Smart Multi-purpose Trolley

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ABSTRACT

As the age of artificial revolution 4.0 approaches, most robots are being designed to replace mortal workshops and services. However, there is still a veritably limited amount of assiduity in using robots for service, much like servers do in cafés. This paper reports on the initial creation of a line-following restaurant service robot. Customers at cafés and hospitals deal with a lot of issues because of rush-hour traffic and waitstaff accessibility issues stemming from manual order processing. Many people were terrified of dying from viral diseases as a result of the Nimbus outbreak. The SMART MULTI-PURPOSE TROLLEY we designed can get around these restrictions. The robot's purpose is to inspect the size and condition of food establishments.

Keyword : - *ESP 32 Microcontroller, Smart Multi-Purpose Trolley, Line following, Sensors* **.**

1.INTRODUCTION

Wheeled mobile robots have grown commonplace in a variety of industries, from military to civilian uses, in recent years. Wheeled robots have shown to be adaptable, especially in consumer environments, using cutting-edge technologies like image processing and smart detectors. Notably, motivated by similar endeavour in Japan, a team created Mortar, which means a wheeled robot waiter. Given their ease of use and efficiency, this breakthrough has spurred the notion of using wheeled mobile robots as servers in restaurants. To avoid spills, it is crucial to have precise control over the robot's speed, which calls for research into alternative control methods such PID controllers and modulation-based techniques.

In addition to controlling speed, adding sensor modules is essential to improving the robot's performance. In a Research on a Danang neighborhood eatery, wheeled mobile robots were outfitted with specially designed sensors for course tracking, a sound module for client contact, and ultrasonic detectors for obstacle avoidance. The Smart Multi-purpose Trolley's design is presented in this paper, with a focus on line-following methods and controller configuration. Overall, the study highlights the potential of wheeled mobile robots for use in restaurant service and emphasizes the continuous efforts to improve their usability and effectiveness in practical environments.

2. LITERATURE SURVEY

The disadvantages of using traditional human waiters are highlighted by Akshay Agarwal et al. [1], with a focus on time consumption and financial considerations. Sapaty, Peter Simon [2]: Talks about developments in military robots and presents Spatial Grasp Technology (SGT), a cutting-edge method of advanced unmanned systems control. Topakci M. and Unal I [3]: Present an autonomous robot with GPS guidance that can be operated remotely and is intended for precision farming. Lopez J. and others. [4]: Introduce BellBot, a mobile platform-based automated hotel assistance solution. Malik Neeti et al.
[5]: Present the Serving Robot, a tiny robot made to function as a personal helper in a variety of settings. Pieska Sakri et al. [6]: Offer customer operation via an Android tablet linked to a database of current restaurant menus. Mishra Neelima and others. Dr. Ashish Dutt Sharma, Dr. Dinesh Goyal, and Neelima Mishra [7]: Increase the effectiveness of café service by suggesting improvements like gyro balance for chargers and optimizing several aspects including ordering, serving, balancing, and communicating in restaurant robots. The usage of Atmel's AVR microcontroller in line following robots is discussed by Mehran Pakdaman and M. Mehdi Sanatiyaan [8], M.

Pakdaman, M. M. Sanaatiyan, and M. R. Ghahroudi [12], who offer insights into the development and application of these robots. In beaneries, M. Kamruzzaman and M. Tareq [9] introduce an intelligence-based system that uses RFID technology to provide menu ordering, reservation-making, and customized menu recommendations

3. METHODOLOGY

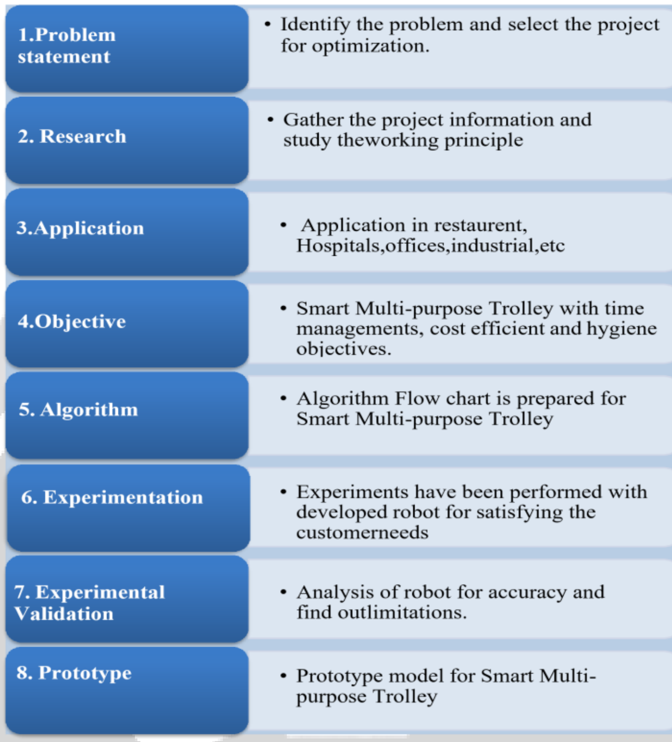


Chart.1: Methodology

3.1 Methodology Overview

The ESP32 is the primary controller used in the technique overview. It was selected because of its many input and output pins, which allow it to interface with a wide range of sensors and transducers. Peer-to-peer communication, networking, web page serving, and sensor data processing are just a few of the IoT features made possible by the ESP32. The ESP32's integrated Wi-Fi module is used in this system to facilitate communication, allowing users and robots to interact using the BLYNK IoT application. Robotic movement is accomplished by use of 45 RPM geared motors that are driven by a lithium-ion rechargeable battery. An L298N motor driver, which is governed by the ESP32 controller, is in charge of the motors' directional control.

RFID cards and readers are used to identify table numbers; an RFID card is specific to each table. A line-following system made up of two infrared sensors is used to track the robot's movement. These sensors identify the existence and strength of infrared radiation reflected by the surface. The robot may navigate along preset paths with the aid of this mechanism. Based on infrared sensor technology, proximity detectors are used in touch screen phones and other gadgets that need to detect touch input while in operation.

4. BLOCK DIAGRAM

The block diagram shows how a customer enters the restaurant, uses a web application to place an order, and the user provides the table number for food delivery. The robot then returns to the kitchen unit to serve the food, and both the user and the robot wait for the next order. The project plan only allows for four tables

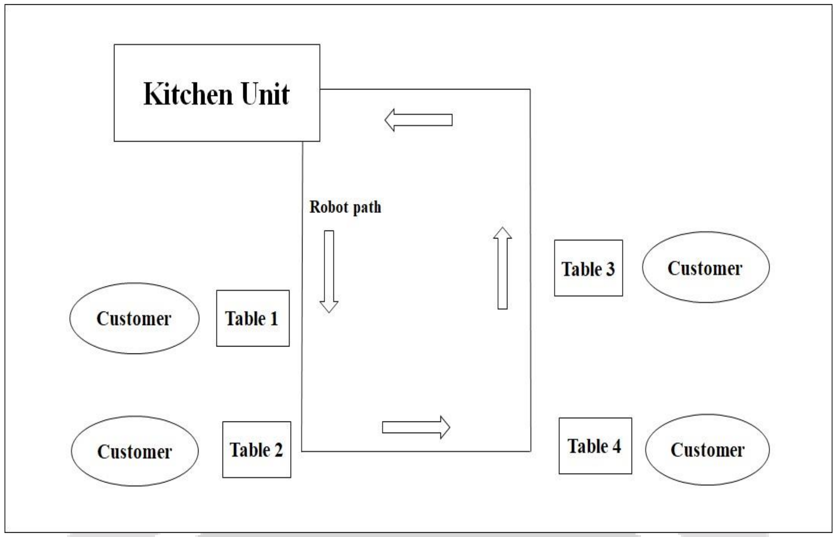
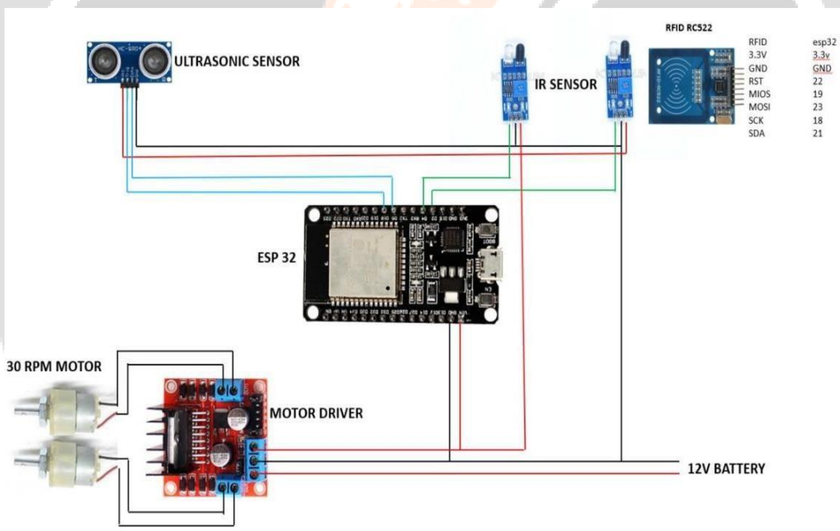


Diagram.1: Block diagram

5.PROJECT IMPLEMENTATION

5.1 Experimental Setup



Dia.2: Connection

Components connection:

The motor driver is connected to GPIO pins 32, 33, 25, and 26 on the ESP32; the ultrasonic sensor's Trig pin is connected to D18 and echo to D5 on the ESP32; the infrared sensors are connected to D2 and D4 on the ESP32; battery ground is connected to GND, and the 12volt input is connected to Vin. Motors 1 and 2 are connected to Out1 and Out2 of the motor driver, respectively.

5.2 Physical Modular Testing

5.2.1 Speed of the robot without an upper body is elaborated as follows,

Tri al	Distance (cm)	Time (sec)	Speed (cm/s)
1	160	5	32
2	160	5.63	28.4
3	160	5.66	28.2
4	160	5.90	27.1

5	160	5.82	27.4
6	160	5.90	27.1
7	160	5.91	27
8	160	5.81	27.5
9	160	5.83	27.4
10	160	5.88	27.2
		Average Speed	27.93 cm/s

Table 1: Speed of robot without body

According to the table, it results that the speed of the robot is 0.27 m/s without an upper body

5.2.2 Speed of the robot with an upper body is elaborated as follows

Trial	Distance (cm)	Time (sec)	Speed (cm/s)
1	160	6.47	24.7
2	160	6.52	24.5
3	160	6.78	23.5
4	160	6.54	24.4
5	160	6.58	24.3
6	160	6.72	23.8
7	160	6.66	24
8	160	6.68	23.9
9	160	6.50	24.6
10	160	6.48	24.6
		Average Speed	24.2 cm/s

Table 2: Speed of robot with a body.

As the upper body weight is 6.5 kg, the speed of the robot has been reduced by 4 cm/s.

5.3 Object Detection

If any object is appeared in between the path of the robot, the robot will get stopped before 10cm until the path is not cleared.

Image1: Object Avoiding

5.4 Tools and Technology used

The Motor Driver L298N Dual H Bridge, Ultrasonic Sensor HC-SR04, Microcontroller ESP32, IR Sensor, RFID Reader and Card RC522, Battery, Adapter, Switch, Motor, Jumping Wires, PVC pipe, Elbow, T-joint, and Plywood are some of the parts that make up the robot-waiter.

Technology used:

1.Arduino IDE:

The Arduino IDE is public-source software, which is utilized to scratch and upload code to the Arduino boards [4]. The IDE operation is able for distinct operating networks similar to Windows, Mac OS X, and Linux. It supports the programming languages C and C++.

2.Blynk IoT:

Blynk is an IoT stage for iOS or Android smartphones that are used to regulate Arduino, Raspberry Pi, and NodeMCU via the Internet [9]. This operation is used to produce a graphical interface or mortal machine interface (HMI) by collecting and furnishing the applicable address on the available contraptions.

3.Line following algorithm:

We have coded the line following the algorithm using Arduino IDE software in which the robot will follow the black line.

6. RESULT AND ANALYSIS

6.1. Practical Result Analysis

Here the motor is tested under all conditions. The reading of the motor RPM and the voltage across it is illustrated below. Inertia is neglected [3]

Duty Cycle (p)	Voltage Across Motor	RPM
0%	0	0
25%	3	16
50%	6	29
75%	9	45
100%	12	58

Table.3: Analysis of the effect of PWM on RPM of Motor

6.2. IR Sensor Testing

The robot waiter will bring on the prodigy of line following. Two IR sensor modules are used in front of the robot namely the left sensor and right sensor and they are used for line following and setting the robot waiter on line. The robot's trajectory is designed in black. Presently black is calibrated as true and white is as false.

Input		Output (PWM)		Position	Action
GPIO 2	GPIO 3	GPIO 12	GPIO 13		
False	False	255	255	All sensors on a white surface	Go forward

True	False	127	255	The left sensor on black	Turn left
False	True	255	127	The right sensor on black	Turn right
True	True	0	0	Both sensors on black	Stop

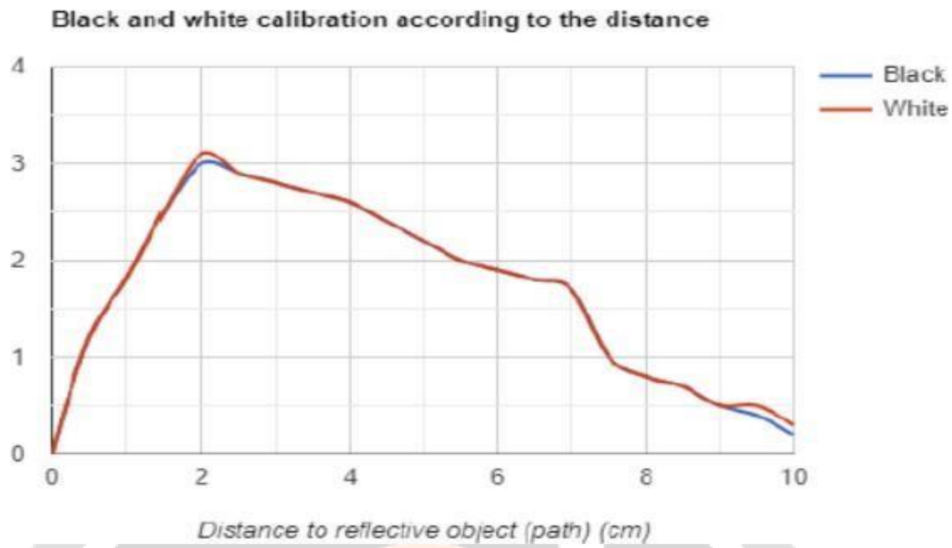
Table.4: Arduino functioning logic

Utilizing the reflection principle, which states that white entirely reflects light while black absorbs it, the IR sensor was calibrated by measuring the voltage readings corresponding to black and white reflections at intervals of 0.5 cm from the ground. The following outcomes were obtained from twenty tests that evaluated black and white calibration at different distances.

Distance to reflective object (path) cm	Output voltage (V)	
	Black	White
0	0	0
0.5	1.2	1.2
1	1.8	1.8
1.5	2.5	2.5
2	3	3.1
2.5	2.9	2.9
3	2.8	2.8
3.5	2.7	2.7
4	2.6	2.6
4.5	2.4	2.4
5	2.2	2.2
5.5	2	2
6	1.9	1.9
6.5	1.8	1.8
7	1.7	1.7
7.5	1	1
8	0.8	0.8
8.5	1.7	0.7
9	0.5	0.5
9.5	0.4	0.5
10	0.2	0.3

Table.5: Analysis of the effect of PWM on RPM of Motor.

6. 3. Test Results in Graphs



Graph.1: Table vs lines demonstration

6.4. Percentage Of success and Failures

A pie chart of the total percentage of success and the total percentage of failures can be represented as follows,

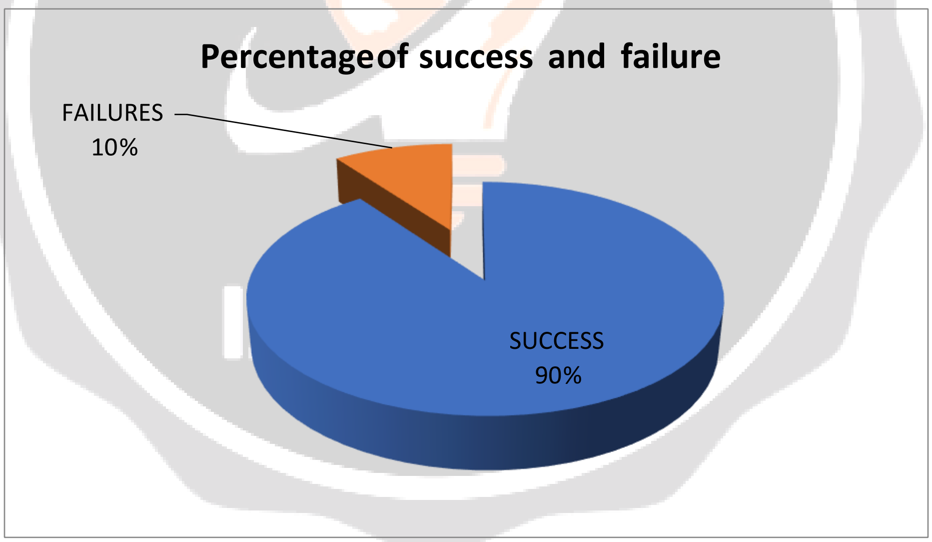


Chart.2: Percentage of the Success and Failure

As we have taken 30 number of trials on which 27 were trolley works according to the plan and remaining 3 trials were unsuccessful. In this case our percentage criteria states that our system works 90% accurate and the failure count was 10% and this is due the certain reasons Failure occurs in different forms such as obstacles being small in height. Due to ultrasonic sensors fail to sense the object which will affect collision. Also, it will not work on non-shiny surfaces (mostly black). The reason is IR sensors which not receive the signals; the black surface absorbs the signals. At the end we can achieve 100% of accuracy if system works with system and environment properly.

7. CONCLUSIONS

In conclusion, Robots are becoming more and more commonplace in daily life because of their effectiveness and time-saving features. Using line-following technology, our affordable restaurant robot design ensures compactness and safety while serving. The robot moves down a black line, uses an ultrasonic sensor to identify obstructions, and stops 10 cm away from them until the path is clear. Notwithstanding positive testing results, drawbacks include the possibility of spills from small wheels and the requirement for more fluid turning algorithms. Robots, on the other hand, provide a distinctive dining experience and may improve restaurant service in the future.

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