carrier that can bring the luggage bag automatically and can recognize a user without any touches using the Arduino Uno microcontroller and Ultrasonic sensor (HC-SR04). The second one is, to develop a system that can implement at the hotel and help workers to bring the luggage bag easily to the customer room. Lastly, this project can analyze human interaction and movement through positioning and distance. The research contribution for this project is it can implement in many ways and many places such as a supermarket, airport, factory, and hospital. It also can help in reducing the spreading of the virus.

Keywords: Smart Bag Carrier, Human Detection System, Ultrasonic Sensor

1. Introduction

In recent years, robot technology has developed significantly. Automation is the use of computers, control systems, and information technology to improve quality in the manufacture and distribution of products. The use of control systems and information technology eliminates the need for human work in the manufacture of goods and services.

Nowadays, the world has been shocked by the presence of a dangerous virus, known as Covid-19. With the presence of this virus, the whole world is experiencing an economic collapse. Various sectors of the economy have collapsed especially the tourism economy. The tourism economy is very important for a country, it is because the tourism economy sector is one of the main sources of income for a country. With this virus, everyone is afraid to go on vacation because this virus can be spread through touch [1].

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For countries that want to boost the country's economy, they should upgrade the tourism sector by converting hotel luggage trolley to smart bag carrier that can move on its own without any touch by a human. With this method, people are no longer afraid to travel because there is not much contact going on with them [2]-[3]. A four-wheel robot-based was designed to introduce the desired automated framework. The main objective of this project is to design a smart luggage bag carrier that can bring the luggage bag automatically and can recognize a user without any touches using the Arduino Uno microcontroller and Ultrasonic sensor (HC-SR04). The second one is to develop a system that can implement at the hotel and help workers to bring the luggage bag easily to the customer room. Lastly, this project is able to analyze human interaction and movement through positioning and distance.

2. Materials and Methods

2.1 Smart Bag Carrier Design

This robot is proposed to do carry a bag that can move on its own without any touch by a human. A four-wheel robot-based was designed to introduce the desired automated framework. An ultrasonic sensor is used on an integrated device to detect the signal obtained by this sensor. The Ultrasonic sensor (HC-SR04) is also used to detect the motion of a body in front of it. Two power window motors are used at this bag carrier to move this robot. Originally, the power window engine was produced for the power window of the vehicle, but many robot builders have used it in recent years to build their robots, especially for combat robots because of its performance. The universal motor will be implemented in this project because it has high starting torque and very high horsepower to carry the luggage bags [4]. Other than that, Arduino Uno is the component that will implement into this project. Arduino Uno will receive the data from the sensor to operate the system.

2.2 Smart Bag Carrier Operation

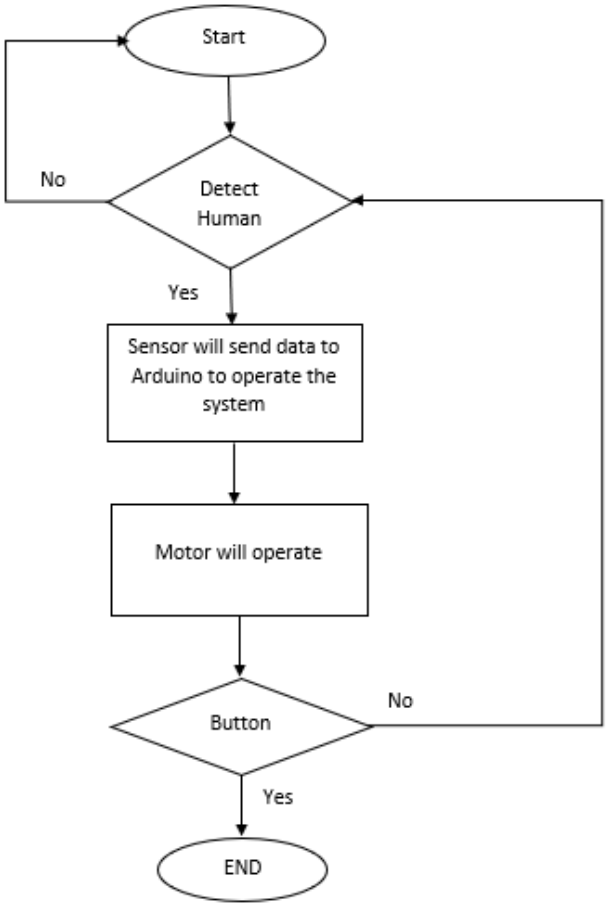

Figure 1: Project Methodology Flow Chart

Figure 1 shows the methodology of the smart bag carrier with the human detection system works. First, an Ultrasonic sensor (HC-SR04) is also used to detect the motion of a body in front of it. When there was a human in front of the Ultrasonic sensor, automatically the sensor will detect and start to work. The Ultrasonic sensor will detect the human and send the data to the Arduino UNO to operate the system. The Arduino Uno will be utilized as a microcontroller to interpret and handle incoming data, generate required information, and operate the responsive system (output). To run the system, C++ is used as an Arduino language. After that, the power window motor was used in this carrier bag system to accommodate the heavy luggage bag. The motor will operate the wheel and will follow the instruction from the Arduino.

2.3 Smart Bag Carrier Performance Evaluation

Figure 2 shows the block diagram for the smart bag carrier by using Arduino Uno. There were got the Rf remote control to switch ON/OFF the robot and the receiver will receive the instruction from the remote control and send it to the Arduino to start the program. After that, the Ultrasonic will detect the human and the Arduino Uno will run the program which is can control the movement of the power window motor.

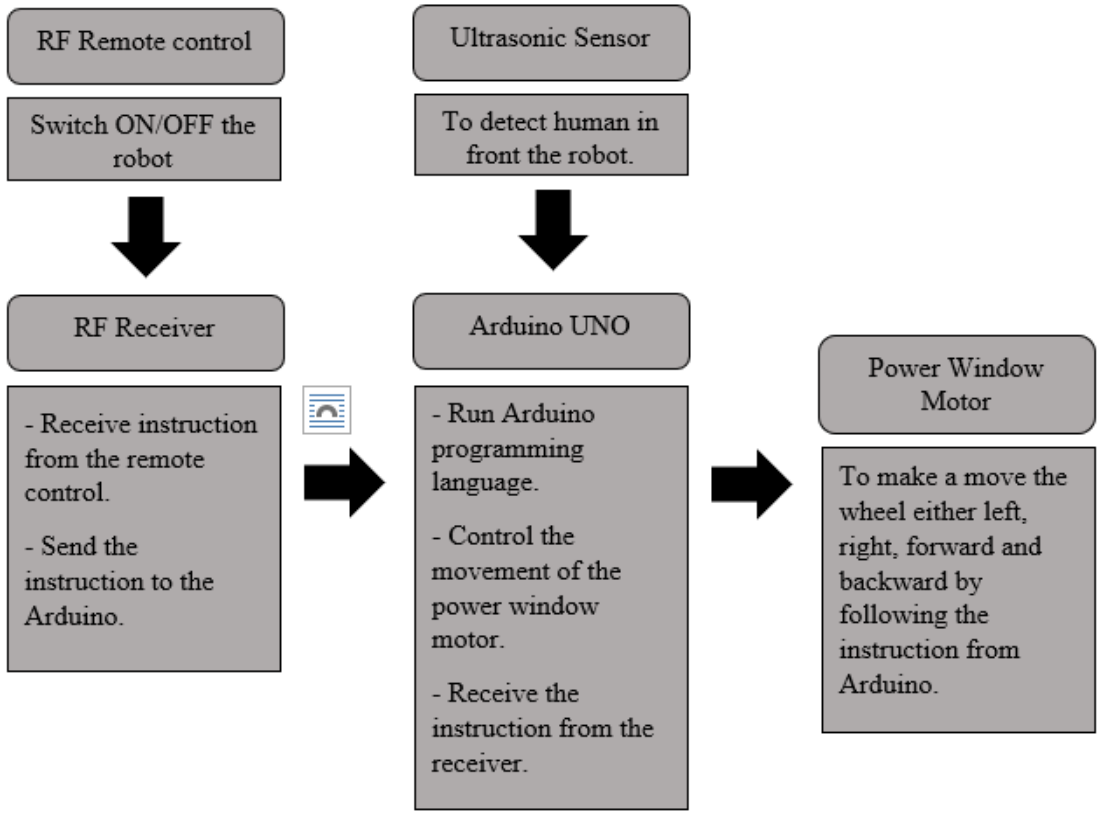

Figure 2: The block diagram for smart bag carrier by using Arduino

3. Results and Discussion

This section examines the functioning of each piece of hardware utilized in this project. The experiment was carried out to evaluate the ultrasonic sensor's accuracy as well as the accuracy of other important components such as the RF remote control, ultrasonic sensor, and power window motor. It also has to do with the design that was created with Solid Works program. The graphic illustrates the Smart Bag Carrier's design in terms of meeting the user's requirements.

3.1 Ultrasonic Sensor Test

This experiment aims to ensure the ultrasonic sensor can measure the distance of an object. This is important because in this project the ultrasonic sensor is the main sensor that is used to detect the human in front of it. A few analyses in Figure 3 were taken to see the measurement of the accuracy of the distance from the sensor to detect the human.

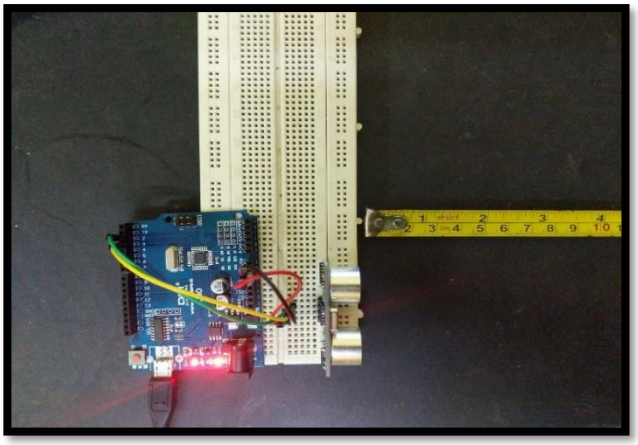

Figure 3: The Ultrasonic Sensor Measurement and Accuracy Test

Figure 4 they were output from the serial monitor that we run from Arduino IDE software. The maximum distance that was taken is up to 50cm. Table 1 above, shows the analysis of the accuracy of the detection Ultrasonic sensor.

From Table 1, 10 different distance measurements were taken to measure the functionality ultrasonic sensor. From the table, when the distance of the object is increased, the error of measurement is slightly increasing. The error shows farther away from the ultrasonic sensor; the error will be increase. Moreover, the other test that was done is how far the ultrasonic sensor can detect the human. The ultrasonic sensor can detect the human below 1 meter. After 1 meter, the ultrasonic cannot detect any human in front of it.

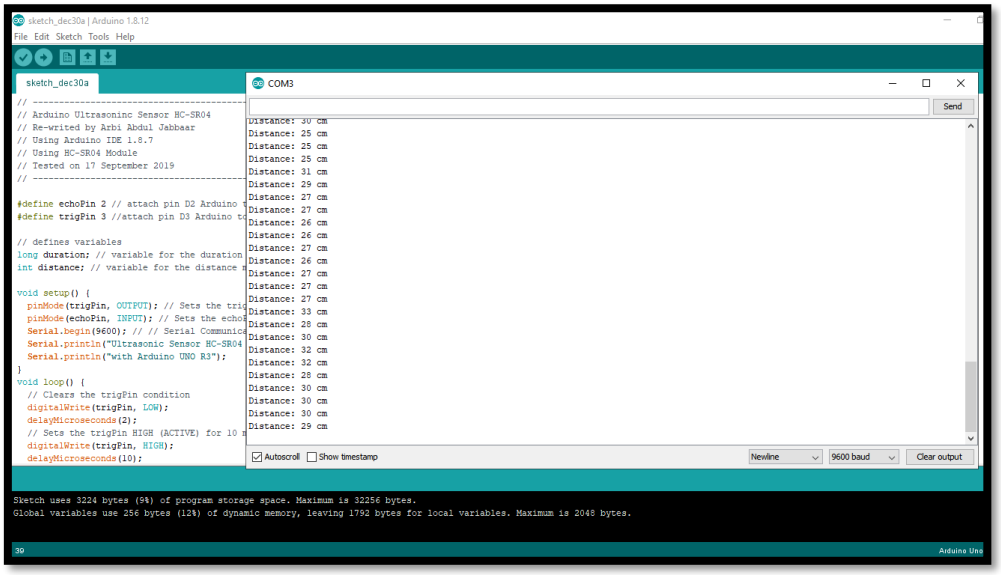

Figure 4: Output from Serial Monitor

Table 1: The measurement ultrasonic sensor to the human

No.	Actual distance using a measuring tape (cm)	Output from serial monitor IDE	Error
1.	5cm	4cm	1cm
2.	10cm	10cm	0
3.	15cm	16cm	1cm
4.	20cm	18cm	2cm
5.	25cm	24cm	1cm
6.	30cm	29cm	1cm
7.	35cm	34cm	1cm
8.	40cm	38cm	2cm
9.	45cn	43cm	2cm
10.	50cm	47cm	3cm

3.2 Directional Test

Figure 5 shows that the three main sensors which are ultrasonic sensors were plugin at the prototype. Four connectors were used from the sensor. The four connectors that are used are Vcc, Echo, Trig, and Gnd. Vcc and ground are the input for the three ultrasonic sensors left, right, and middle that connect to the 12v battery. Echo connector will be connected to the Arduino pin A1 for the left side sensor, Arduino pin A3 for the middle side sensor and Arduino pin A5 for the right-side sensor. Trig connector will connect to the Arduino pin A0 for the left side sensor, Arduino pin A2 for the middle side sensor and Arduino pin A4 for the right-side sensor. Figure 5 shows the installation of the tire and motor at the front of the prototype. The motor will be connected to the 4-channel relay. After installed, a 12v battery will plug in to check the motor as a result the motor can move forward and backward.

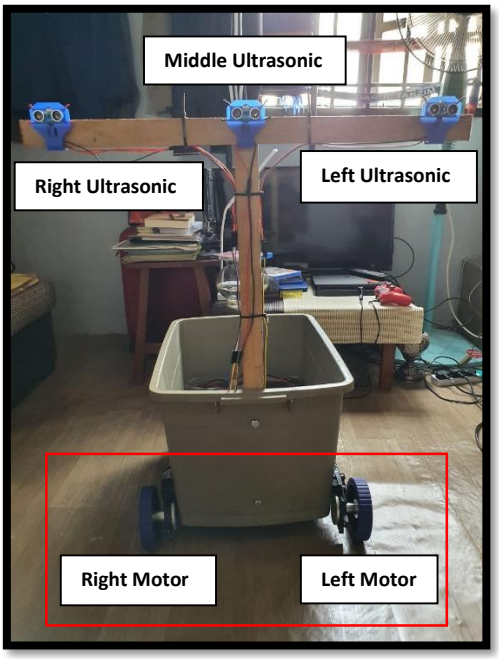

Figure 5: Positioning of Ultrasonic Sensor and Power window motor

Table 2 shows the ultrasonic sensor test with the power window motor. The result shows if the right side of the sensor the left motor will go forward and the right motor will move backward. For the middle sensor, the left and the right motor will go forward, and lastly, for the left sensor, the left motor will move backward, and the right-side motor will move forward.

Table 2: Directional Test

No.	Ultrasonic Sensor	Right Motor Direction	Left Motor Direction
1.	Right Sensor	Anticlockwise	Clockwise
2.	Middle Sensor	Clockwise	Clockwise
3.	Left Sensor	Clockwise	Anticlockwise

3.3 Load Weight Test

In Figure 6 shows the four different luggage bag weights that measure by using a digital weighing scale. These four different weights of luggage bags will be put into the trolley to test the capability of the trolley to move. In Figure 7 shows the luggage bag that was put into the trolley.

Figure 6: Load weights measure by using the digital weighing scale

Figure 7: Luggage bag at the trolley

In Figure 7 shows the luggage bag that was put into the trolley. The results shown in Table 3 are the capability of the trolley to move with the four different weights of the load. This result has shown the load between 5kg to 10.8kg the trolley will move faster and smoothly compared to a load that weight is above than 15.5kg, the trolley still can move but it will move slowly.

Table 3: The measurement of load weight

No.	Weight of luggage bag using a digital weighing scale (kilogram)	Capability of the trolley to move
1.	5kg	Move faster
2.	8kg	Move faster
3.	10.8kg	Move faster
4.	15.5kg	Move slowly

3.4 Speed Test

Based on result in 3.3 section, the weight of the luggage bag was the same as the value to do the speed test. There was two-point within 2 meters that will the trolley move from point A to point B. Hereby is the formula that will use to calculate the speed:

$$s = \frac{d}{t} \qquad Eq.1$$

s = speed

d = distance (m)

t = time (s)

From result at the Table 4, it is reasonable to infer that the heavier the luggage bags are, the slower the trolley will reach at its destination. With a weight range of 5kg to 10kg, the average time for the cart to arrive from point A to point B is 77.5 seconds.

Table 4: Speed result

No.	Weight of luggage bag using a digital weighing scale (kilogram)	Time trolley from point A to point B	Calculation of the speed using the formula
1.	5kg	76 second	0.0263158 m/s
2.	8kg	78 second	0.025641 m/s
3.	10.8kg	79 second	0.0253165 m/s
4.	15.5kg	87 second	0.0229885 m/s

4. Conclusion

In conclusion, this project was able to achieve the objective for this project based on sequences of an experiment for each of the components and a full functionally experiment of the robot. This project managed to achieve the preliminary target that can work according to its general workflow which can detect the range of the human and also can follow the human according to their destination. The first objective is achieved based on the resulting experiment ultrasonic sensor and power window motor test. Each of the sensors was performed very well. The second objective is accomplishing by built a

prototype of this robot that can carry the luggage bag by using the power window motor. Lastly, the robot was successfully analyzed human interaction and movement by using the ultrasonic sensor and power window motor. Therefore, overall, for this project can be defined successfully because all the objective is achieved.

Acknowledgment

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