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Conference Paper · December 2017

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Design And Implementation of A Robotic Technique Based Waiter

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Abstract—Life is going to be tough and challenging latterly without thinking anything bearing technology. For various robotic applications, our daily life is becoming smarter and handy day by day. Robotic waiter is one of the best examples of daily life automation. By this technology, a mobile robot can take order and serve food or beverage to the person in any environment of restaurant, hotel, office or household. This paper presents description about a robotic waiter technique along with the design of microcontroller based robot which works effectively in a restaurant and office environment within a certain area. A prototype design of a wheel based moveable robotic waiter has been shown in this paper. The prototype waiter robot has been designed and implemented to receive order-request via android apps, then to collect food/drinks(max600gram) from kitchen boy, then to travel to the destination (the person who send order-request) and again to come back to its source point completing the order of requested food/drinks.

Keywords— *Robotic waiter, Microcontroller, step counting, location sensing.*

I. INTRODUCTION

The robots are being designed to become a part of ordinary people to live for an increasing extent. To assist human with tedious tasks or difficult, their tasks may range from play or entertainments. The robot will closely interact with a human group in everyday environments, in these kinds of application. This means that it will be essential to create models, intuitive and natural communication between robots and humans [1].

Nowadays, robotic waiter is creating huge attraction in restaurants, hotels and offices. Considering robotic technique based waiter, there are numerous innovative technologies developed by researchers, to make easy ordering services like adopting mobile robot[2], collecting dining decisions[3], wireless call system[4], waiter-robot[5], self-service ordering system for restaurant[6] and automated menu-recommender[7].

In this paper, a robotic technique based waiter has been designed and implemented for an office having two rooms. The waiter robot has been designed to receive the order-request via android apps, collect food/drinks(max600gram) from kitchen boy, travel to the destination(the person who send order-request) and come back to its source point after the handover of requested food/drinks. The designed robot has been constructed by available local devices. As well as, the traveling technique from source to destination has been implemented in this waiter robot.

II. BACKGROUND & LITERATURE REVIEW

The human waiter often create problems in restaurants, hotels and offices. They make mistakes in the most common blooper with customer's orders. Most of the time, waiters forget to make a change or add a precise item and also forget to place the customer's order to the kitchen. In addition, the customers also have to wait for the waiters to give their orders. The waiter is the one who remembers the food item and the customer is bound to depend on the waiter where there are so many possibilities of error occurrences. Sometimes, they also made wrong bills [8]. A robot waiter can solve these problems smartly. There are many projects and researches done on weightlifting robot, waiter robot, pion/MLSS robot and service robot.

Rupali Saple et al. [9] in his research proposed that the customer's can take their refreshment by pressing the buttons, where using the black line following technique the robot reaches the customer's table. When customers settled down in their chair of the restaurant they simply press a button to order for their refreshment. On switching the button a LED at the receiving side will make the robot to move to his destination (customer's table) which also had a LED that glows brightly creating a junction between the robot and the table. The robot headed towards the table following the black line and takes order of the customer. In the same way following the black line the robot comes back to source destination.

Neeti Malik, Neetu Rani, Alpna Singh, Pratibha, Srishti Pragya [10] proposed that the customer can gave orders via keypad. In the keypad the list of food items along with the prize has been provided so the customer can order from them easily without calling or waiting for someone. The LCD monitor shows the placed order on the screen. After taking the customer order, the robot will move towards the exact table location by the following black line. After serving the customers refreshment then the robot comes back towards the source position.

The development and design of a waiter robot, where the customer gave the order by using electronic menu bar and the bluetooth module transferred data to the kitchen from the customers table at a baud rate of 9600 bps has been shown by M. Asif et al. [11]. The robot waiter by using line following technique reaches the destined table. In the project four IR sensors were used where the two sensors installed on the sides for counting the table, the other two sensors in the center are used for line following where the robot has been always

connected to internet. The reception point using the communication network sent order to the kitchen from the table. Then the robot waiter transferred the refreshment to the customer's table from the kitchen .

Sakari Pieska, Juhana Jauhiainen, Markus Liuska, Antti Auno [12] recently proposed in their paper that the customer's can order through application works on an Android tablet. The database connects to this application and download the real-time in the restaurant's menu. So the customer can easily browse the menu bar and order it. By pressing a button the customer can call the waiter. The waiter comes, for confirming the order and count the bill. In the kitchen's display this menu can be displayed. When this refreshment item is ready, then the kitchen staff can mark them as done. This refreshment item is visible in the cashier and also in the waiter application so that they can easily deliver them to the customer.

The studies by Harish Phapale, Prashant Patil, Sanjay Turate, Anshu Chaudhary, Prof. Mahesh Bhagwat [8] have shown that the advanced technology like touch screen menu display can play a vital role in the order process of the customer. It improves the efficiency and reduces the workload of the waiters by creating an intelligent restaurant. The system worked on an android tablet. The application of android, download real time menu bar list and access database. So the customer can easily browse and choice their items and order it.

Sakari Pieska et al. described a design of scalable service robot system for different groups of user in public and private environments. When the restaurant has been scanned by the sensors, the robot can give a voice command to go to the predefined location in the restaurant. There are different kinds of voice commands can be taught to the robot. The robot moves by using the voice commands or by interacting with other software. It has been used for delivery food to a table since the robot has been using a tray. The robot has a touch screen which is a service menu application and which contains the different applications for customers [13].

As the above mentioned all works, focuses on the serving task in the restaurant, here in this project it has been tried to create a prototype of robotic waiter which can serve customers after having the order given by the customer sitting on the table by only pressing a button. The robot designed in this project travel from the source point to the destination table by step counting of wheels revolution where the travelling distance has been measured and loaded in the robot. The designs and implementations of the robot waiter have been completed using existed appliances locally. These robot waiter can work in different areas such as restaurants, hospitals, office environment etc.

III. ROBOTIC TECHNIQUE BASED WAITER

Most of the waiter robot had designed by using line following technique. But in this design, wheel step counting have used in the programming of Arduino. To serve tea/coffee according to the user's order through wireless communication, an automated system is designed by using a ready-made microcontroller kit "Arduino mega". The Robot waiter designed with basic 6 units as :

- Main controlling unit (microcontroller)
- Motor Driver unit
- Apps: order receiving & Processing unit
- Bluetooth : Robot to user communication unit
- Load cell unit
- Robot position & travelling unit

The working floor layout for the robotic based waiter is shown in the figure 1. Here the room-1 & room-2 is the destination 1 & 2 respectively. Firstly, when the robot receives a command from room-1 or room-2 through android apps, the robot will follow some procedure. The robot asks for food to the kitchen boy and waits for the food to load on its load cell. After receiving food, robot travels to the destination following pre-programmed data (corresponding room) stored in its memory. Then the robot requests the person to receive his/her food. After handovering the food, it comes back to the destination. The complete process of operation & decisions are showing in the Figure 2.

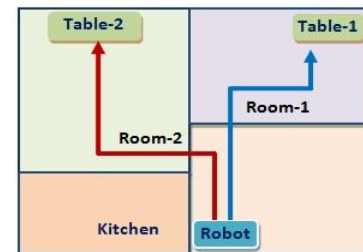


Figure 1. Floor layout where waiter robot will serve.

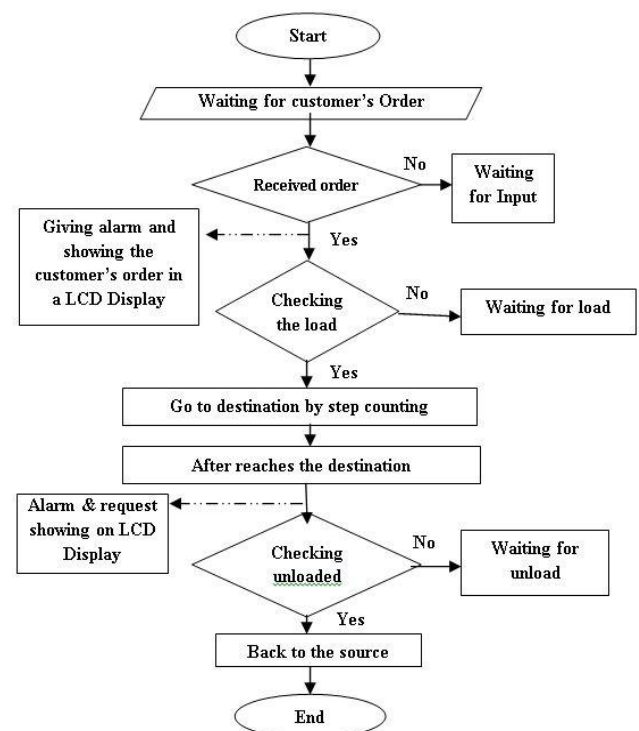


Figure 2. Step by step process flow diagram

A. Operation Process

The waiter robot will serve tea/coffee according to the user's order through wireless communication. The main controller is Arduino MEGA. After connecting the robot waiter to the DC power supply it will be waiting for customers command. When a customer selects a command for the robot by using android apps, that instantly the Bluetooth module will sense that command and through that command to the Arduino MEGA. Arduino MEGA has a microcontroller chip whose chip will be loaded by the program and it will do the work to follow the loaded program. When Arduino MEGA have the code (like as "A" or "B" anything that could be from "A" to "F") it will send data to the LCD display for displaying the drink's name (like as "Coffee", "Tea", "Water") along with displaying the location of the source of the command. At the same time an alarm will ring.

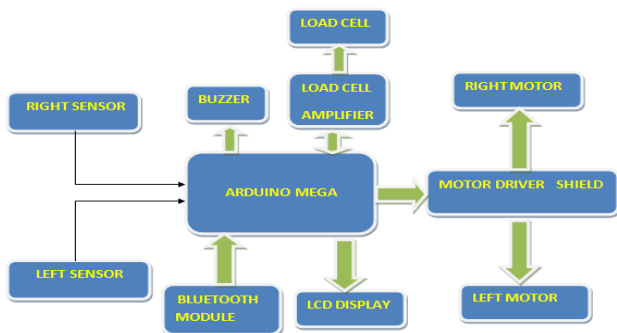


Figure 3. The process flow diagram of "Robot waiter".

The load cell sensor will connect to the digital port of Arduino MEGA and always give the feedback to the microcontroller. The robot will be waiting before to get a load. When the robot will get a load from the kitchen staffs then microcontroller will drive four DC gear motor with the help of the motor driver shield. The program will mention before that where is the room location or table location. Although the location will be mention in the program the robot will move easily towards the exact location by measuring step. This project will have to use rotary encoder for counting robot wheel revolution and this encoder will be connected to the digital pin of Arduino mega. When the robot will reach the exact location, then it will make an alarm and also show "Take your drink" on the LCD display. When the customer will receive their drink, then the robot will come back to the starting point or kitchen.

B. Incorporated Technologies

The main components used to design the robot waiter are described below:

1) *Arduino* : Arduino is an open-source electronics prototyping platform, easy-to-use software and hardware. It's intended for designers, hobbyists, artists and anyone interested in creating interactive objects or environments [11]. Arduino has a 54 digital input/output pins. In this project Arduino takes the input from the motor encoder sensor and operate the motor by its wheel revolution counting. It also takes input from the load cell to sense the robot is loaded or unloaded. In this

project lot of digital pins are needed to connect an additional device. Thus for this project the "Arduino MEGA 2560 board has been a suitable one.

2) *Motor Encoder* : In this project "rotary encoder" is used to count the robot wheel revolution. First of all it need to measure the exact room location in an office or a table located in a restaurant. After measuring that location, this measured value has to get mentioned in Arduino program. When the robot understands that measured value, it will go towards the exact location perfectly.

3) *Load Cell* : A load cell is a transducer which converts force into a measurable electrical output. In this project the sensor has been used to sense the load as the purpose to know when the robot is loaded and when it is not.

4) *Android Apps*: This robot will work by an android apps to operate this robot from a remote distance, shown in Figure 3. Hence, it will need to create an android app because the google play store has not availed this kind of apps. Here, in this project the app has been created for two rooms.

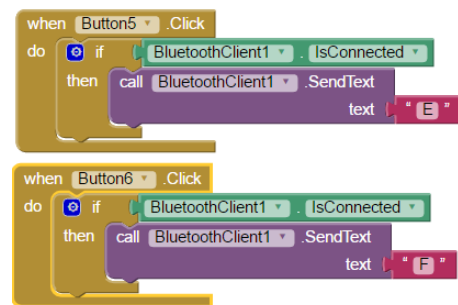


Figure 4. Android apps settings



Figure 5. User layout of Android apps

C. Implementation of Robotic Waiter

To implement the robot waiter, travelling from source (kitchen) to destination (order requested person) is the major issue to discuss. Here we have design two packages for two rooms. Each package setup is for particular movement through a route and specific number of rotation of left wheel and right wheel. Table I describes the number of revolutions of back wheels need to reach destination.

TABLE I. NUMBER OF REVOLUTIONS OF BACK WHEELS NEED TO REACH DESTINATION ROOM-1 AND ROOM-2

Task		Number of Revolution	
		Left Wheel	Right Wheel
Destination Room-1 (PKG-1)	Robot Go Forward (10 ft)	250	250
	Robot Turn Right	20	0
	Robot Go Forward (4 ft)	100	100
	Robot Turn Left	0	20
	Robot Go Forward (2 ft)	50	50
Destination Room-2 (PKG-2)	Robot Go Forward (8 ft)	200	200
	Robot Turn Left	0	20
	Robot Go Forward (4 ft)	100	100
	Robot Turn Right	20	0
	Robot Go Forward (6 ft)	150	150

Figure 5 shows the assembled Robot with motor encoder and Arduino mega. Figure 6 illustrates the final outlook of implemented robot waiter with a cup of drink. When the robot waiter has been connected to a DC power source it waited to get a customer’s command. After a customer selects their drink by using android apps the command reached to the robot. Instantly the robot gave an alarm and showed the drink name along with the customer’s location on the LCD display.

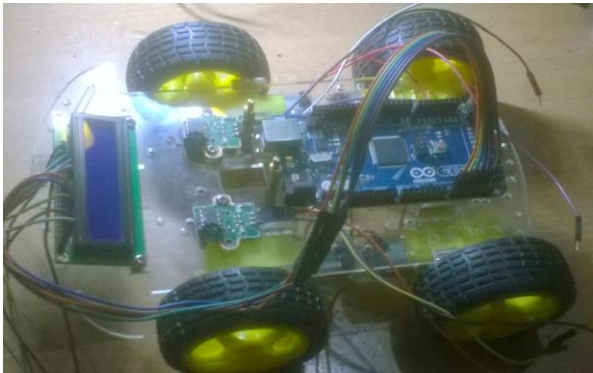


Figure 6. Robot with motor encoder and Arduino mega



Figure 7. Complete setup of a robot waiter with a cup of drink

As a kitchen staff put the ordered drink on the robot it sensed the load and went to the exact location by counting its wheel revolution. When the robot arrived to the exact location, it made an alarm and showed “Take your drink” on the LCD display, as shown in Figure 5.

The robot waiter will never come back to the starting point or kitchen before the customer takes their drink. So, when the customer has taken their drink from the robot it came back to the starting point or kitchen following the same process of counting of wheels revolution.

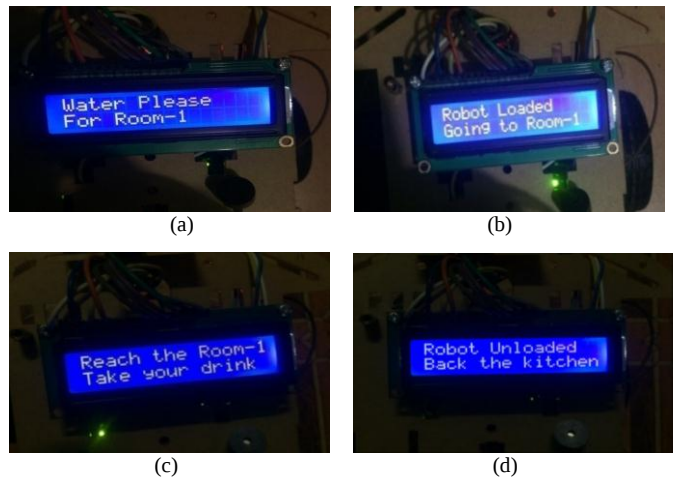


Figure 8. Display the information of job done by Robot Waiter ; (a) After order received & asking for load, (b) After load received, (c) After reach the destination, (d) After handover load to requester.

IV. DISCUSSION

In this design, the waiter robot can receive and execute only one request at a time. There are no memories or buffering techniques to handle more than one request asking at the same time. It can be solved in future extension of this project. The structural design has not included in prototype model of waiter robot. It is implemented only for testing the logic operation. So the height of the robot was kept very short (8inch). The structural design of waiter robot can be the future extension of this project.

The errors of human waiters can be overcome by the robotic waiters. The robotic waiter can be very attractive, smart and cost effective. The approximate cost of the prototype waiter robot is 8000BDT only. The targeted advantages of designed robot are mentioned below.

- Reduce the extra manpower.
- No need to use noisy alarm/calling bell.
- Identify your refreshment smartly.
- Give the information about room location.
- Working at places 24/7 without any salary.
- It can perform tasks faster than humans and much more consistently and accurately.

Some limitations of the design are

- Limited distance between source and destination
- Sometimes step counting does not work correctly due to change of wheel friction according to weight of load(food).
- Wheel friction is a barrier when the robot move.

The robots are used in developed countries for accomplishing precarious jobs, for example, coal mining, rescue people and such jobs which have a threat towards human lives. It is almost impossible to buy these robots for developing countries like Bangladesh because of the price. But some organizations and universities in Bangladesh are opening R&D sector to design and implement them in a cost effective way and in a small scale which signifies a promise in the evolution of technology. In the field of robotics to cope up with the advanced world, more concentration should be given to get the benefits of robotics. The products can't maintain the international standard due to the limitations of R&D sectors.

This design can be extended in size and also in weight lifting capacity. There is huge scope in design of the movement from source to destination. Here fixed code has been loaded in microcontroller which may create complex in increasing number of destination.

V. CONCLUSION

The robots can make our life easy and with the advancement of technology robots can be a part of our everyday life. Researchers and Engineers of developing countries like Bangladesh are working very hard to pull up the living standard of the country [14]. Robots can be seen everywhere like as in technical innovation, including self-educated technicians to educate researchers. Unfortunately, those innovations and researches could hardly effect our humanitarian developments and social life due to the lack of ability and opportunity of commercialization. This paper focused on designing a waiter robot and implemented this kind robot using simple technologies with equipments available in local market having very low cost. This robot has been designed to work effectively in restaurant, office and hospital environments. Some future work includes the use GPS module to call the robot. Another way would be giving command to the robot by using a smart android app, where the customer will give their command by typing in the apps. The project has been implemented for two rooms, but further it can be designed to operate for more rooms or destinations.

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