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Restaurant Waiter Robot

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Abstract

In the current scenario, the restaurants from all over the world use manual waiters, i.e., the humans where the customers are being served by them. As communicable diseases are widespread, the need for social distancing and safety are major concerns nowadays. There is a need to ensure the least number of personal contacts. We can resolve the issue by introducing a restaurant waiter robot, where the robot sanitizes the dishes and serves the food to the customer. This will attract more and more customers and also will lead to a healthy lifestyle. The domain of the project is the internet of things (IoT), where we are building a robot using the microcontroller Arduino. We know that this project belongs to IoT. IoT is the system of interrelated computing devices, mechanical and digital machines, objects, and the capability to transfer data over a network without requiring human to human or human to machine interface (HMI). Thus, our robot is an application where the customer is recognized by the table number. The different table numbers can easily be authenticated without any confusion. The online system allows the customer to order the required items. It also provides a chance for the customer to order as many times he wants without much interaction with the waiter. It also includes water and beverage serving as per the need. In the end with all the orders done, the robot will collect the money via cash or online payment. Apart from this the history of customers is also fed to the system and the same way the rewards or offers can be awarded.

Keywords: Arduino, Field mapping, Semi-autonomous, Sensors, Waiter robot.

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Introduction

The main objective of the project is to curb the need for human waiters in a restaurant and improve the overall service of a particular restaurant. This system has been developed to simplify the process of restaurant service. For a restaurant service to be ideal, speed and accuracy play a vital role and a robot is specialized in these very well. A centralized database is maintained where the information of all the customers is maintained. Whenever a restaurant introduces something exciting and new in the town, the people in the town are attracted to it. Serving robots could act as a special attraction to the youth as well. The automatic robots act as an attraction to many customers.

Every month the restaurant has to pay the waiters their monthly income. Introducing the robots would mean only a one-time payment and apart from that it will consume electricity to charge it and would be less as compared to the human waiter. For a restaurant, this would be a one-time investment, and thus, making it a cheap alternative. Service tax which was at a nominal 5% once, is now at 15%. It was further increased to 14% for transactions that happened on or after 1st June 2015, and then for transactions that occurred on or after 15th November 2015, the new Swachh Bharat Cess at 0.5% was added that increased the tax further. Keeping the fact in mind that the robots are serving and hence, the service tax that is imposed on the bills could be reduced to a level as well.

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Problem Background

In recent years many studies have shown that service is the main attraction to the customers after good food. In a world of a pandemic, there is a need to distance from people and in this case, robots can be the solution. This can be the attraction to the customers and solution to revive the restaurants that are being shut down due to the pandemic.

Problem Statement

A restaurant waiter robot that travels from the kitchen to the customer and vice versa to serve the order. The robot is connected to the WiFi that receives the orders from the customers. The system should be developed keeping in mind the high accuracy, speed, and user-friendly interface.

Related Work

Automated Restaurant System

The system was initiated in the 1950s in Japan. Kaiten or rotating/conveyor belt sushi restaurants were invented. More recently, a Japanese entrepreneur has put the concept of highly automated and profitable restaurants that go way beyond a mere conveyor belt. This includes mere six servers and minimal kitchen staff can service a restaurant up to seating of around 200 people.[2,3] The disadvantage includes that there is a lot of infrastructure expenditure and high maintenance and electricity are required.

Automatic Billing

Restaurant technology has improved billing operations in restaurants tremendously. As soon as the customer is done dining, the system generates an automatic bill. The bill is created according to the kitchen order ticket (KOT), which is different every time, thus, eliminating the mixing up of orders and bills. An automatic bill ensures that there are no delays in the billing and improves the overall customer service. Most systems also provide the splitting of the bill feature, which makes it easier for customers to pay for their orders. This system improves accuracy and removes the confusion without any human involvement.[4-6]

Customer Relationship Management (CRM)

Customer relationship management (CRM) is a tool that is used widely to manage customer relationships. It helps us to manage and maintain customer relationships. We can use a valuable CRM database to come up with customized offers and discounts based on the customers' ordering habits and restaurant visiting frequency. It helps us to send personalized emails and newsletters containing offers, menu additions, events, and other updates to keep the customer informed.

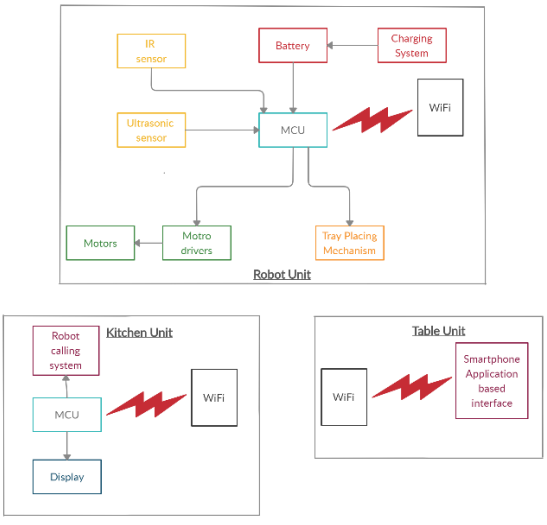

Figure 1: Block diagram of a restaurant waiter robot

Proposed Solution

In this paper, we propose a system that connects the kitchen to the customer via the app, and the food transfer is done by the robot. It also covers several essential requirements, such as, speed, smooth traversal, and proper communication.

Methodology

The problem of restaurant automation deals with the design of a strong communication system and a robot as a waiter, which can coordinate with the rest of the players in the system. It shows that at least three segments could be identified namely robot, customer, and kitchen. The system is such that the customer through his phone app orders the required items. As soon as the final order is given, the kitchen gets feedback and the food preparation starts. Now when the food is prepared, a ping is sent to the robot, which travels to the kitchen and receives the order, and thus, the robot arrives at the table with the food along (Figure 1).

In addition to this, the robot is such that it would be capable of serving water as required by the customer. To accomplish this, there will be a slot assigned for water refilling in the robot, and as per the requirement of the customer, the glass is placed every time whenever he needs it. Once the customer is done with his food, the bill is generated in the app itself and the payment is done right there if it is online, and the cash is given to the robot if the customer wishes to pay by cash.

Working Flow

As soon as the customer enters, the table number in the phone app, the robot via kitchen gets a ping to travel to that particular table and greet the customers or even serve water if an order for water is given via the app, also mentioning the seat numbers of the table. The robot and the kitchen are connected via WiFi. The allocated space for the glass is known by the robot and is hardcoded for every seat number. The traveling of the robot is done by line tracing using a light-sensing array (LSA), which ensures the proper traversal even at the junctions.[7] Now that the water and the greeting are done, the next part comes to the order which has nothing to do with the robot. So, meanwhile, the robot can greet the other customers. The required items are ordered by the customer via the phone app or either by the browser. After a while as soon as the ordered food is prepared, the feedback is sent to the robot about the same. Now the robot knows the traversal path to the kitchen and as soon as the robot is free with his greeting or water serving, it travels to the kitchen and picks up the food in the tray. The robot now travels to the particular table number and extends the tray to the table using the forklift mechanism.[4] The forks are such

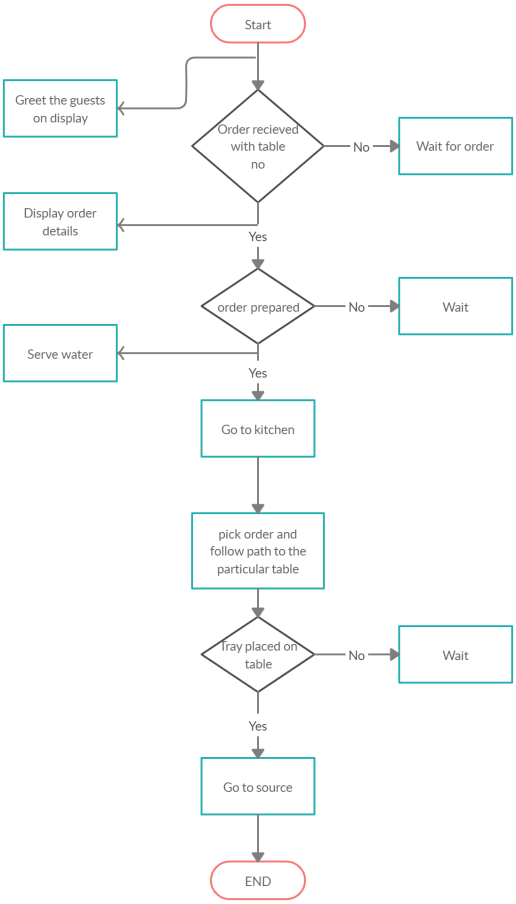

Figure 2: Workflow diagram

that it passes through a cavity made on the table and places the tray carefully. After placing, the forks go down and the robot moves behind. Similarly, anything else required by the customer is fed to the app and the same cycle continues. In the end, if the bill is to be paid by cash, the robot collects the cash in a chamber and moves to the kitchen or the reception as per the restaurant's choice (Figure 2).

Tray Placing Mechanism

For the tray placing mechanism, we are using a forklift and leadscrew.[8] Initially, the fork will be lifted and a tray will be placed on it. An elevated surface will be provided on the table, the width of this surface will be less than the distance between the forks. So as soon as the robot reaches the particular table and it is aligned with the junction on the line, the forks will come down and the tray will get placed.

Safety

The safety aspect of the system has been carefully designed. Hence, the robot moves at about 0.3 m/sec and slows further down when the ultrasonic sensor detects an object and comes to stop if it is very close to the object. An emergency switch is provided on the easily accessible robot, this switch will cut off the mains supply in an emergency. As the robot is

Figure 3: Forklift using lead screw mechanism

powered by a lithium-polymer (LiPo) battery, it is important to ensure the battery is not overused by using the battery alert system and if the robot overpowers by drawing a high level of current, the fuse will cut its supply to prevent further damages to the system.

Result

The defined system was initially implemented on a smaller scale where a small robot was made and it was made to travel through different orientations of the restaurant and thus, improve the reliability of the traversal. The communication part of the system was also taken care of using WiFi and the cash collection was made more reliable and secure. The implemented prototype of the system was tested for various constraints and loopholes but the result was quite satisfying. The robot is tested with five sample tables, and the accuracy is around 95%. The tray placing mechanism also gave astonishing results.

Discussion

The system is made keeping in mind the necessities required as a waiter including speed, accuracy, and cleanliness. The idea is to reduce the person to person contacts in a restaurant, thus, attracting a lot of customers in the times of pandemic. Also, the employment factor is kept in mind, but increasing the automation will increase the number of setups and thus, the number of workers required. Now the

next factor would be to improve the speed of the orders and with less confusion about the orders and automation is the best answer available.[5] Keeping in mind the development in the electronics field wherein the circuits are minimized to a large extent, this helps to reduce the size of the robot and thus, requiring less space on the ground. The system can prove to be a great customer attraction as well. Automation is something that is growing at a very large rate and this system is going to flourish soon in the market.

Conclusion

The robotic waiter system is a design concept that integrates semi-autonomous robots with an ecosystem that provides knowledge of the environment, in which the robots operate. These robots are omnidirectional. This allows for a quick translation from research to the industry. The robots are designed to be productive and efficient replacements where there is a shortage of human labor, which does mundane and repetitive work, such as, carrying food to the tables. Besides, the ability to carry more than one order in the robot significantly helped in reducing the workload of a waiter during peak periods. Tests with the prototype and full-scale robot in the restaurant have shown that the design can assist in the restaurant, and therefore, the next challenge is to have multiple robots in the restaurant. With a one-off development of the smart eco-system, the initial cost will be high, which will increase the total cost significantly as compared with using waiter robots with human skills and abilities. But once it is properly set up, it will be more efficient and cost-effective.

Future Scope

Based on the work presented in this paper, there are various advanced features that we can add to the system. We could work on field mapping of the restaurant, for which we can use rotary encoders. With the help of field mapping, the error in traversal can be minimized and the time for traversal of the robot can also be reduced to a great extent.

As we can see in recent times, everyone is trying to avoid human contact in the COVID-19 pandemic. These robots can be modified as per the requirement and deployed in any field, like medical, industries, households, etc. Robots like these can be used in the isolation wards to serve the medicine or food to the affected person. It can also be used in industries as a helping hand.

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