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IMPLEMENTATION GRAPH SEARCH TECHNIQUE ON A NAVIGATION LINE FOLLOWER ROBOT

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ABSTRACT

In today's world the use of robots is increasing. The robotics technology is replacing man work at a fast pace throughout the world. At restaurants and hotels, the customer faces a lot of problems due to congestion at peak hours, unavailability of waiters due to manual order processing. These limitations can be overcome by our design and beverages. This study intends to automate this sector using graph search algorithms instead of laying railway tracks which are both expensive and inconvenient. To achieve this purpose an autonomous robot with computer vision as its primary sensor for gaining information about its environment for path following is developed. The proposed Line follower Robot (LFR) consists of a webcam (for scanning QR code) mounted on a robot (Navigation Unit) and connected to Raspberry pi. A Graph traversing algorithm will be applied to adjust the robot on the line. We use the technique of line follower for the robot to move

1.INTRODUCTION

Restaurant waiter robotics has been attaching huge interest in the last few years. They are the focus of a great deal of current research and almost every major university has one or more labs that focus on robotics & its application. The main goal of this research is to establish effective ways for a robot to navigate from one place to another. *Robot*

navigation means its ability to determine its own path towards some goal location.

A LFR (Line follower robot) is basically a robot designed to follow a line or path. Generally, the path is predefined and can be either visible like black line on a white surface with a high contrasted color or it can be invisible like a magnetic field. In order to detect these specific markers or lines, various sensing may vary from simple low-cost line sensing circuit to expensive vision system

In this paper we demonstrate the idea of an automatic serving robot. In this paper we made a robot which provides proper service to customers at restaurants. Customer needs to scan the QR code present on the table, after scanning the code the customer will counter a mobile application on their own mobile itself. There they can order the food. As the orders will directly display in the kitchen, the cook will load the order on the robot & then the only task of the robot is to serve the food on particular table

2. LITERATURE REVIEW

Few of the research papers were studied and the following inferences were understood in accordance with restaurant service robots. Tzou Jyh-Hwa and Su Kuo L [1] gave an overview on the generation of robots where they have explained about two generations of robots. In the first generation there was usage of tape on the floor, infrared sensors for obstacle detection, chain mechanism and motors to move dishes forward. It implemented different layers for different components used. They used a large touch screen monitor for human machine interface. In the second generation robot they used a laser positioning system and used wireless technology for ordering. Robots can take dishes and also order using a touch screen.

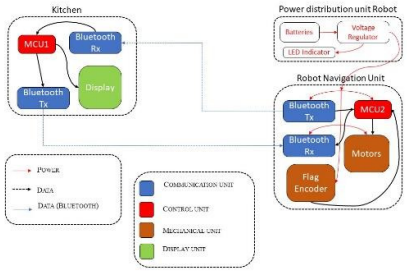
Mehran Pakdaman and M.Mehdi Sanatiyaan [2] gave us an introduction about line followers and how they used Atmel's AVR microcontroller.

Abdullah-Al Nahid and Abdullah Al Mamun [3] used sensors like LDR, LED and sensor resistance and voltage divider arrangement for the algorithm. They made simple, low-cost line following robots without using any microcontroller.

3. DESIGN AND DEVELOPMENT

The Project can be divided into two main components, *the Kitchen unit (Central unit) and the robot (Navigation unit)*. As shown in Figure 1, both units have their very own power distribution unit. In the power distribution units, 3.7v batteries are used to power the units. Specifically, 9v is used for the robot

The MCU is used to decide when the next order should be sent depending on the robot's execution status. Lastly, in the Navigation Unit, there is a MCU, Bluetooth module, motor, flag encoder & a raspberry pi. The raspberry pi is used to perform the path-traversing algorithm. The ATmega328p microcontroller used as the MCU has insufficient memory for the algorithm execution. The encoder or flag is used to trace the node number in the path. The MCU on the robot is used to handle the main controls of this unit. Lastly, similar to that of the Central Unit, the Bluetooth module is used to transmit and receive data from the Central Unit.



One addition to the Design Block Diagram from the design document is that we decided to implement the path-traversing algorithm using
A-star (A*) algorithm. Hence, this requires that we use Raspberry Pi for the aforementioned memory issues.

We will be using wifi (integrating in ESP32 SOC) [5] into our project. One would be situated beside the MCU in the kitchen while the other would be situated on the robot. They will be used to send signals between the robot and the kitchen. There would be two kinds of signals sent. The first one is when the MCU in the kitchen would send out a new destination to the robot. The robot's MCU would use this information to identify an optimized path that it should take. The second one is when the robot is done completing its task, it would send a signal back to the MCU in the kitchen. This is to notify the central unit that it is done with its task. Henceforth, the MCU in the kitchen can send it a new patron to serve.

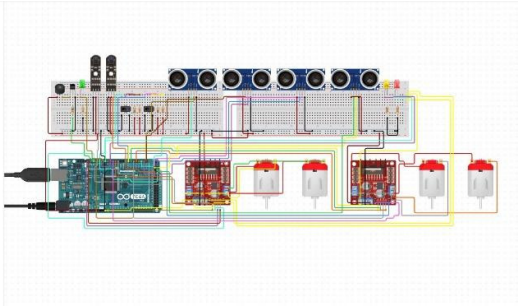
ESP32 SOC [5] has fairly low power consumption as it runs on BLE. In order to establish a connection, the MCU sending the signal has to go into initiator mode and the MCU, the advertiser, will send a connection request. Once the connection has been established, their roles become master slave and slave device. Now, the master slave is able to send information to slave device

4. ELECTRICAL DESIGN & COMPONENTS

Line follower (*A line follower robot is used to follow the complete path within the restaurant. It has line sensors on it, Whenever the robot starts its sense for black colour. When the sensor senses black colour the robot will move forward on that line. Whenever the value of the sensor changes it is a time to take decision for robot to turn left or right*)

Obstacle detection and avoidance (Ultrasonic sensor are used in the robot so that they will calculate the distance between the robot and the object or any person standing on the path and after a particular distance as per the algorithm the robot will stop i.e. it will detect the obstacle and for avoiding it, it will stop and for the advancement a piezo buzzer is placed which will start when there is something in the path so if there is any person then he/she will move aside and if there is any object someone will move that aside)[4]. Indicator LED's indication of the particular tasks, and different states situations (figure-2 show all the electrical stuff).

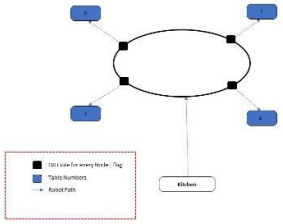
The motor on the robot is a BO motor. It can provide sufficient power for the robot's load and is the among cheapest option. We will be using two motors to change direction by rotating its wheels in opposite direction.



5. PATH FINDING ALGORITHM

The path-finding algorithm is very critical to the robot. It will be given a destination location from the MCU in the kitchen and it will calculate the shortest way to navigate there. We will use Breadth-First Search, a graph-based search algorithm to identify the quickest path the robot can take. This algorithm will take into account the positions of the tables in the restaurant and identify a path that avoids them. Because of time constraints, in our project, the table's positions will be hard-coded into the robot using QR Code.

The MCU in the kitchen would always be aware whether the robot is completing a task or is waiting for a task. When the robot is waiting for a task, the MCU in the kitchen sends new destination coordinates. The robot will act on those instructions and move onto its next task accordingly. The path would be calculated using a Breadth-First Search algorithm using its starting location, which the robot will always be aware of, and its destination, which it would get from the kitchen



According to the path diagram (shown in figure 3) Navigation Unit (robot) detects the Node using QR Code scanner. The robot navigation unit detect the right node in the path that they travelled, so according to the algorithm robot run on the path circuit and delivered the ordered on each table there will be a QR code could be scanned which will redirect will be directly sent to the kitchen unit.

The robot is first placed near the kitchen (on the line). When the food is ready, the chef can place the items inside the robot and click the table number on the keypad for delivery. The robot will start making its way to the table following the line. In case of obstacles in the path, the ultrasonic sensors will detect them and stop the robot from moving. And also, when it detects the obstacle, a piezo buzzer will alert the person to move or move the obstacle. The directions for the table are already coded in the robot for smooth running.

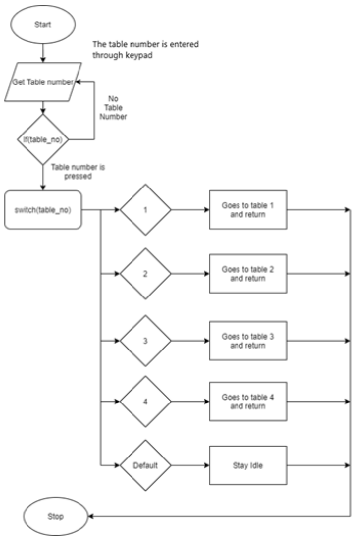
The alternative option for the bluetooth module that we used *Espressif* ESP32 that is *(Integrated Bluetooth BL 5 & Wifi 2.4 GHz 802.11 b/g/n)* [6]

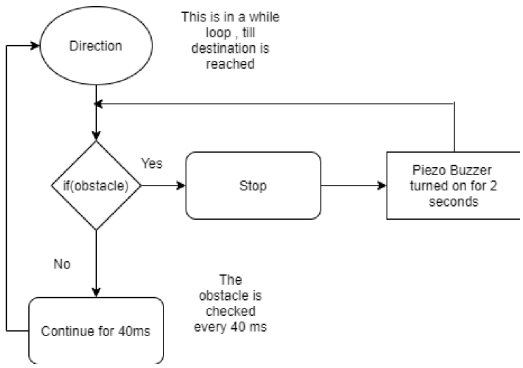
ESP32 is suitable for communication via BLE and wifi. It has a dual core ***Tensilica Xtensa lx106*** *dual core (one for protocols and other one is used for computation).*

There are several ways to improve our project. First, we suggest integrating the path-finding algorithm with the robot movement code. In this way you can have a fully functioning robot. Next we can also use rechargeable batteries with higher capacity to power our robot.

The motor on the robot is a BO (Battery Operated). It can provide sufficient power for the robot's load and is the among cheapest option.

For future development, we suggest building a charging port. Using IR beacons, the robot is projected to be able to return to its charging port once it has completed all the task. By implementing this, the users will not have to manually remove its battery and charge it before putting it back when the robot has to be used again. Next, we recommend implementing collision safely. Lastly, we suggest improving the path-finding procedure such that the tables and the obstacles would not have to be pre-programmed.





6. LINE POSITION DETECTION

Using the LFR technology, the navigation unit detects the path using IR Sensors attached to the robot.

The first thing we would do is to get the layout of the restaurant. We would map the restaurant to a *x & y* coordinate system. We would account for the boundaries (i.e. walls) and the locations of the tables. We would also add a '*home base*' for the robot. This is where the robot '*rest*' when it has no orders to deliver. Generally, it would make sense for this to be closer to the kitchen/staff. Once we have these values, we would program them onto the MCU. This would be a one-time task unless any of the value change.

The images are taken by the camera one after one. As soon as possible the analysis of an image is completed the system responds to the information gathered from the first image. An example of the path is illustrated in *fig-2*. After enhancing the image, the enhanced image is then split into segments via *image segmentation algorithm run on MCU* the location of the pixels that matches the required line colour is determined. Then, the mean of the pixel positions is calculated to give the center of the colour with respect to the picture [4]. According to these the microcontroller will therefore issue a signal to the motors to adjust the robot to trace the line.

CONCLUSION

This study proposed a method for vision enhancement of a LFR using digital image processing techniques. The results are evaluated qualitatively and quantitatively from the points of PSNR (Peak Signal-to-Noise Ratio). The proposed LFR is robust against environmental factors such as darkness, lighting, camera distortion as well as line color. The suggested future work is directed for two aims; enhancing the proposed approaches as well as increasing the capabilities and applications of the proposed approaches.

Lately in this technology world, people have started accepting robots as a part of their lives because it not only makes getting work easier but also the amount of time required is less. The efficiency and productivity of the robot is also more. Though there are many robots available all over the world, cost has become a major factor to customers since we have used the concept of line follower to make the robot move.

Restaurant is a place where family and friends come to have a fun time and to make their visit more enjoyable and memorable, robots are a different way to serve food for the people. Our robot is a very useful solution to all types of restaurants and in future it can be enhanced more.

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[5] https://www.espressif.com/en/products/socs All espressif SOC's that integrated BLE and wifi 2.4 GHz 802.11 b/g/n (802.11n up to 150 Mbps) that is used to enable wifi devices

[6]https://www.espressif.com/sites/default/files/documentation/0a-esp8266ex_datasheet_en.pdf

EPS8266EX espressif SOC that integrated Wifi 2.4 GHz 802.11 b/g/n (802.11n up to 75.5 Mbps)

