Line Following Robot Using RF Technology

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ABSTRACT: This research paper shows a prototype creation of a Line Follower Robot (LFR) based on an Intelligent Command using radio frequency (RF) technology. Mostly, microcontroller chips are used to create the Line Follower Robots. One of the most fundamental and fundamental problems with microcontroller chips based Line Follower Robot is that they are preprogrammed. Due of these preprogramming limitations Line Follower Robot cannot accept any instructions and commands from outside users in real time other than what has already been set. The proposed prototype systems are designed and demonstrated to identify, understand and adjust the robot's actual output and movements along the path by obtaining information from three Light Based Resistor (LDR) sensors in real time through the PC-connected Parallel Port Interface Circuit (PPIC). In C-language a computer program is implemented to accept user commands and also autonomously monitor the robot according to the signals received.

KEYWORDS: Line Following Robot, Radio Frequency, command based, RF Transmitters, RF Receivers.

INTRODUCTION

Avoidance of obstacles is a prime condition of some autonomous Robot. Obstacle Robot avoidance is built to allow robots to navigate in unknown locations ambient, preventing collisions. Evading barrier the robot senses obstacles along the road, avoids them and resumes their continuing. There are some very well-known robot methods wall-following navigation, Edge detection, line detection watch. One of the commercial systems uses wall mode on a floor cleaning robot for long period corridors. A more general and widely used method obstacle avoidance approach is edge dependent identification: Identification [1].

Line follower is an autonomous robot that either follows white line black line or black line white line. Robot must be able to detect and keep track of particular rows. For special cases like cross-over where robot can have more than one route that can be followed, the robot must follow predefined path. The next segment address the line follower robot that follows black line in white area and turn right whenever cross-over or Y-shaped turns [2].

The invention of smartphones has changed human society, enabling man-machine interaction. An increasingly inexpensive Android smartphone that almost anyone can purchase as a communications device. This smartphone is not only a communication tool but can also effectively support our daily activities. Compared to current robot microcontrollers like Arduino or STM32, the modern smartphone has high computing power which comes from its microprocessor. Besides that it is fitted with various sensors such as proximity sensor, accelerometer sensor, ambient-light sensor, etc. Smartphones also come with Bluetooth, Wi-Fi and various advanced operating systems, such as Android [3], IOS and others. In addition, Bluetooth and Wi-Fi are used as channels of communication for controlling mobile robotics. In the research an Android-based operating system based smartphone is used, Since Android is currently very popular platform for the operating system. Not only is it popular but an Android phone's price can be very inexpensive. Additionally, Android uses Java programming language that is open source, so its applications can be easily created and updated. Robot is reprogrammable manipulator system that was programmed to execute a human command to facilitate human function. Robot weapons, attached to a fixed location, can move rapidly and accurately to perform repetitive tasks in the industrial production line. But there is a major drawback to these robot arms: lack of mobility. A mobile robot, by comparison, will be able to fly around its world and have more versatility in applying its capabilities.

The main problem with LFR is wired connections [4], and the key limitation is the length of cable. As the length of a wire increases, the signal strength attenuates and the attenuation delay in timings along with the signal intensity increases as well. RF is used to solve these problems because it offers a simple way to relay signals without conductors and thereby reduce the attenuation and time delay. The current approach solves the problem of managing LFR using the added command mode features. The LFR command mode is operated using instructions based on a PC built in the C-programming language. Many research from applications focused on Radio Frequency Identification (RFID) [5]. RFID tag is connected in these systems for receiving and transmitting information from and to a remote control unit. The strength of these RFID systems is that they can solve problem line of sight as well as loss of line and limitations. So far, many robots, the RF-based line is designed. But they are not being implemented for control via PC. The proposed RF-based LFR prototype has been built and is operated with a Personal Computer (PC) [4].

DEVELOPMENT OF SYSTEM

Two separate RF chips were used to transmit and receive the signals between the robot and the PC. The 35 MHz RF is used to monitor robot movement, and 27MHz is used for information transmission [6].

Construction of a command based LFR using RF technology, a 35 MHz RF based car that acts as a robot, has been selected. The reasons why this type of RF car was chosen are:

a. Wireless network functions

b. Simple to install, to set up and to monitor

c. Top loss

The biggest benefit of using RF technology is that it does not require line of sight, making this system more effective than one that uses wired or wireless technology based on infrared. During robot physical design the elements involved are:

Transmission System

A robot's direction was controlled via PC with 35MHz RF remote. A robot transmission is composed of two wheels (i.e. left and right), coupled separately with two direct current motors [7].

The Robot Control process is shown in Table 1. Moments Allowed are:

a. Moving forward

b. Moving backwards

c. To the right (in clockwise direction)

d. Left (anti-clockwise)

e. Rotation: 360 degrees.

A	B	C	Function
1	O	1	Forward
1	1	0	Right (Clockwise)
0	1	1	Left (Anti-Clockwise)
0	0	0	Error
1	1	1	No Line Detector
0	1	0	White Track

Table 1: Operation Table For Robot Movement

DC motor control

There are two motors involved in the robot movements i.e. Motor left and Motor right. The power of these motors is controlled by a PPIC-connected RF transmitter. Robot speed and turning is controlled from Computer using the information obtained from the LDR sensor values i.e. A, B, and C as shown in Table 2 [8].

A	B	C	Signal	Right Motor	Left Motor
1	0	1	S1+S2	1	1
0	1	1	S2	0	1
1	1	0	S1	1	0

Table 2: Operation Table of Motors

The robot's movement is controlled via PPIC i.e. from PC 's four data-out pins. Data0, Data1 and Data3. PPIC's PC pins setup and their description are shown in Table 3.

a) The Relay numbers 1 and 2 are activated to drive the robot forward, which lets the transmitter produce signals S1 and S2.
b) The Relay number 3 and 4 are activated to push the robot in reverse direction, producing S3 and S4 signals.
c) Then the Relay number 1 is triggered to generate signal S1 to move the robot in the right direction (clockwise).
d) Finally, to push the robot in the left (counter clockwise) direction, then the Relay number 2 is activated to generate signal S2.

The Robot Movement PC Pin Configuration is outlined in Table 3. The relay series is connected via PPIC to PP to a PC. In PC there are four pins out of PP Info, i.e. Data 0, Data 1, Data 2 and Data 3 which are connected to PPIC and four RC transmitter switches [9] are controlled from these four data signals i.e. Respectively S1, S2, S3, and S4. And three PC Input Data pins, i.e. To collect sensor information from the sensor receiver circuit, i.e., data A, data B, and data C are used. As for S8, S9, and S10. And eventually PC pins are grounded from 18 to 25.

PC Pin #	Description	Relay #	Signal #
2	Data 0	1	S1
3	Data 1	2	S2
4	Data 2	3	S3
5	Data 3	4	S4
10	Data In A	5	S8
11	Data In B	6	S9
12	Data In C	7	S10
18-25	Ground	GND	-

Table 3: PC Pin Description of PPIC

PC Pin #	Operated Relay #	Transmitted Signal #
2	1	S1
3	2	S2
4	3	S3
5	4	S4
18-25	Grounded	Common

Table 4: Pin Configuration Of Robot Movement

Placement of sensor

Sensors are located at a robot's front bumper. The robot's main goal is to position its B (middle) sensor on the tape line, and two other A (left) and C (right) sensors off the tape line. If the tape line ever moves past these two extreme sensors then the robot corrects to keep monitoring by turning in the right direction. Sensors are mounted over land from 1/16 "to 1/8.The sensors are positioned to get optimal results and this arrangement fits well for 3⁄4 "long tape lines.

Sensor array

The left sensor is called A, the middle sensor is called B and the right sensor is named C. If the sensor reads A=1, B=0 and C=1, then it is assumed that the robot is at the center point on the tape and that it is ready to push the robot forward.

The PC decides on the next step based on the algorithm given below which attempts to position the robot in such a way that L and R both read 1 and M read 0. Table 5 indicates those conditions.

A: Left	B: Middle	C: Right
1	0	1

Table 5: Sensor Array Conditions

Sensor Transmission

The Red LED is used for transmitting light on the tape (line) and the LDR is used for detecting the reflected LED light as shown in Fig.1. The sensor output is an analog signal which depends on how much light is reflected back. This analog signal is transmitted by 27MHz RF based transmitter which transmits these signals to the PPIC-connected sensor receiver circuit.

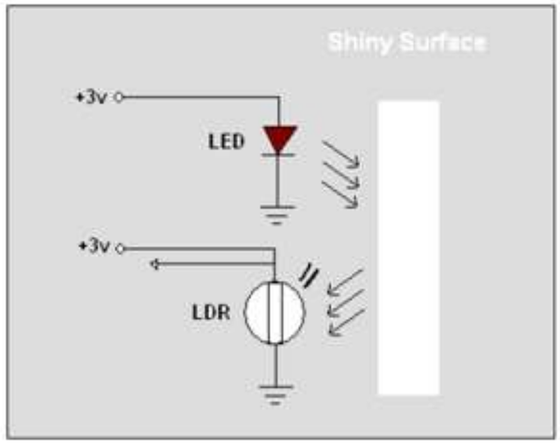

Fig.1: Circuit Diagram Of Sensor Circuit And How Line Is Detected

Then, as illustrated in Table 3, PPIC fed these three signals to PC through three PC input pins. Table 6 shows the description of the transmitted signal of the Sensors and Table 7 shows the pin definition of the received signal of the Sensor at the PC.

Sensor #	Transmitted Signal
LEFT	S6
MIDDLE	S7
RIGHT	S5

Table 6: Sensors Transmitted Signal

Received Signal	Relay #	PC Pin #
S8	5	10
S9	6	11
S10	7	12

Table 7: Sensors Received Signal To PC

CURVE LINE ANALYSIS

A robot's action is determined by way of sensor receiver circuit according to received signals via PPIC.

- If A (Left Sensor) reads 1, B (Middle Sensor) reads 0, and C (Left Sensor) reads 1, then the RC transmitter produces the S1 and S2 signals and the robot moves forward
- In comparison, if A (Left Sensor) reads 1, B (Middle Sensor) reads 1, and C (Left Sensor) reads 0, then the S2 signal is created from the RC transmitter and the robot moves in the right direction (Clockwise).

- · Eventually, if the robot travels in the left (anti-clockwise) direction, then the Relay number 2 is activated to produce S2.

Algorithm used

Following the algorithm is designed to autonomously monitor the robot and decide on the robot's next step via sensor information.

1. IF A= left sensor that reads 1,

   C = right sensor, read 1,

   B = center sensor that reads 0,

   Then step in direction forward.

2. 2. IF A < = 0, B > 0, C > 0,
   Then move in Anti-clockwise direction (left)

3. IF A > 0, B > 0 & C < = 0,
   Then move in Clockwise direction (right)

4. IF A > 0, B > 0 & C > 0,
   Then exit Line Lost

5. IF A<= 0, B < = 0, C < = 0,
   Then output ERROR

6. Repeat phase one to five.

CONCLUSION

The problem with LFR's based microcontroller was accepting user commands in real time environment, so this problem was solved by replacing the microcontroller with PC to provide additional facilities. To solve this problem RF was used to provide a simple way to transmit signals without conductors and thus remove the attenuation and delay in time. Such additional features provide users with wireless control of the robot as well as allowing users to operate in certain areas that are too unsafe to explore. Additional modules of range finder (ultrasound or infrared) and a gripper may be used. These modules will allow the robot to implement diverse and more complex algorithms. In addition, adding a gripper would allow more sophisticated algorithms to carry items, play soccer and various industrial applications to be implemented in robot.

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