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Food Delivery Monitoring System with a Line Follower Robot

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Abstract: This project offers contactless food delivery. The food delivery robot works autonomously to deliver food for patients. It comes with sensors and a line detection mechanism with turning at 30°, 45°, 90°, and sharp curves. Arduino Uno is used as a microcontroller to process and manage the input data, and control responses for output data. The infrared sensors are used to recognise the line. The ultrasonic sensors are used to sense obstacles and hence, stop the tray movement. The monitoring system is linked to Blynk app. The total length of track is 10 meters.The time taken for food delivery to reach every station is recorded with two different weights. It is concluded that the developed system can perform contactless food delivery and also can avoid crashing into people when someone blocks the movement of the robot.

Keywords: Food Delivery Robot, Contactless, Monitoring system

1. Introduction

The World Health Organization (WHO) on 30th January 2020 has publicly declared the COVID-19 pandemic as a "global emergency" because of the rapidity at which it had spread worldwide. On 27th February 2020, Malaysia experienced the second wave of COVID-19 infections [1]. On 8th September 2020, Malaysia declared the third wave of COVID-19 [1]. Malaysia reported a record high of 6,075 new COVID-19 cases on 19th May 2021, as the country continues to battle the third wave of infections [2]. The death rate is highest amongst older people compared to young ones, while male patients are more susceptible and at risk compared to female patients in the same age group. Patients with pre-existing cardiovascular diseases/hypertension, diabetes, cancer, and chronic respiratory disease have a greater probability to pass away due to COVID-19 complications compared to patients without comorbid conditions. Therefore, it is important to use hand sanitizers, face masks and practice social distancing to avoid the viral infection which can spread through sneezing, touching, and shaking hands. In this case, alternate technologies involving medical robots and telemedicine systems are in focus to control the spread of infection to a large population.

Due to the rapid spread of COVID-19, it is necessary to track all contacts of cases and quarantining them for the incubation period, to reduce the risk of further transmission. Therefore, the best method is

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social distancing, ranging from spatial separation of 1 or 2 meters to banning mass gatherings and imposing lockdowns [3]. This leads to problems in the healthcare facilities where patients are admitted, it is necessary to minimize contact with healthcare personnel. The shortages of mask and personal protective equipment (PPE) has led frontline medical workers to ration their use of the disposable gloves, isolation gowns and respirator mask that reduce the spread of infection. The purpose of this project is to offer contactless food delivery directly to the patient. This food delivering monitoring system provides alerts by using Blynk app when each tray is placed or removed. The movement of the food delivery works as line detection where the robot will follow the line and turning at 30°, 45°, 90°, and sharp curves.

2. Methodology

2.1 Project Overview

This line follower robot is an electronic system that can detect and follow the line drawn on the floor. A light-dependent resistor (LDR) sensor has been attached to the robot whose resistance varies with light intensity. When the LDR receives the maximum amount of light then its resistance goes to its minimum value, ideally zero, and when no light falling on the LDR then its resistance goes to its maximum value, ideally infinitive. The ultrasonic sensor is used to stop the robot when any object came. To design a line follower an ultrasonic sensor is needed to measure the distance to an object. Besides, the food delivery system is to monitor the status through Blynk app on a mobile phone. The status is shown in Blynk app when the tray is removed or placed in the slot.

This technology focused on the delivery of safe, timely, efficient, effective, patient-centred, and equitable health care. Firstly, the Blynk app is a platform to control Arduino Uno. At this point, the robot will be activated through data transfer from Arduino to node MCU, and then to Blynk app. The motor will move forward when both sensors touch bright colour. Both motors will be stopped because of presence black colour which make the motor to stop. An infrared sensor will be used to detect the line colour where these devices work by measuring the amount of light reflected into the receiver. The ultrasonic sensor also uses to detect the obstacle. The line follower robot will stop when the object blocks the track and the robot will continue moving when track are broken.

The ultrasonic sensor is used to detect the movement of the tray. Each tray has 3 slots and every slot has one ultrasonic sensor. The status is shown in Blynk app when the tray is at the original place where all the LEDs in Blynk app will light up. The other condition shows the tray is at 20% removed, 50% removed, 80% removed, and 100% removed. Figure 1 shows the block diagram of a food delivery monitoring system with a line follower robot while Figure 2 shows the flowchart of the line follower robot and Figure 3 shows the flowchart of food delivery monitoring.

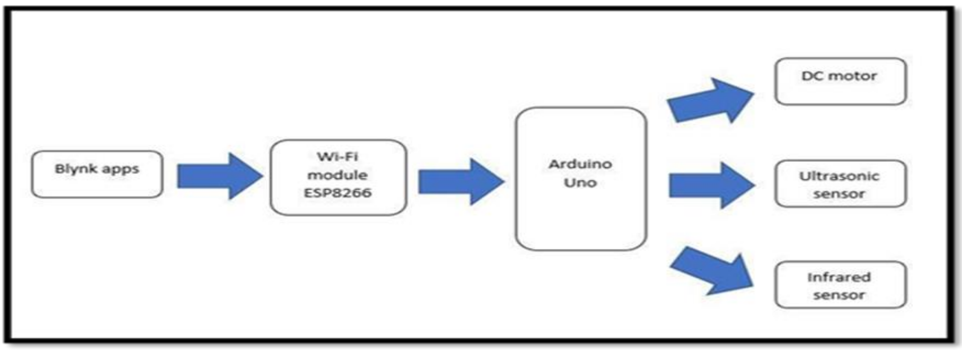

Figure 1: The block diagram food delivery monitoring system with a line follower robot

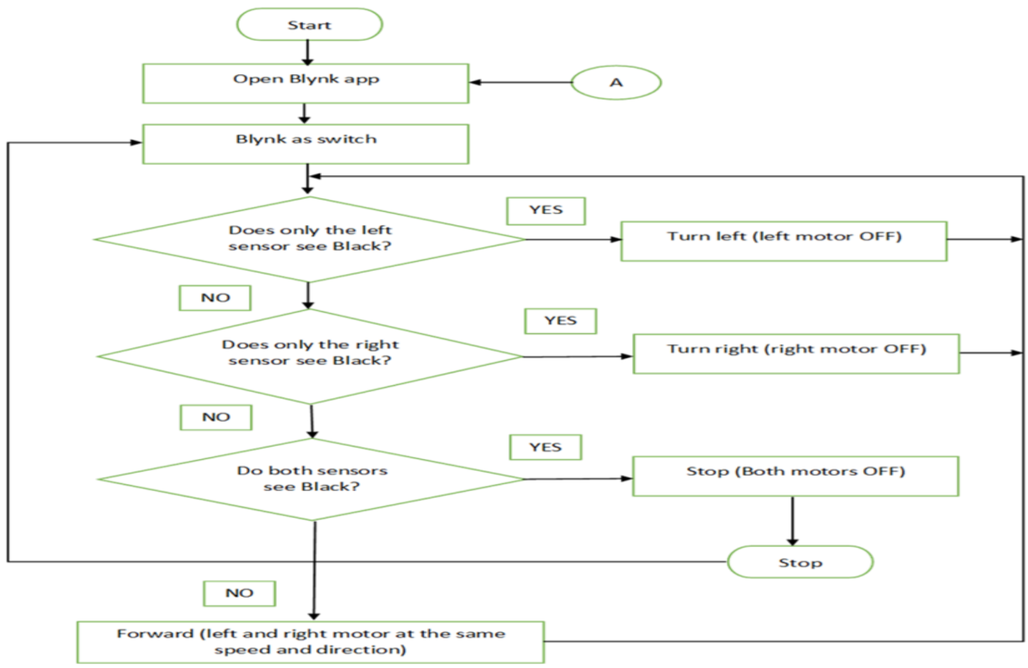

Figure 2: The flow chart of the line follower robot

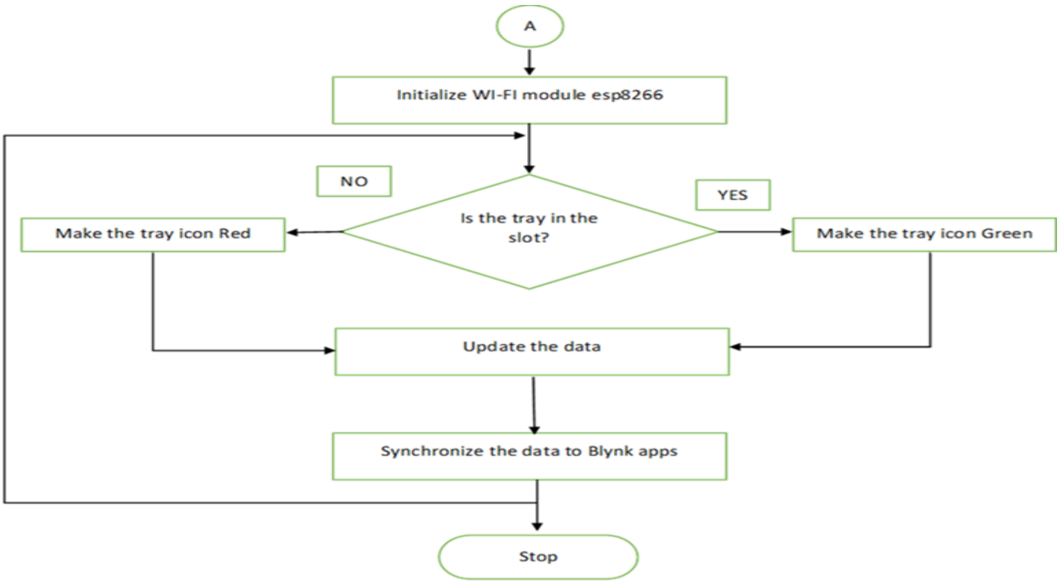

Figure 3: The flow chart for the food delivery monitoring system

2.2 Hardware and software

In this project, the circuit is divided into two parts which are the line follower robot and the monitoring system of tray movement. The hardware that is used for the line follower robot is an infrared sensor, DC motor, ultrasonic sensor, motor driver, servo motor, and Arduino Uno. Next, the hardware that is used for the tray monitoring system is an ultrasonic sensor and Wi-Fi module ESP8266. The software that is used for both parts is Arduino IDE, Proteus Professional, SolidWorks, and Tinkercad.

3. Results and Discussion

3.1 The project design

The movement of the robot used 4 wheels with a line follower and an ultrasonic sensor are needed to measure the distance to an object. The tray has 3 slots and each slot has 3 ultrasonic sensors connected with Blynk app to monitor the movement of the tray. Figure 4 shows the full design of a food delivery monitoring system with a line follower robot. Every component has been tested individually and then assembled.

Figure 4: Food delivery monitoring system with a line follower robot

3.2 Ultrasonic sensor test

The aim of this experiment is to ensure the ultrasonic sensor can measure the distance of an object. This is important because in this project the function of the ultrasonic sensor is to avoid obstacles whether human or object is in front of the robot. Besides, the movement of the tray will be monitored using Blynk app. An analysis in Figure 5 was taken to see the measurement of the accuracy of the distance from the sensor to detect the human or object in front of the robot. Figure 6 shows the output from Blynk app. The maximum distance that was taken is up to 60 cm. Table 1 compares the data of actual distance using a metal ruler and from Blynk app. From the test above, 10 different distance measurements were taken to observe the functionality of the ultrasonic sensor.

Figure 5: The measurement of the distance to detect tray and object

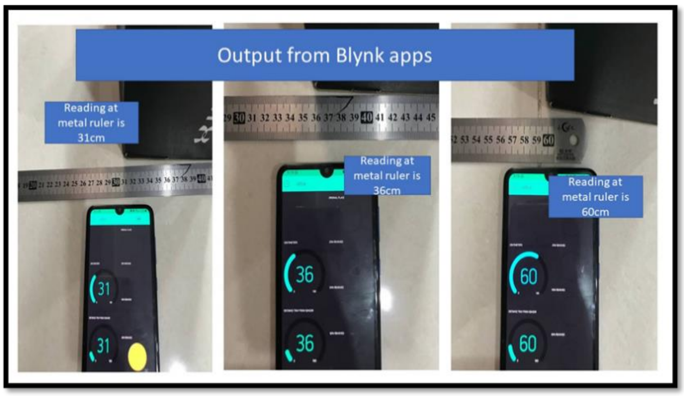

Figure 6: Output from the Blynk app

Table 1: The measurement ultrasonic sensor to the object

No.	Actual distance (cm)	Output from Blynk app (cm)	Error (cm)
1	6	6	0
2	12	12	0
3	18	18	0
4	24	24	0
5	30	29	1
6	36	35	1
7	42	42	0
8	48	48	0
9	54	54	0
10	60	60	0

3.3 Effectiveness in monitoring the tray movement

This experiment is to test the effectiveness of the system to monitor tray movement. Figure 7 shows the widget in Blynk app. The first condition shows the tray is at the original place where the LED in Blynk app will light up accordingly as shown in Figure 8 and Figure 9.

Figure 7: Widget in the Blynk app

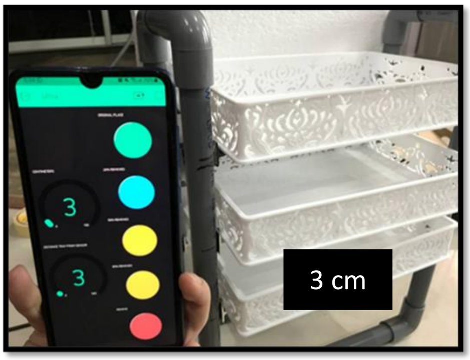

Figure 8: The tray at its original place

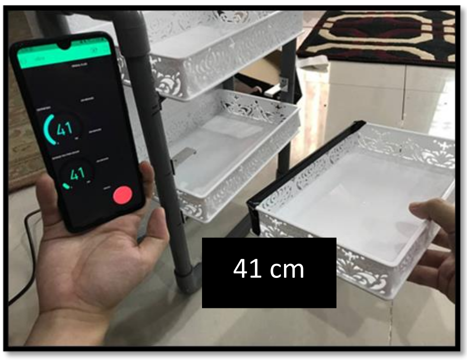

Figure 9: The tray is removed

3.4 The movement of the robot

This experiment is to test the performance of movement of a line follower robot. The movement of the line follower robot is depending on the rotation of the DC motor. This robot uses 4 DC motors which determine the directions of turning 30°, 45°, 90°, and sharp curve. The area of the track is 36000 cm^2. Figure 10 shows the movement of the line follower robot and Figure 11 shows the position of DC motor.

In this experiment, the rotation of wheel can be observed from side view of the robot shown in Figure 12. The direction of the robot is moving forward which the DC motor 1 and DC motor 3 turns anticlockwise while DC motor 2 and DC motor 4 turns clockwise. Next, the left direction in this situation shows the same turning where DC motor 1, DC motor 2, DC motor 3 and DC motor 4 turns clockwise. Lastly, DC motor 1, DC motor 2, DC motor 3, and DC motor 4 turn in the same direction which is anticlockwise. Therefore, a food delivery monitoring system with a line follower robot can do a simple movement. Table 2 shows the rotation of the motor.

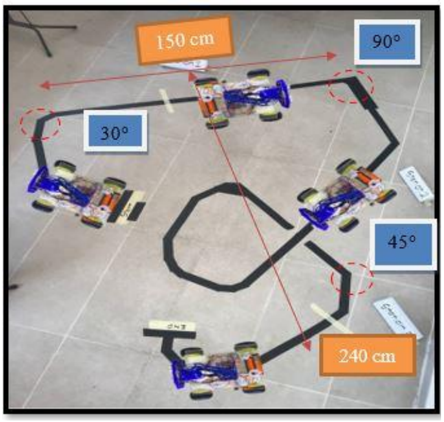

Figure 10: The movement of line follower robot

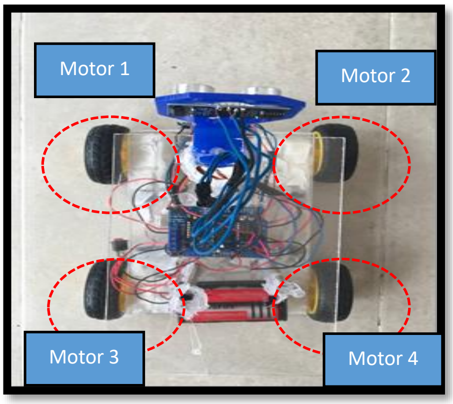

Figure 11: Position of DC motor

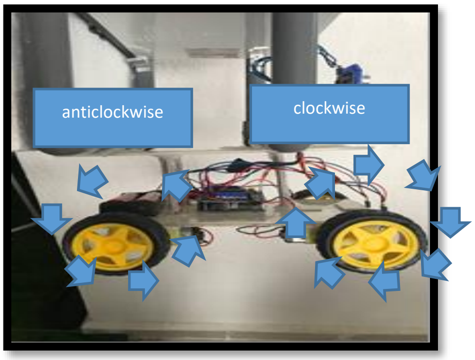

Figure 12: The rotation of the wheel

Table 2: The rotation of the DC motor

Direction of robot	Motor 1 (left forward)	Motor 2 (right forward)	Motor 3 (left back)	Motor 4 (right back)
Straight	anticlockwise	clockwise	anticlockwise	clockwise
Left	clockwise	clockwise	clockwise	clockwise
Right	anticlockwise	anticlockwise	anticlockwise	anticlockwise

3.5 Effectiveness in delivering food at every station

This experiment is to observe the time taken for the robot to stop at every station. There are 3 stations for the robot to stop. The time is taken from starting line until the robot reaches the first station. After that, the robot will continue and will stop at the second and the last station. The time taken to stop at every station, distance travelled from starting line to each station, and angle of turning will be recorded. Figure 13 shows the number of stations and Figure 14 shows the time taken for the robot to stop at a certain station. Table 3 shows the result analysis from experiment.

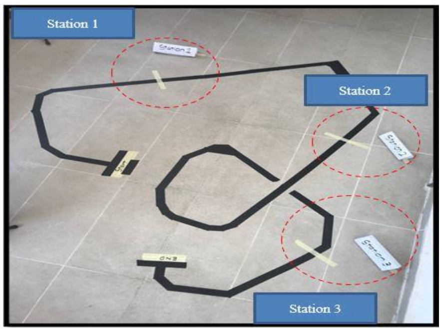

Figure 13: Number of stations

Figure 14: Time is taken to stop at station 2

Table 3: Result analysis from experiment

No of stations	Time is taken from start to every station (s)	Distance travel from starting line to each station (cm)	The angle of turning (°)
1	9.75	128	30, 45
2	21.16	288	45, 90
3	37.49	528	30, 45, curve

3.6 Effectiveness of several weights delivering food turning at 90°

This experiment is to test the performance of the food delivery robot turning at 90° with different weights. The time is taken from station 1 until the robot reaches station 2. Figure 15 shows the total weight of the food, Figure 16 shows the time taken is recorded, Table 4 shows Figure 17 shows the graph of weight against time and the result analysis of total weight with time.

Table 4: Result analysis of total weight with time

No.	Time taken from station 1 to station 2 (s)	Total weight carries by food delivery (g)	The angle of turning (°)
1	4.43	172	90
2	7.29	320	90
3	12.38	622	90
4	16.35	942	90
5	18.41	1114	90

Figure 15: Total weight of food

Figure 16: Time taken is recorded turning at 90°

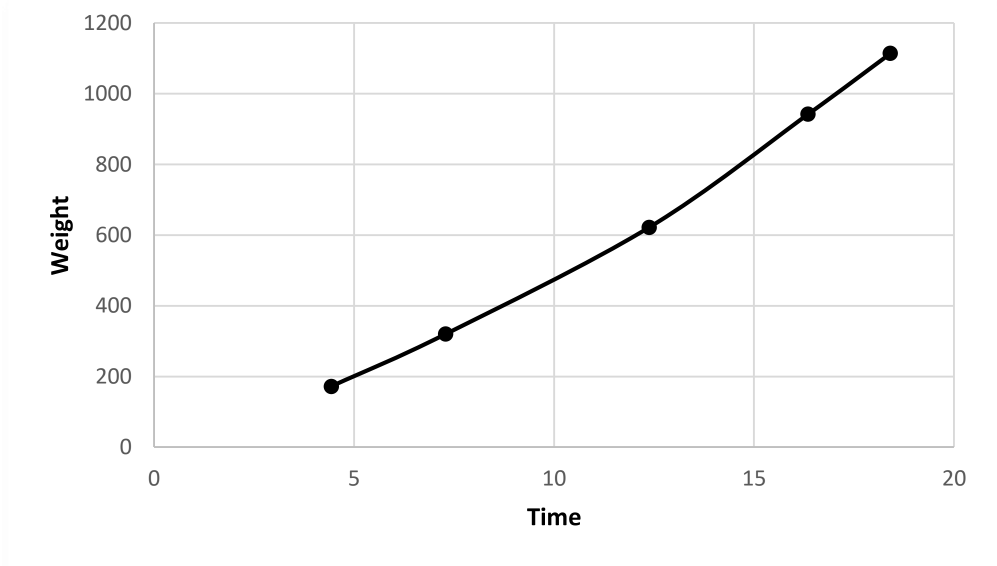

Figure 17: Graph weight against time

3.6 Effectiveness for the robot to stop when facing obstacles

This experiment is to test the ability of the food delivery robot to stop when facing obstacles which are done for two different situations at the track surface. In the first situation, the line track is blocked with an empty box. For the second situation, the human legs will step on the line track. The final result shows the same output for both situations where the food delivery robot will stop immediately but it differs in distance. Figure 18 and Figure 19 show the food delivery robot stops in both experiments.

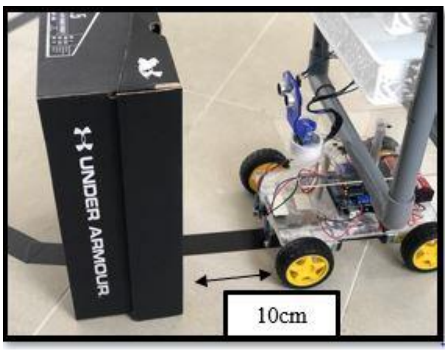

Figure 18: The distance is 10 cm from the box

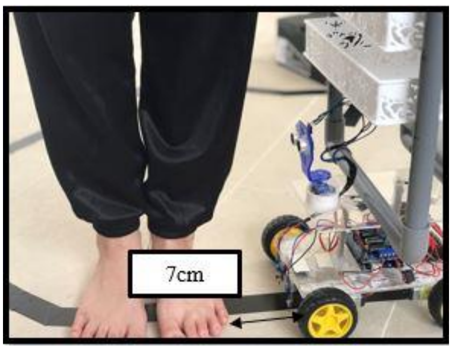

Figure 19: The distance is 7 cm from human leg

4. Conclusion

This project has achieved the objectives based on the conducted experiments and the food delivery robot is successfully functioning. The first objective is achieved by building a functioning food delivery monitoring system with a line follower robot that helps staff in the hospital to deliver food. The second objective is achieved based on the performance of the line follower robot for turning at 30°, 45°, 90°, and sharp curve. The last objective is successfully achieved as the robot provided alerts for tray movement by using Blynk app.

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