Waiter Robot – Solution to Restaurant Automation

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ABSTRACT

This paper describes the design and development of a waiter robot which is considered as a possible solution to restaurant automation. The robotics technology is replacing manual work at a fast pace throughout the world. In classical café, restaurants and hotels, the customers face a lot of problems due to congestion at peak hours, unavailability of waiters and due to manual order processing. These shortcomings can be handled by using a restaurant automation system where 'Waiter Robots' are used for ordering food and beverages. The desired order is also transmitted on wireless network to the kitchen via menu bar. The menu bar is based on the LCD, Keypad and the Bluetooth module. The customer places the order using electronic menu bar. This order is sent to the kitchen and reception using communication network. The waiter robot then transfers food from the kitchen to the customer.

Keywords: Waiter Robot, restaurant automation, Line following, Menu bar

1. INTRODUCTION

Robots are used to serve humanity. The branch of robotics that plays such a vital role is called "social robotics" [1] . Social robots in today's scenario are now communicating with human, interacting and relating to society in all aspect and are capable of understanding social terms [2]. Due to the modernization in robotic technologies, many new designs and mechanisms are being implemented which are able to read human thoughts and understand actions. Such robots find vast applications in assistive robotics e.g. to help out injured, sick and elder people [3]. Theses robots are adaptive, i.e. they can be used in multi-mode as per scenario [4]. So far, the robots are those who learn from us, but that time will not be so far when the teacher will then be learner. There is an ever rising trend in using robots in restaurants for automation [5]. These robots can welcome guests, take orders, serve food to customers [6]. Designing such robots can be effective to learn advance concepts in human-robot interaction, develop new models and protocols for communication as well as use new architectures for real time path planning, guidance and control.

This paper is structured as follows: Section 2 presents the problem formulation; design of the robot waiter is discussed in Section 3 with all sub-systems,

Figure 1 Waiter Robot developed at RIU, Islamabad

2. PROBLEM DEFINITION

Robots can be divided in two main types. The first one deals with the teleoperated robots while the second one is autonomous robots. Teleoperated robot is remotely controlled and guided by a human operator who views and senses the environment through the robot sensors. Whereas, the autonomous robot has multiple sensors to detect events and measure state information which is then used to apply control logic [7]. We need to design an autonomous robot to carryout various tasks by itself, whereas commands are sent to the waiter robot via communication network.

The problem of restaurant automation deals with the design of a communication system and a waiter robot which can coordinate with rest of the players in the system. The overall block diagram is shown in Fig. 2. It shows that at least 4 segments could be identified namely Robot, Customer, Kitchen and the reception segment.

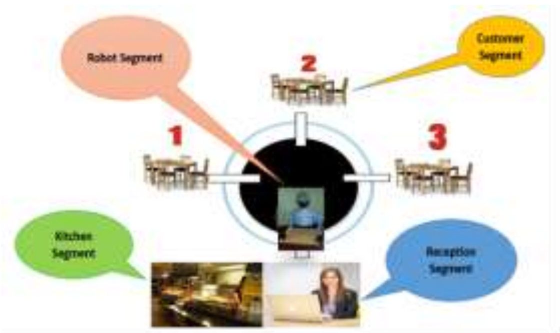

Figure 2 System level diagram

These segments are required to coordinate through a communication network for satisfactory delivery of food items as ordered by the customer.

3. DESIGN OF ROBOT WAITER

The robotic technology takes the place of manual work. In manual café systems, one can witness a lot of problems. The robot waiter is an innovation and the concept can be used for restaurant automation in various fast food chains.

The robot waiter works as a line following robot for which four sensors are used. The project has two important parts namely the Menu Bar and the Robot itself.

3.1 MENU BAR

The menu bar is based on the LCD, Keypad and the Bluetooth module. The LCD is used to display the order of menu bar, while the Keypad is used to select the order. The customer places the order using electronic menu bar. The order is sent to the kitchen and reception using Bluetooth. The Bluetooth module is used for the wireless communication having the range of 10 meters in non-line of sight (NLOS) while 50 meters in line of sight (LOS).

The robot waiter will work on the phenomenon of line following, we have used four IR sensors; the two sensors in the center are used for line following and set the robot waiter on line, The other two sensors installed on sides are used for table counting, i.e. if the robot count one, it means that it has stopped on the first table, and if the robot count two, the robot has stopped on the second table for 20 seconds and so on. The command to stop at the table number is sent to the robot wirelessly from the kitchen using WLAN wireless transmitter. This is because the range of WLAN is higher as compared to Bluetooth.

We have used IR sensors as feedback element to keep the robot tracking the line. Once all sensors are "ON" for the first time, the controller waits for the RF command. If command is for table 1, then the microcontroller follows these instructions:

a) If all sensors status is "ON" for the second time, then wait for 20 seconds.

b) After 20 seconds, a motor "ON" command is sent till all sensors are "ON" the fourth time, same as for table number.

c) In case, when second sensor is "ON" and third sensor is in "OFF" condition, the microcontroller sends command to motor 2 "ON" and motor 1 "OFF" in order to follow the line.

Similarly, in other cases, the second sensor is "OFF" and third is "ON". So, in this way, we control the robot on track line and accuracy is also improved.

This Block diagram explains the working of our menu bar as shown in Fig. 3. In this menu bar, a 4x4 key pad is fixed from which customer selects an order. It has a microcontroller which receives command and work according to need. Then, the desired order will be shown on a 16x2 LCD. The microcontroller will send order to kitchen and reception through Bluetooth Module (2.4 GHz).

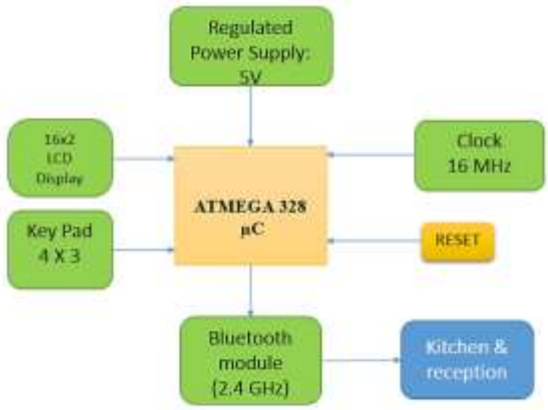

Figure 3 Block diagram of Menubar

4.1 Keypad Interface:

The keypad is used for placing the order. It is a simple 4x3 keypad which is used for the selection of order. When turned 'ON', the microcontroller power up the 4x3 keypad and always checks the column. If the voltage level is changed, then microcontroller senses that some command is being sent from the user and then it can check the condition. Then, according to the condition, it can send data to LCD and Kitchen as well as Reception.

5.1 LCD Interface:

We interface the LCD with keypad so that the customer can see his order. The R/W (read/write) pin of the LCD is used to display messages. If the microcontroller sends '0' to the R/W pin then it is in "read mode" used to read characters from the LCD. However, if the microcontroller sends '1' to that pin it is in "write mode". Since, the LCD is used to display the order which the customer wants, we only require write mode by displaying the order to customer when he is typing keys. The LCD has 16 columns and two rows and is monochrome display. The LCD used in menu bar is 16×2. We use only 4 pins of the LCD for data receiving. So, there is a variable resistor placed for the control of brightness of the LCD. This LCD has pins and schematic diagram are shown in Appendix-A (Figure 9).

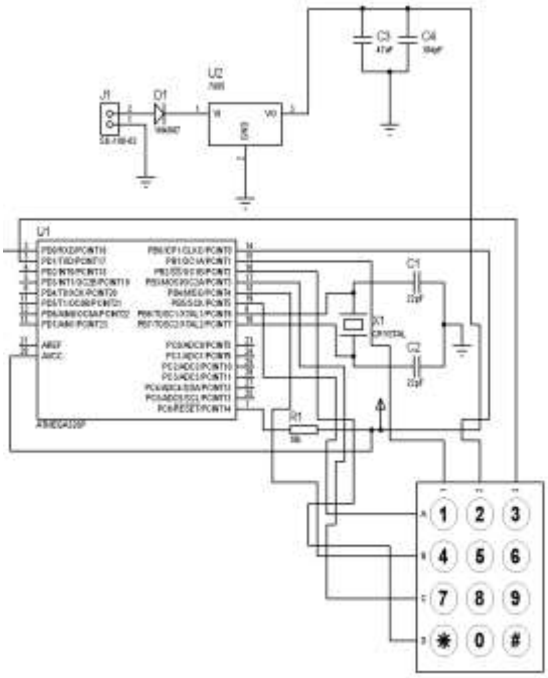

Figure 4 Schematic diagram of key-pad interface with Microcontroller

6.1 Bluetooth Interface:

Bluetooth module (HC-06) contain 4 pins namely power (Vcc), ground (GND), Rx (receiving) and the Tx (transmitting) pin. In this circuit, we use crystal frequency of 16MHz for heart beat signal according to their basic requirement. We have used the Bluetooth module as a wireless communication device for the communication between the Reception, kitchen and Menu Bar. The Bluetooth module transfers data from the table to reception & kitchen at a baud rate of 9600 bps. The customer selects the order, the order transfer wirelessly via Bluetooth to the kitchen and reception.

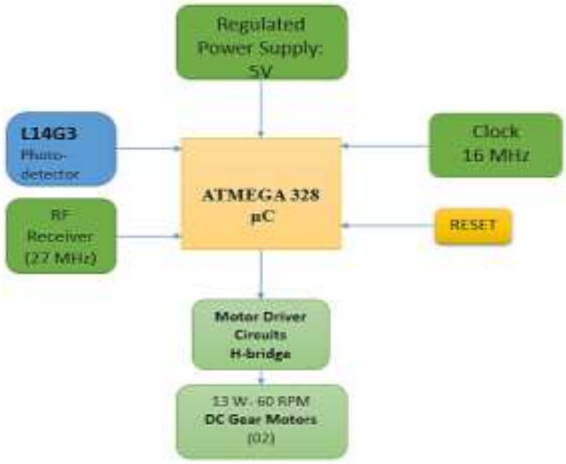

Figure 5 Robot block diagram

7.1 Voltage Regulator:

Voltage regulator provides the voltage levels according to our need as shown in Fig. 5. For this project, we require two regulators; First regulator can regulate +5V and other provides 3.3V. The +5V regulator used for the supply of a microcontroller and the second one with 3.3V regulated output is used for supply to the X-BEE module. For +5V regulator we use LM 7805 and for 3.3V we used LF 33 regulator.

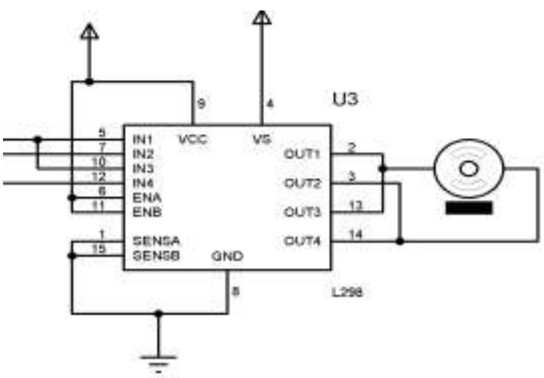

Figure 6 H-bridge Motor Driver

3.2 ROBOT CONTROL DESIGN

The main board block diagram of waiter robot is shown in Figure 4. When receptionist gives command through RF transmitter and main board, the robot receives that command through RF receiver and forwards it to the microcontroller (ATMEGA 328). Then, the microcontroller will drive motor through H-Bridge as per programmed instructions as shown in Fig. 5.

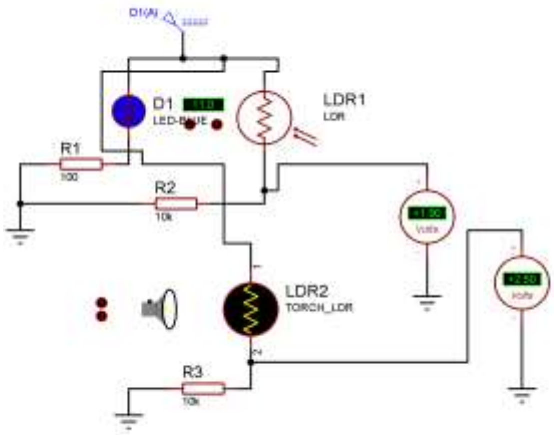

Figure 7 Line tracking sensor circuit

As seen in the block diagram of the robot, ATMEGA 328 microcontroller is managing all tasks for the motor driver as well as communication with the other sub-systems.

Fig. 6 shows the line tracking sensor circuit. The central two sensors are used for line-following and set the robot waiter on line. The two side-sensors are used for tables. If the robot counts one, it means it will stop on the first table, and if the robot counts two, the robot stops on the second table for 20 seconds. The command for table is sent to the robot via wireless link from the kitchen using wireless transceiver.

5. CONCLUSION

The robot waiter presented in this paper is a part of resturant automation system. The system is found to perform well in a mock-up resturant as demonstrated in the lab. Multiple customer tables are placed for stop-over, order placement and delivery from the kitchen. More experiments are being planned for improved performance and better human machine interface (HMI) design.

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