ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2016

Automated Service System for a Restaurant Using a Line follower Robot

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ABSTRACT: A robot can be used to operate/control a restaurant to collect orders and deliver the same The line follower robot identifies and moves along a predefined path. The path may be a black strip on a white background or a white strip on a black background or also it may be invisible like the ones used in a magnetic field. The path used in our project is a black one on a white background. Using IR sensors the path is traced and the readings of the sensors are used to drive the motors drivers which are installed on the robot and responsible for the robot movement.

NRF transceivers are used for communication between the robot and the customer, thus identifying the path between the customer and kitchen. Using this path, the robot would collect orders from the customers and deliver the same.

KEYWORDS: nRF(Nordic Radio Frequency) Transceiver ; Infra-Red Sensors; Motor Driver; Automated Restaurant

I. INTRODUCTION

Basically electromechanical machines that have the capability to perform desired functions when programmed can be termed as robots. Some of the practical applications of a line follower are industrial applications were these robots can be used as automated equipment carriers in industries replacing traditional conveyer belts in automobile. Some recent development is of line follower is seen in applications such as floor cleaning, guidance in public places, library assistance, entertainment, education etc. Using on-board hardwired control circuit , a robot can be used as a line follower which basically follows a predefined path accurately. The operation of the line follower consists of acquiring the line position using IR sensors affixed on the front end of the robot and steer it in the required direction.

A good robot should satisfy the following requirements:

- It should be light weight.
- It should be able to take smooth turns.
- It should be able to carry weight without spilling it.

The main motivation behind the project is to relate the principles of line following robots known to improvise food serving in restaurants. The robot is responsible for transporting food from the kitchen to the customers seated on tables affixed with transmitting antennas. A keypad and LCD are used to select from possible options. This whole concept can be useful for entrepreneurs in restaurants to serve customers differently and in more innovative way.

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II. MOTIVATION

In an era where robotics is developing so fast, the human mind can be freed from being involved in meager labor to something more creative. With this intention, we intend to build a robot that would reduce the human effort in a restaurant or a Café by collecting the order from the customers and delivering the same .

The advantages of this being:

- Higher efficiency
- Though the investment required is high , the subsequent expenditures are much lower as compared to the conventional methods.
- Speed can also be improved

Since this does not require a lot of thought , human involvement can be avoided by using well programmed robots as butlers.

III. PROBLEM DEFINITION

In an era where robotics and automation are developing so fast , this project intends to combine both the aforementioned fields to develop and automated serving system for a restaurant.

Our aim is to build a robot which will replace the butlers in restaurants. For this we intend to build a line follower with a RF transceiver which will perform the above task. This is our attempt to use robots for greater efficiency and saving human time and efforts. Even though there is a significant expenditure involved to make this work, it is only a one time investment and is economical in the long run. Furthermore, the labour savings allow the restaurant to spend approximately twice on other aspects of the restaurant.

IV. APPROACH TOWARDS THE STATEMENT

- To tackle the above problem, we will take one step further from the normal level 3 robotics. The basic idea of the project is to build a line follower with a RF transceiver.
- It is a machine that follows a line, either a black line on white surface or vice-versa.
- Two sensors are used for precise and accurate movement of the bot. The sensors that are used can either be infra red sensors or light dependent resistors.
- Each table will have a RF transmitter and a receiver will be given to the bot. Thus there would be a master receiver and a number of slave transmitters depending on the number of tables.
- The NRF transceivers are used for transmission and reception. They are ultra-low power RF transceiver ICs that operate in the 2.4 GHz ISM band.
- So whenever a customer on a particular table wants to place an order, he sends a notification through the transmitter on his/her table, the robot will go to that particular table to take the order.
- A keypad will be attached to the robot, and a menu will be given to the customer. All the items will be numbered and the customer will have to enter the number corresponding to the desired item on the keypad to place the order.
- The robot after taking the order comes to the chef who then prepares the dish and places it on the bot which will serve it to the respective table.

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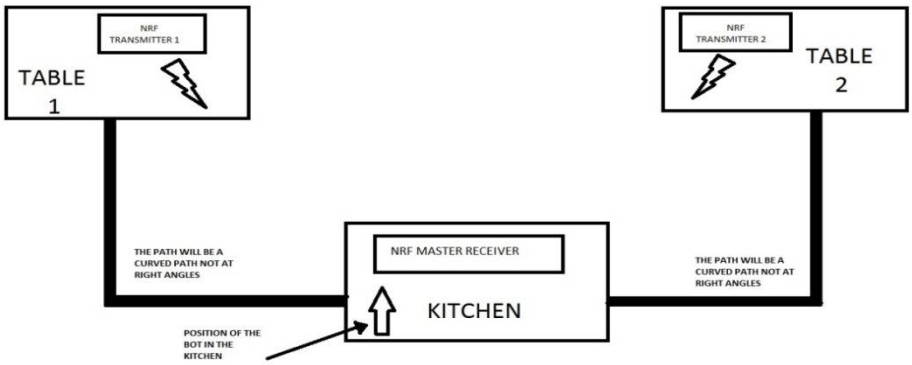
V. BLOCK DIAGRAM



As seen in the block diagram , the robot in placed facing north in the kitchen. Each table is given a unique code for its identification. Assuming table 1 transmits its code, the robot on receiving this turns left and then tracks the path to reach the intended table. Then using the keypad and LCD placed on the robot, the order is placed by the customer. Once order is placed, the robot returns to the kitchen informing the order. Once the order is ready, the robot delivers it to the table.

VI. SYSTEM OVERVIEW

The smart and intelligent line following robot based butler is divided into the following elements- NRF transceiver, LCD, keypad, IR sensors, Motor driver. An IR sensor is used for which a robot can follow a line drawn on the floor. A transceiver is a combination of transmitter/receiver in a single package. nRF is a single chip radio transceiver for the global license free 2.4GHz ISM band. LCD is video display that utilizes the light modulating properties of Liquid crystals to display pictures or text on a screen. Keypad is a set of buttons arranged in a block or a pad which usually bear digits, symbols and usually a complete set of alphabetical letters.

A. Arduino Uno:

Arduino is an open-source computer hardware and software company, project and user community that designs and manufactures microcontroller-based kits for building digital devices and interactive objects that can sense and control the physical world. These systems provide sets of digital and analog I/O pins that can be interfaced to various expansion boards ("shields") and other circuits. For programming the microcontrollers, the Arduino platform provides an integrated development environment (IDE) based on the Processing project, which includes support for C, C++ and Java programming languages.

B. Sensors:

IR or VISIBLE light is emitted from the emitter (IR light is mostly preferred to avoid interference from the visible light which is generally around the robot. However IR light is also present in atmosphere but its intensity is much less than that of visible light, so IR light can give much reliable output. For better accuracy of the sensors, they must be covered properly for the isolation from the surrounding.)

C. nRF Transceivers:

The nRF24L01 is a single chip radio transceiver for the global, license-free 2.4 GHz ISM band. The transceiver consists of a fully integrated frequency synthesizer, a power amplifier, crystal oscillator, demodulator, modulator and Enhanced Shock Burst protocol engine. In addition, the nRF24L01 also offers an innovative on-chip hardware solution called ‘Multi-receiver’ that can support up to six simultaneously communicating wireless devices. This makes it ideal for building wireless Personal Area Networks in a wide range of applications.

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D. Liquid crystal display:

A liquid crystal display, or LCD, is a video display that utilizes the light modulating properties of liquid crystals to display pictures or text on a screen. By wiring an Arduino microcontroller to the pins of an LCD display it is possible to program the microcontroller to display a desired text string or image on the screen. An LCD display is composed of pixels made up of liquid crystals. Each pixel of an LCD typically consists of a layer of molecules aligned between two transparent electrodes, and two polarizing filters (parallel and perpendicular), the axes of transmission of which are (in most of the cases) perpendicular to each other. Without the liquid crystal between the polarizing filters, light passing through the first filter would be blocked by the second (crossed) polarizer.

E. Motor Driver:

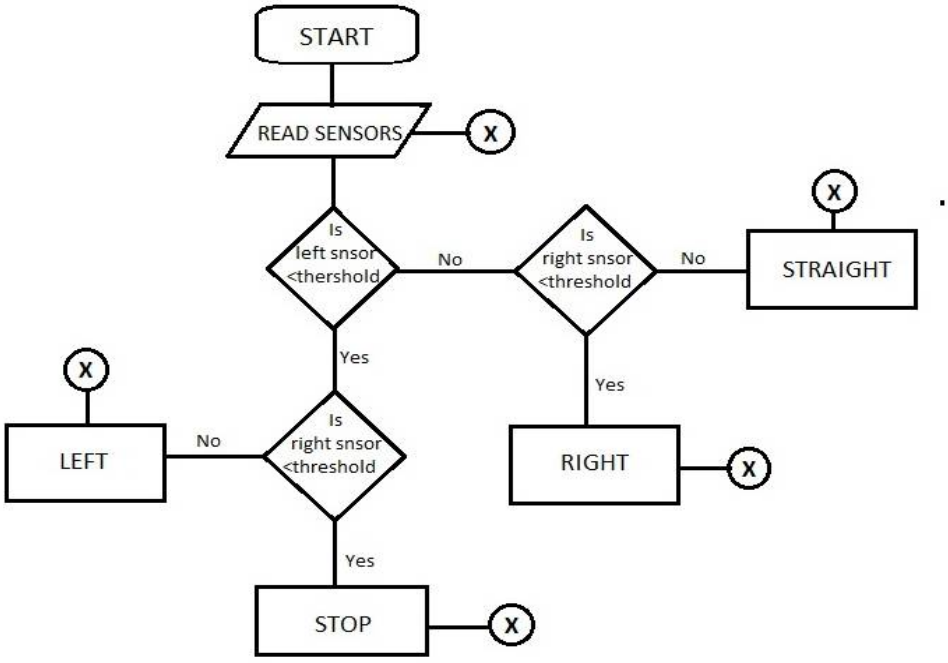
L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction.

F. Keypad:

A keypad is a set of buttons arranged in a block or "pad" which usually bear digits, symbols and usually a complete set of alphabetical letters. If it mostly contains numbers then it can also be called a numeric keypad. Keypads are found on many alphanumeric keyboards and on other devices such as calculators, push-button telephones, combination locks, and digital door locks, which require mainly numeric input. So to connect a keypad to a microcontroller such as an Arduino is very valuable for building many different types of commercial products.

VII. WORKING

The robot used in the project basically consists of 2 wheels (whose motors are driven by motor driver L293d) and a caster wheel(used instead of the forward wheels) mounted on a chassis. An array of sensors is used to detect the line. This is done by emitting IR or VISIBLE light. The flowchart for sensor working is given as:



The movement of the controlled by motor driver is given in a tabular format as shown:

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Table 3.1 Movement of the bot

Movement of the bot	Left Wheel	Right Wheel
Forward movement	forward	forward
Backward movement	backward	Backward
Left movement	no movement	Forward
Right movement	forward	no movement

The communication between the tables and the robot takes place using NRF Transceivers. Each table will be given an unique code. To call the robot to a particular table, this code is transmitted Upon receiving the code, the robot goes to the table , takes the order and returns back. The nRF transceivers which work in the 2.4Ghz band have The transmitter pipe which must have the same address as the receiver . The nRF24 radios use "logical channels" for communications within a physical channel. Basically a pipe address is sent ahead of every data transmission on a particular channel (frequency); a receiver of the "same pipe" listens for this address and upon detecting a match attempts to process the data packet which follows i.e. the transmitter pipe must have the same address as the receiver . The nRF24 chip supports listening simultaneously for up to 6 data channel pipes.

On reaching the correct table order is taken from the customer with the help of a A 16-button keypad. It has four columns and four rows. Pressing a button will short one of the row outputs to one of the column outputs. From this information, the Arduino can determine which button was pressed. For example, when key 1 is pressed, column 1 and row 1 are shorted. The Arduino will detect that and input a 1 to the program.

The LCD displays what is entered on the keypad by the customer . By wiring an Arduino microcontroller to the pins of an LCD display it is possible to program the microcontroller to display a desired text string or image on the screen.

Once the order is placed the robot returns to the kitchen and informs the cook about the same and the order when prepared is delivered to the respective table using the mechanisms discussed above.

VIII. SIMULATION RESULTS

The performance of the system was measured for two cases: testing the robot in an environment where the light intensity was gradually varied, checking the effect of obstacles on transceivers.

Firstly, When placed in an environment with ample light, the sensors performed their function accurately and the robot followed the path without any deviation .For a relatively darker environment the robot was tested. Out of 20 trials taken, for 3-4 trials the sensor readings were found to be erroraneous leading to abrupt movement of the bot. Secondly, range of NRF transceivers was adversely affected, when a large number of obstacles were encountered between the transmitter and receiver. This was concluded by varying the number of obstacles between the transceivers.

The results shown in the images below are as displayed on the serial monitor of Arduino IDE. '101' is the message that is being transmitted by NRF transceiver placed on one of the tables. Once the message is received the sensors on the robot are used to track the path to the table.

The decisions for robot movement are made as follows:

- If both the sensor readings are above the threshold value , the robot will move forward.
- If both the sensor readings are below the threshold value, the robot will stop.

If one the sensor reading is below the threshold , then the robot will turn rightwards or leftwards accordingly

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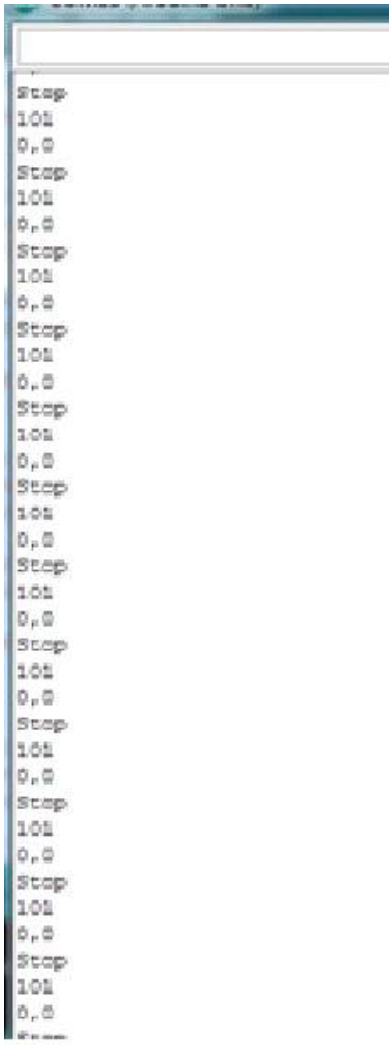

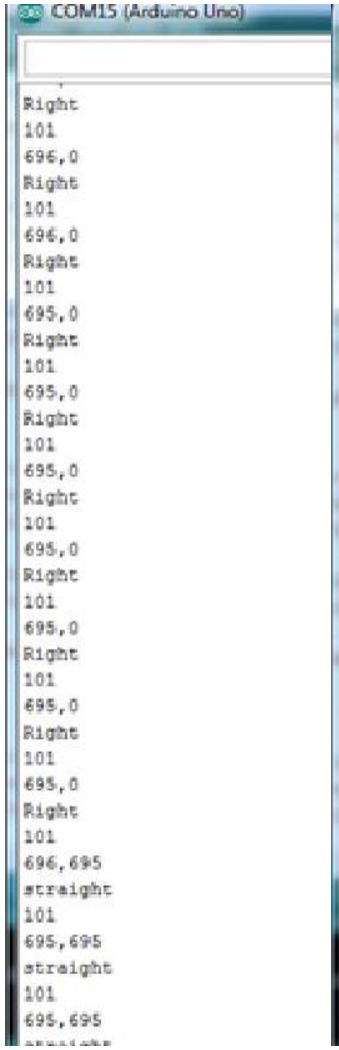

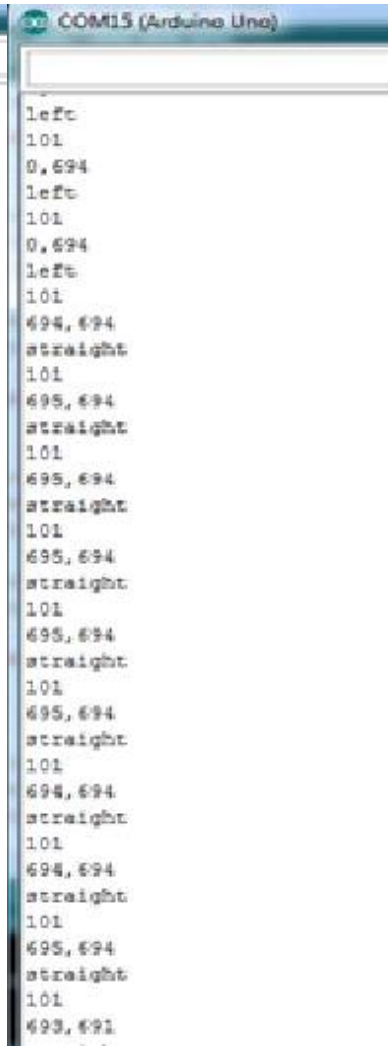

IX. CONCLUSION AND FUTURE WORK

The bot upon receiving the signal from the NRF transmitter installed on the tables traced the path (using the IR sensors installed on the front end of the robot) collected the order from the particular table , brought the order back to the kitchen, and delivered the same. The major drawback of this project is that the robot can cater at the max two tables.

When the tables are increased it may so happen that there will be orders from say 3 tables simultaneously, then an algorithm for the shortest path like Djikshtra's algorithm can be loaded. This will enable the robot to take the shortest path thus reducing the time taken . Also obstacles on the path can be detected and thus avoided using suitable sensors.

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