AN AUTONOMOUS ROBOTIC TROLLEY FOR WAITER SERVICE IN RESTAURANT WITH SMART ORDERING SYSTEM

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Abstract

A typical food ordering system in restaurants is waiter taking the order from customers through pen and paper which may encompass errors. The customer has no idea of when the food would be served at the table and has to wait at the end for manual billing process. The customer has to remember the number of food item ordered and has no clue of the budget of the food item ordered. A new methodology is proposed to overcome such difficulties faced by a customer in the restaurant. The main objective of the proposed work is to deploy a smart ordering system for restaurants providing robotic delivery. It meets the demand for rendering any time 24/7 dining service. An Arduino controller is used at the food ordering as well as at the kitchen module and Zigbee transceiver is used as a communication link between two arduinos. For robotic operation, Nuvoton microcontroller is used and IR sensors are used for detecting the path of the line following robot.

KEYWORDS: Robotic Trolley, Restaurant, Order, Microcontroller, IR Sensors

I INTRODUCTION

The system for ordering the food in the conventional method involves the task of taking the orders from the customers manually. During peak hours the duty of the waiters' increases and they can make mistakes while taking the orders or passing the ordered items to the chef in the kitchen. Then the waiter has to deliver the food item to the customer and issue the bill. Due to faster change in information technology leads to automation of frequently used routine tasks in the restaurants. By using technology, we can reduce the routine task of waiters. The customer can sit in the respective table and they can select the items from display provided at each and every table. A line following robotic trolley can used to deliver the food at customers table.

II LITRATURE SURVEY

In this paper Author Aamir Attar et al., have worked on a line following robot. They have described how to build a line following robot and can avoid obstacle using different electronic sensors such as ultrasonic sensor and IR sensor. It is designed in such a way that the robot has enough intelligence to cover up almost all the space given for it. The direction of the robot is defined by the user and can avoid the obstacle which is encountered in its path [1].

Author Harish Phapale et al., worked on a paper which deals with technology like touch-screen menu display. The propensity of this system is to build a dining table service. This system has touchable menu list on the table and using fingers, the customer gives an order to the restaurant server [2].

M. Srilekha et al., have worked on an automated robot which uses the IR sensor to detect and follow the designated route. The robot will follow the black line indicated on a white surface, which appears like a magnetic field, without human guidance. It also describes mechanisms for correcting wrong moves using closed-loop feedback system [3].

In this paper, Author Tuhin Ghosh et al., have described GUI touch screen mechanism. The customer selects their order using a tablet and the selected food items are forwarded to the kitchen utilizing a central server. Moreover, customer's records are kept in the database. The database can be utilized later for identification of the customer and future use [4].

In this paper, Author Mayur D et al., have used personal digital assistance technology for taking the orders and gave the contact screen-based managing system for the restaurant by making use of a tablet [5].

Though researchers worked on different technologies for food ordering and how to work on with line following robot, none of them have come out with a single solution of ordering and delivering food using a line following robot. This motivates us to work on a system where technology is used to reduce the routine work of the restaurant. The customer can order the food referring to the menu card which is placed on every table and confirms the order by pressing relevant keys on the keypad. The corresponding information will be displayed at the kitchen module where the chef can view the ordered food items and then places the food items on the tray of the robotic trolley. The robot is instructed to deliver the food at the designated table based on input given by the chef. The robotic trolley has the intelligence to avoid the obstacle by triggering an alarm indicating that its path blocked. The robotic delivery system provides efficient day in and day out services to the customers, increase business development with the help of 24/7 service. The proposed work is to design an autonomous robotic trolley for waiter service in the restaurant with the smart ordering system.

III METHODOLOGY

As soon as the customer arrives in a restaurant, he or she occupies a table. Each table in restaurant has an electronic keypad with display system. The customer can select the food items from a hard copy of the menu card provided at every table. In the hardcopy of the menu card, serial number of each food items name is mentioned as shown in table 1. The serial number in the menu card is the corresponding number in the keypad. Customers have to order their food items through keypad. Once the customer presses a particular key, the corresponding food item name, quantity along with the price gets displayed on the 16×2 LCD. At the same time, the ordered food item is sent to the kitchen using Zigbee. The information about the table number, food items and its quantity will be displayed on the LCD in the kitchen unit where the chef can view the ordered food items. Depending on number of food item ordered, a message of time take to deliver the food on customer table is displayed. So the customer will come to know at what time food will be delivered and become tolerant.

After the food is cooked, the chef in the kitchen places the ordered food item on the tray of the robotic trolley. Push button switch is used by chef to select the designated table to deliver food. Based on push button input selected by the chef in the kitchen, the robotic trolley will arrive to deliver the food at the designated table.

The proposed block diagram is divided into three parts i.e., food ordering system, kitchen module and food delivery system.

Figure 1 shows block diagram of the food ordering system which has Arduino UNO controller. It is interfaced with a 4×4 keypad and a 16×2 LCD for displaying food item name, quantity and price. A Zigbee unit is used to communicate the information from table to the kitchen module. Here Zigbee is used instead of Bluetooth since range of Zigbee is more compared to Bluetooth. A flowchart describing the step by step operation of food ordering system is shown in figure 2.

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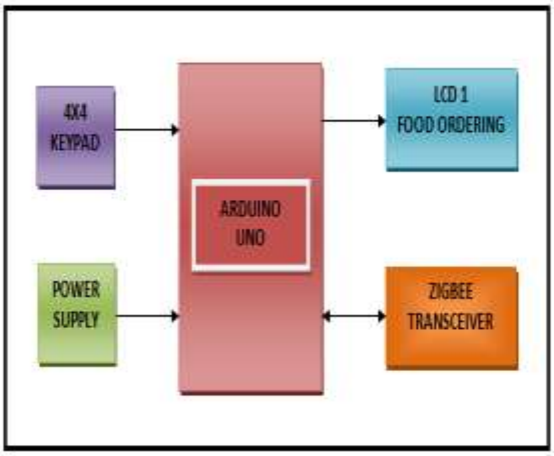

Figure 1: Block diagram of food ordering system

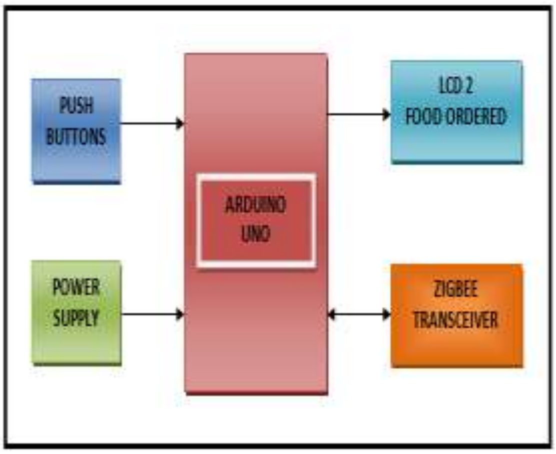

Figure 3: Block diagram of kitchen module

Figure 3 shows block diagram of the kitchen module that has an Arduino UNO controller also and interfaced with push buttons, 16×2 LCD display and a Zigbee unit. Arduino UNO is powered with 5V power supply.

The output of the ordering unit will be the input to the kitchen module. The ordered items, quantity and table number appears on the LCD of kitchen module. The ordered quantity plays a critical role to chef for determining the time required for preparing the food. A flowchart describing the step by step operation of kitchen module is shown in figure 4.

Figure 5 shows block diagram of food delivery system, using line following robot. It has a microcontroller W78E052D which is connected to three IR sensors. In robotic food delivery system, two IR sensors i.e., IR sensor 1 and IR sensor 2 are used to detect the black line and IR sensor 3 is used for sensing the emptiness of the tray. Motor driver L293D is used to drive motor 1 and motor 2 of the robotic trolley which receives signals from W78E052D microcontroller based on the information from the IR Sensors. A flowchart describing the step by step operation of robotic trolley system is shown in figure 6.

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i) Flowchart of Food Ordering System

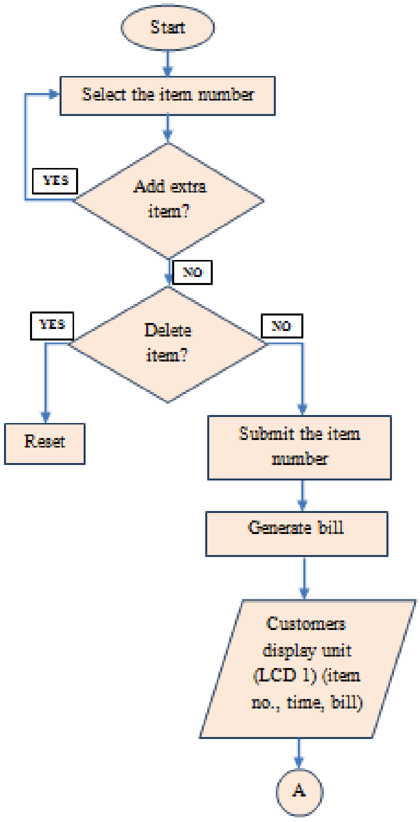

Figure 2: Flowchart of food delivery System

ii) Flowchart of Kitchen Module

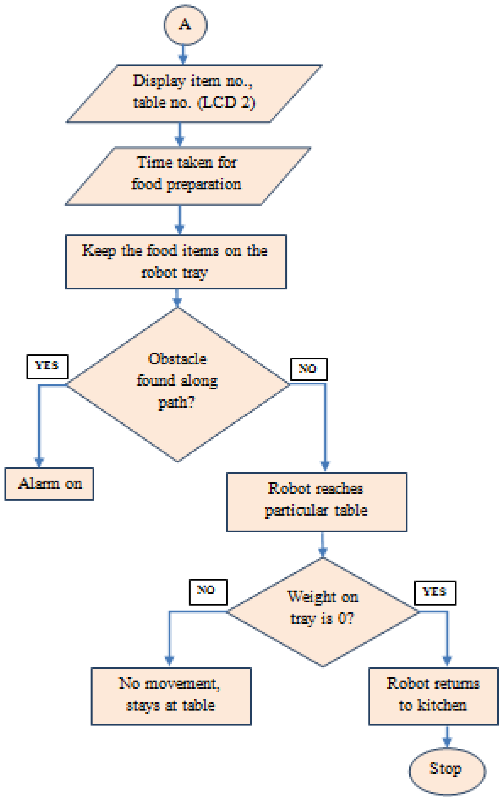

Figure 4: Flowchart of kitchen module

The chef places the food items on the robotic trolley and press a push button switch as per the ordered table number and the robotic trolley carry the food items and moves to the designated table.

Table 1: Menu Card

Sl. No.	Food Items Name	Price
1.	DOSA	10 Rs/-
2.	IDLI	20 Rs/-
3.	RICE	15 Rs/-
4.	CHAPATHI	20 Rs/-
5.	PAROTA	30 Rs/-
6.	KULCHA	35 Rs/-
7.	GHEERICE	30 Rs/-
8.	POORI	40 Rs/-
9.	CURD RICE	30 Rs/-

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#	SUBMIT BUTTON	

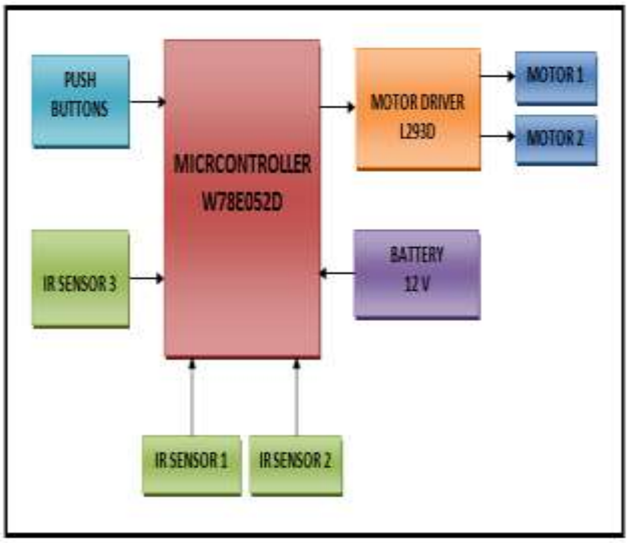

Figure 5: Block diagram of food delivery System

Sl. No.	Food Items Name	Price
1.	DOSA	10 Rs/-
2.	IDLI	20 Rs/-
3.	RICE	15 Rs/-
4.	CHAPATHI	20 Rs/-
5.	PAROTA	30 Rs/-
6.	KULCHA	35 Rs/-
7.	GHEERICE	30 Rs/-
8.	POORI	40 Rs/-
9.	CURD RICE	30 Rs/-
#	SUBMIT BUTTON	

While the trolley moves f[illegible]red along the path, an automatic alarm will be generated to indicate that there is an obstacle. Listening to the alarm, if the obstacle does not move automatically, then the waiter arrives and clears the path for the robotic trolley. After the dinner, the customer pays the bil[illegible]h button switches and their operations used by the chef in the kitchen while taking orders from the customer.

iii) Flowchart Robotic Trolley Operation

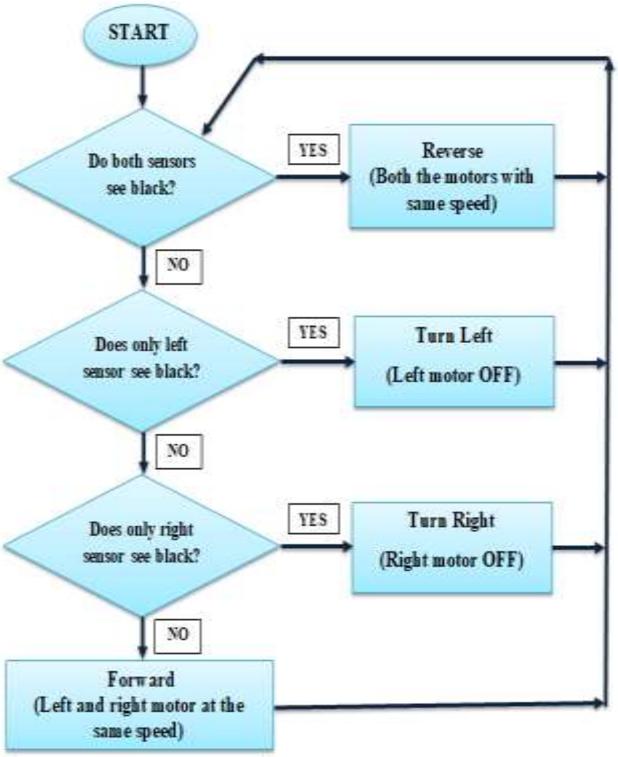

Figure 6: Flowchart of robotic trolley operation

Table 2: Operated by Chef in kitchen

Push Button Switch	Operation
1	5 minutes
2	10 minutes
3	15 minutes
4	ORDER ACCEPTED

IV ROBOTIC TROLLEY DELIVERY SYSTEM

The robotic trolley has a height of 2 feet and it can carry a maximum of 3 kg of food items. In robotic trolley, there are four wheels two front wheels and two rear wheels. There are two IR sensors, IR sensor 1 (right sensor) and IR sensor 2 (left sensor) to control the wheels of the motor driver of the robot. If the IR sensor value is '0' it indicates that the IR sensor is detecting any other colour strip except the black colour. If both IR sensor values are '0'then robot stops. If anyone of the IR sensor out of two sensors value is 1, it indicates that the IR sensor is detecting black colour strip and depending on two different sensor values, motor moves in a particular direction. Table 3 represents the working of robotic trolley with motor and IR sensors.

When the left sensor and right sensor detects colour strip other than black strip then both the left motor and right motor will stop. That is Left Motor 1 (LM1) = 0, Left Motor 2 (LM2) = 0, and Right Motor 1 (RM1) = 0, Right

Motor 2 (RM2) = 0. LM1 and LM2 are two connections for the front left wheel. Similarly, RM1 and RM2 are two connections for the front right wheel. So there is a pair of connections for the left and right front wheels. For the robot to move in the forward direction the left sensor and right sensor detects the black strip and both the front wheels will rotate in the clockwise direction. That is LM1 = 1, LM2 = 0, RM1 = 1 and RM2 = 0.For the left direction, the left sensor detects the black strip and the right sensor detects other colour strips.

Table 3: Robotic Operation

INPUT		OUTPUT				Robot Movement
Left Sensor	Right Sensor	Left Motor		Right Motor		
		LM1	LM2	RM1	RM2	
0	0	0	0	0	0	STOP
0	1	1	0	0	0	TURN RIGHT
1	0	0	0	1	0	TURN LEFT
1	1	1	0	1	0	FORWARD
1	1	0	1	0	1	REVERSE

Left motor remains constant that is LM1 = 0 and LM2 = 0 and right motor moves in the forward direction that is RM1 = 1 and RM2 = 0. For the right direction, the right sensor detects the black strip and left sensor detects other colour strips. Left motor moves in the forward direction that are LM1 = 1 and LM2 = 0 and the right motor remains constant that is RM1 = 0 and RM2 = 0. For the robot to move in the reverse direction the left sensor and right sensor detects the black strip and both the wheels will rotate in an anticlockwise direction. That is LM1 = 0, LM2 = 1, RM1 = 0 and RM2 = 1. The trolley has two push-button switches for selecting two different tables. IR Sensor 3 detect the food is present in trolley or not.

V RESULT AND DISCUSSION

Case I: Food ordering system is powered on

Figure 7 shows the hardware of the food ordering system kept in a box.

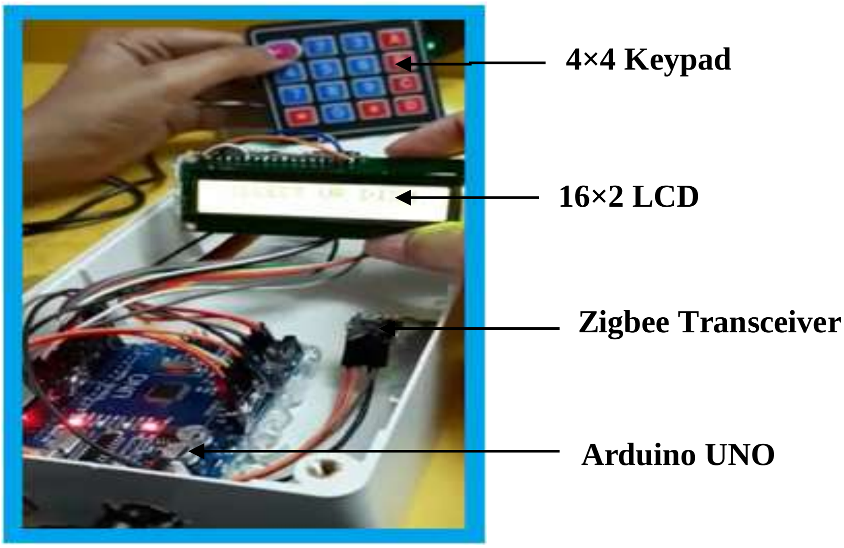

Figure 7: Hardware of food ordering system

At the top of the food ordering box, a 4x4 Keypad and LCD is fixed. As soon as the food ordering system present at customer table is powered on, it displays the message “SMART RESTAURANT ORDERS” on LCD and the next immediate message displayed will be “SELECT UR DISH”, as shown in figure 8.

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Figure 8: Food ordering system is powered on

Figure 9: Food ordering system module when key 1 is pressed

Case II: Customer press key '1' to select food item

As the customer selects the food item from the hard copy of the menu and if key 1 is pressed, then a message is displayed on LCD 1 screen indicating the quantity of food ordered, food item name and cost of food is as shown in figure 9. The customer has selected one DOSA of cost 10 rupees. So the quantity is 1, the food item is DOSA and cost of it is Rs: 10.

Case III: Customer pressed key '3' to select food item

As the customer selects the food item from the hard copy of the menu and if key 3 is pressed, a message is displayed on LCD 1 screen indicating, the customer has selected RICE of cost 15 rupees. So the quantity is 1, the food item is RICE and the cost of it is Rs: 15, as shown in figure 10.

C **Figure10: Food ordering system, when key 3 is pressed**

Figure11: Food ordering system, when key 8 is pressed

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If the customer presses key 8, a message is displayed on LCD 1 screen indicating the customer has selected POORI of cost 40 rupees. So the quantity is 1, the food item is POORI and the cost of it is Rs: 40, as shown in figure 11.

Case V: Customer pressed key '8' again

The customer has to press key '8' twice to order two quantity of POORI, for which a message is displayed on the LCD 1 screen indicating the customer has selected two POORI of cost 80 rupees. So the quantity is 2, the food item is POORI and the cost of it is Rs: 80, as shown in figure 12.

Figure12: Food ordering system, when twice key 8 is pressed

Figure13: Food ordering system, when key # is pressed

Case VI: Customer pressed key '#' to submit order

After finalizing all food items, to submit the order the customer has to press '#' (hash) key. Once the customer press the '#' key a message is displayed on LCD 1 screen on the customer table "sending the menu" as shown in figure 13. Followed by the previous message, another message displayed on LCD 1 screen is the total cost of food in rupees, as shown in figure 14.

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Figure14: Food ordering system, when key # is pressed

Figure15: Kitchen module showing table number

Once the customer selects '#' key, in kitchen module, the LCD 2 displays the customer table number as shown in figure 15 and as well as details of food ordered. Here the customer has ordered one plate of RICE and two plates of POORI. So it displayed RICE : 1 and POORI : 2, a total amount for food is Rs. 95, as shown in figure 16.

Figure 16: Kitchen module showing ordered food details

Figure 17: Chef presses the push button 4 of kitchen menu

This information is sent through Zigbee transceiver from the kitchen module to the Zigbee transceiver which is in food ordering side. The chef presses the push button 4 of the kitchen module if the order is accepted as shown in figure 17, for which a message "ORDER ACCEPTED" is displayed on the customer table on LCD 1, as shown in figure 18. The chef presses push button 1 or 2 or 3 to inform the customer that the time required for the food item to serve on the table, as shown in table 2. In this case, the chef has pressed push button 2 to indicate 10 minutes required to serve food, as shown in figure 19.

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Figure 18: Ordered accepted displayed on customer table

Figure 19: Chef presses the push button 2 of kitchen menu

After the food is ready, the chef has to press push button 1 or 2 available in the robotic trolley, to indicate the table number of the customer where food going to be served. The food ordered was kept on the food tray available at the top of the robotic trolley. As the chef, press push button 1, the robotic trolley moves forward and stops at table 1. The customer takes out the ordered food from the trolley. As the food is taken out of the trolley IR sensor 3 senses no weight on the trolley and robotic trolley comes back to the kitchen.

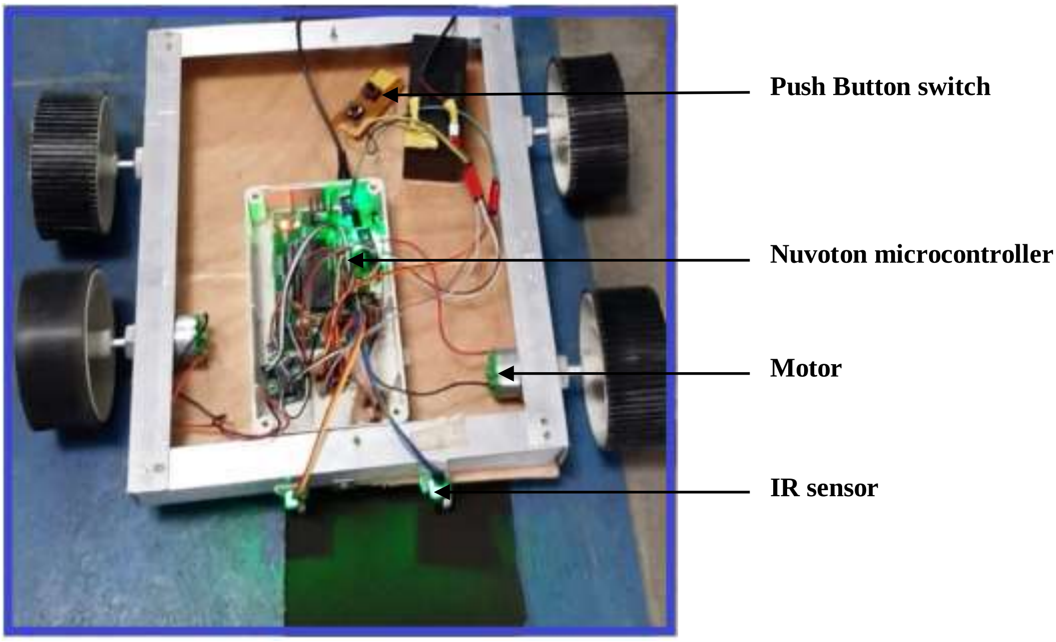

Figure 20 : Hardware of robotic trolley

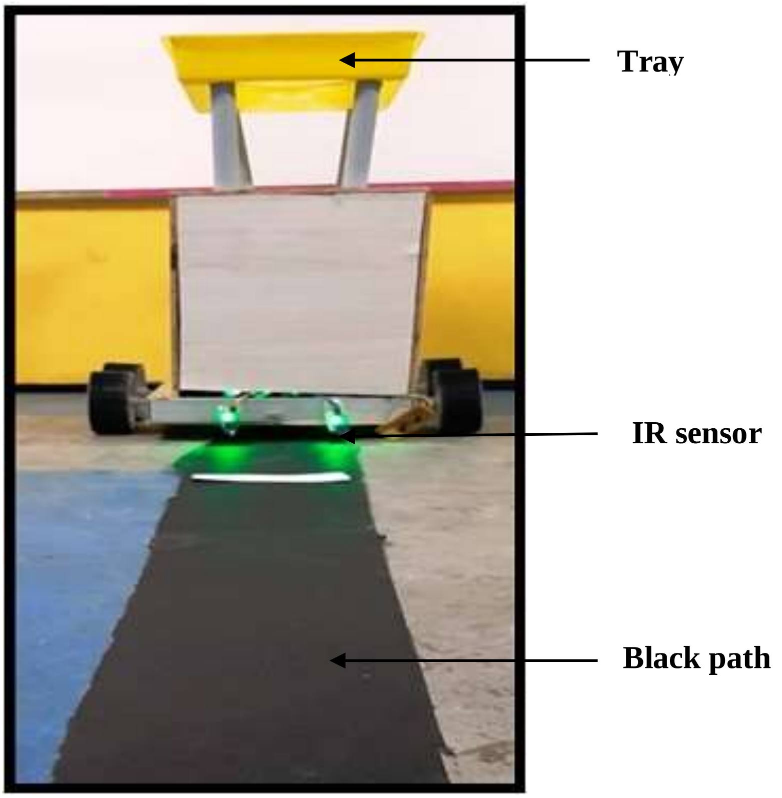

Figure 21 : Robotic trolley and its path to serving table

Figure 20 shows the internal hardware of robotic trolley. Figure 21 shows line following robotic trolley.

VI CONCLUSION AND FUTURE SCOPE

An autonomous robotic trolley for waiter service in the restaurant with smart ordering system is designed and tested for various operations. Arduino microcontroller is used for food ordering, Kitchen module and Zigbee used as a transceiver between two Arduino. For robotic operation, Nuvoton microcontroller is used. IR sensors are used to detect the path of the line following robot. The robotic delivery system provides efficient day in and day out services to the customers and increases the business of restaurant. The deaf and dumb people can take advantage of the proposed system. At present corona virus (COVID-19) pandemic has an impact on the society in day to day life. This proposed work will be useful and efficient in restaurants and still can manage the regular customer with a reduced number of waiters.

The future work could be the implementation of multiple lines LCD with scrolling facility to display food ordered.

VII REFERENCES

[1] Aamir Attar, Aadil Ansari, Abhishek Desai, Shahid Khan, DipashriSonawale "Line Follower And Obstacle Avoidance Bot Using Arduino", International Journal of Advanced Computational Engineering and Networking, ISSN: 2320-2106, Volume-5, Issue-4, April-2017.

[2] Harish Phapale, PrashantPatil, Sanjay Turate, AnshuChaudhary, Prof.MaheshBhagwat "E-Restaurant Management System Using Zigbee And Iot", ISSN: 2278 – 1323 International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 5, Issue 4, April 2016.

[3] M. Srilekha, NoureenFathima, G. Anusha, D. Shravana Chary Assistant professor "Line Follower Alphabot Using Arduino Micro Controller", International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE), Vol 4, Issue 2, February 2018.

[4] TuhinGhosh,ShubhamBhoir, Prashanth Patel, Nikhil Metha, AmrutaMhatre "Smart Restaurant", International Journal of Industrial Electronics and Electrical Engineering (IEEE), ISSN: 2347-6982 Volume-3, Issue-11, Nov.-2015.

[5]Mayur D. Jakhete Asst. Prof, Piyush C. Mankar "Implementation of Smart Restaurant with e-menu Card", International Journal of Computer Applications (0975 – 8887) Volume 119 – No.21, June 2015.

[6] SakariPieskä, Markus Liuska, JuhanaJauhiainenCentria University of Applied Sciences Ylivieska, AnttiAunoDelitazOyKoria "Intelligent Restaurant System Smartmenu", 4th IEEE International Conference on Cognitive Infocommunications, December 2–5, 2013.

[7] Tan-Hsu Tan, Ching-Su Chang, and Yung-Fu Chen "Developing an Intelligent e-Restaurant With a Menu Recommender for Customer-Centric Service", IEEE Transactions on systems, man, and cybernetics-part C:applications and reviews, vol. 42, no. 5, September 2012.

[8] RadhikaGoel, Assistant Professor, Karan Kaushal, KhushbooYadav, VidhuVaibhav, Chakshu Sharma, Love Gupta, TanuTripathy "The E-Restaurant", 2016 IEEE.

[9] YuhangTian, Gengwu Du, "Infrared Line Following and Ultrasonic Navigating Robot with ATMEGA328 Pro", 2019 IEEE 3rd Advanced Information Management, Communicates, Electronic and Automation Control Conference.

[10]DimitarNikolov, GeorgiZafirov, Ivan Stefanov,KaloyanNikov, StelaStefanova, "Autonomous navigation and speed control for line following robot", Proc. XXVII International Scientific Conference Electronics - ET2018, September 13 - 15, 2018, Sozopol, Bulgaria.

[11] Milan Shah, L.D.College of Engineering; VirajRawal, "Design Implementation of High-Performance Line Following Robot", International conference on transforming engineering education(ICTEE), 2017.

[12] Vo NhuThanh, Dang PhuocVinh, Ngo ThanhNghi, Le Hoai Nam, Do Le Hung Toan, "Restaurant Serving Robot with Double Line Sensors Following Approach", Proceedings of 2019 IEEE International Conference on Mechatronics and Automation August 4 - 7, Tianjin, China.