Smart and Intelligent Line Follower Robot with Obstacle Detection

M. Sri Venkata Sai Surya[1], K. Bhogeshwar Reddy[2], K. Pavan Kalyan[3], S. Senthil Murugan[4]

[1, 2, 3, 4]*Department of Electrical and Electronics Engineering, SRM Institute of Science and Technology, Kattankulathur. Chennai – 603203. India*

Abstract: **Line follower is a intelligent robot which detects a visual line embedded on the floor and follows it. The path is predefined and can be either visible like a black line on a white surface with a high contrasted color or the path can be a complex such as magnetic markers or laser guide markers. In order to detect these lines various sensors can be employed. Generally, infrared Sensors are used to detect the line which the robot has to follow. The robot movement is automatic and can be used for long distance application. Line follower can be modified by giving obstacle detection capability to it. If any object is placed on the path then a normal line follower will try to push the obstacle and hence it gets damaged. By using ultrasonic sensor, the line follower can detect an obstacle and can stop till the obstacle is removed. This type of robots can perform lot of tasks in industries, like material handling. These robots can be used as automated equipment carriers in industries replacing traditional conveyer belts. They also have domestic application and one of the interesting application of this line follower robot is in health care management. As this smart line follower robot has obstacle detection capability it will not be damaged easily as it stops it motion till the obstacle is removed or till the path is changed. This ability of the robot increases it application especially in industries because obstacles are common in any workplace and if the robot is not able to detect the obstruction it will get damaged so this gives an added advantage wherever this intelligent line follower is used.**

Keywords: **Line follower, obstacle detection, autonomous system, intelligent robot. Arduino.**

I. INTRODUCTION

The main aim of any robot is to reduce human effort. According to the purpose different types of robots are designed for practical applications. In any work environment proper monitoring is always needed for better results. This smart and intelligent line follower robot can be used in industries for carrying goods from one place to another. The main reason why this robot can be employed for transportation of goods is its fit and forget ability, [1] which means that once the robot is placed on the desired path the working of the robot is totally automatic, there is no need for controlling the robot manually. This is what makes the line follower robot more efficient and useful when compared to other conventional robots. A traditional obstacle avoiding robot cannot help in transportation of goods because there is no particular path for the robot. It will move randomly by avoiding the obstacles and will not reach the required decision. The movement of obstacle avoiding robot cannot be controlled. A WIFI controlled robot is also not helpful in real time applications because it needs manual operation. It can go in any particular direction and to any destination but the main problem is it needs continuous manual commands, which limit its applications in all the work places. Considering all these factors line follower robot has more useful applications. This conventional line follower robot can be made smart and intelligent by giving it the ability to detect obstacles. This improves the working of the line follower robot, because in any work environment obstacles are common, so if the line follower is not able to detect any obstacles on its path it will collide with it and will be severely damaged. Adding the features of obstacle avoiding robot to a traditional line follower robot prevents any damage to the robot. This intelligent robot can also be installed for health care management in hospitals, which decreases the human effort in monitoring patients and delivery things or medicines [2]. The workers can be used for other tasks instead of transporting goods from one place to other which can be carried out with this smart and intelligent line follower robot.

II. HARDWARE DESCRIPTION

IR Sensor: The Infrared (IR) sensors consist of Infrared (IR) LED and Infrared (IR) photodiodes. The IR LED is called photoemitter and IR photodiode is called receiver. The IR light emitted by the LED strikes the surface and gets reflected back to the photodiode. Then the photodiode gives an output voltage which is proportional to the reflectance of the surface which will be high for a light surface and low for dark surface. Light colored objects reflect more IR light and dark colored objects reflect less IR light.

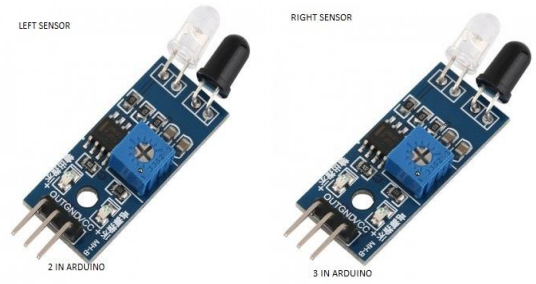

Figure 1- IR Sensor

Ultrasonic Sensor: Ultrasonic sensor is a device which can measure the distance to an object by using sound waves. It will measure the distance by sending out a sound wave at a particular frequency and listening that wave when it bounces back. Ultrasonic sensor will not be able to detect some objects because the reflected sound wave may deviate from its path and will not be received by the ultrasonic sensor and so the sensor cannot detect the obstacle. And also if the obstacle is too small then the sound wave will not be able to bounce back. Accuracy of the ultrasonic sensor also depends on the temperature and humidity of the area where it is being used but this factor can be neglected.[3]

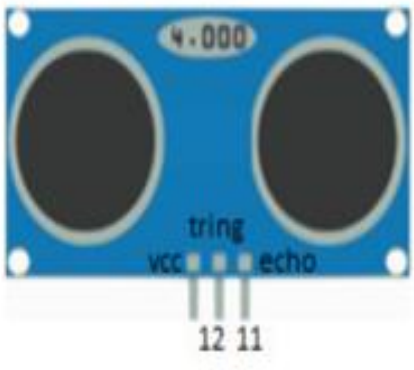

Figure 2- Ultrasonic sensor

Arduino: To create devices which can interact with environment using sensors and actuators the Arduino project was started in 2003 aiming to provide a easy way for professionals. Most of the Arduino boards consist of an Atmel 8-bit AVR microcontroller with varying amounts of flash memory, pins and other features. Arduino boards are programmed via Universal Serial Bus, implemented using USB to Serial adapter chips such as FTDI FT232. A program for Arduino can be written in any programming language with compilers that produce binary machine code for the target processor. The Arduino provides the integrated development environment (IDE), which is a cross platform application written in programming language JAVA. This IDE also supports C and C++ using certain rules of code structuring.

Motor Driver: Motor driver acts like a current amplifier.

Motor driver is used for controlling the current in the motor. The motor driver will provide high current to the motor when low current is received in the circuit. A high value of current is needed to drive these motors. The IC L293D will be able to control two dc motors simultaneously. The motor can be rotated in both forward and reverse direction. The motor driver controls the motors when the robot needs to turn left or right. It completely controls the movement of dc motors.

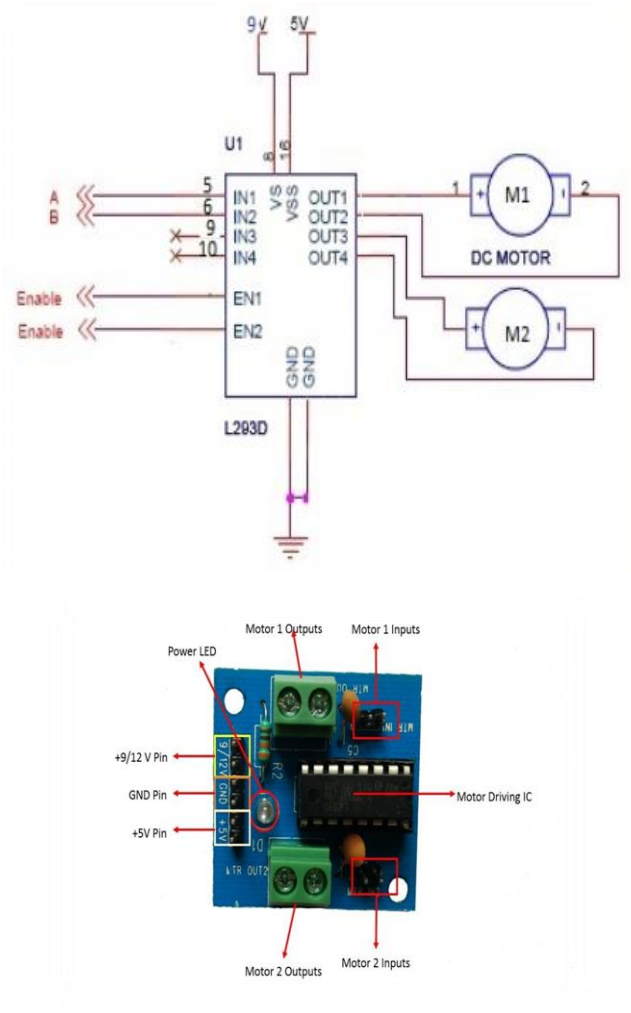

Figure 3 Motor Driver

Motors and Wheels: Two dc motors have been used in this line follower robot which obstacle detection. A castor wheel is used in the front of the robot which makes the movement of robot easy in every direction. The two dc motors are controlled by the motor drive and accordingly the signal the motors will work. The whole system is controlled by Arduino, at which the commands are given about the path and obstacles so it controls the whole robot according to the program given to it.

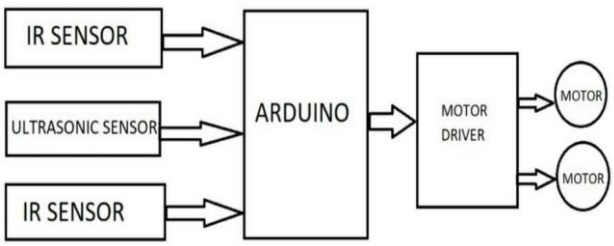

Figure 4 Block diagram of the robot

III. CODE

```
#include <NewPing.h> //Header Library for ultrasonic sensor
int x,y,t1=0,t2=0; //Declaring variables
unsigned int D;
NewPing sonar(12,11,10); //Initializing ultrasonic sensor, Syntax is NewPing sonar(TriggPin, EchoPin, Maxdistance);
void setup() {
pinMode(2,INPUT); //Initializing input pin of Infrared sensor 1
pinMode(3,INPUT); //Initializing input pin of Infrared sensor 2
pinMode(5,OUTPUT); //Initializing output pin 1 of motor driver
pinMode(10,OUTPUT); //Initializing output pin 3 of motor driver
pinMode(6,OUTPUT); //Initializing output pin 2 of motor driver
pinMode(9,OUTPUT); } //Initializing output pin 4 of motor driver
void loop() {
x=digitalRead(2); //Read value of Infrared sensor 1
y=digitalRead(3); //Read value of Infrared sensor 2
D=sonar.ping_cm(); //Check reading of ultrasonic sensor in cm
if(D!=0) { //If ultrasonic sensor reads an obstruction in the vicinity of max distance then stop robot
digitalWrite(5,LOW); //stop motors, stop moving
digitalWrite(10,LOW);
digitalWrite(6,LOW);
digitalWrite(9,LOW);
delay(1000);} //Delay of 1 second
else (D==0); {
if((x==1)&&(y==1)) { //If no IR sensor reads black line at any side then move forward
digitalWrite(5,HIGH); //left motor clockwise
digitalWrite(10,HIGH); //right motor clockwise, moving forward
digitalWrite(6,LOW);
digitalWrite(9,LOW);
t1=0;
t2=0; }
else if((x==1)&&(y==0)) { //If left IR sensor reads black line then turn robot to right
if(t1>=20) {
digitalWrite(5,LOW); //If the robot is stuck while moving right then move robot back for 0.5 seconds and move robot right for 1 second
digitalWrite(10,LOW);
digitalWrite(6,HIGH); //left motor anticlockwise
digitalWrite(9,HIGH); //right motor anticlockwise, moving backward when stuck
delay(500);
digitalWrite(5,HIGH); //left motor clockwise, turning right
digitalWrite(10,LOW);
digitalWrite(6,LOW);
digitalWrite(9,LOW);
delay(1000); }}
else {
digitalWrite(5,HIGH); //left motor clockwise, turning right
digitalWrite(10,LOW);
digitalWrite(6,LOW);
digitalWrite(9,LOW);
delay(500);
t1+=1; }
else if((x==0)&&(y==1)) { //If left IR sensor reads black line then move the robot left
if(t2>=20) { //If the robot is stuck while moving left then move robot back for 0.5 seconds and move robot left for 1 second.
digitalWrite(5,LOW);
digitalWrite(10,LOW);
digitalWrite(6,HIGH); //left motor anticlockwise
digitalWrite(9,HIGH); //right motor anticlockwise, moving backward when stuck
delay(500);
digitalWrite(5,LOW);
digitalWrite(10,HIGH); //right motor clockwise, turning left
digitalWrite(6,LOW);
digitalWrite(9,LOW);
delay(1000); }}
else {
digitalWrite(5,LOW);
digitalWrite(10,HIGH); //right motor clockwise, turning left
digitalWrite(6,LOW);
digitalWrite(9,LOW);
delay(500);
t2+=1; } }
else if((x==0)&&(y==0)) { //If the two IR sensor reads black line at both sides then the robot moves forward
digitalWrite(5,HIGH); //left motor clockwise
digitalWrite(10,HIGH); //right motor clockwise, moving forward
digitalWrite(6,LOW);
digitalWrite(9,LOW);
t1=0;
t2=0; } }
```

IV.WORKING PRINCIPLE

The ultrasonic sensor library has to be installed in Arduino IDE. In the program the both the IR sensors have to initialized. Four output pins of the motor have to be initialized. Three variables have to be declared, two for both the IR sensors and one for the ultrasonic sensor. [4] The two variables which are declared for the IR sensor will read the value of IR sensor1 and IR sensor2. The variable which is declared for the ultrasonic sensor checks for any obstacle till a mentioned distance. If the ultrasonic sensor detects any obstacle in its path all the motors should stop, the four output pins of the motor drive should be programmed as LOW, which means they should stop working. So when an obstacle is detected by the ultrasonic sensor then the motors will stop and the robot will stop till the obstacle is removed from its path. When no obstacle [5] and no black line is detected then the robot should move forward.

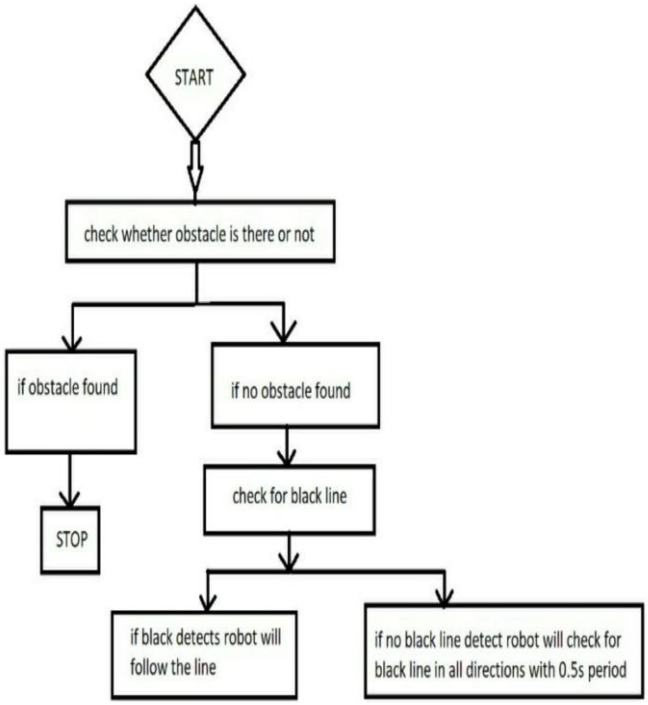

Figure 5: Flow Chart of working of the robot

One pin on either side of the motor will be HIGH and the other two pins will be LOW. This makes the left and right motor to rotate in clockwise direction and hence the robot moves forward. When only left IR sensor detects black line then the robot has to turn left, for that only right motor has to work. When the left motor stops and the right motor is rotating in clockwise direction the robot will turn left. One pin of the right motor should be HIGH and all the other pins should be LOW. When only right IR sensor detects the black line then the robot has to turn right, for that only left motor has to work.

When the left motor stops and the right motor is rotating in clockwise direction the robot will turn left. One pin of the left motor should be HIGH and all the other pins should be LOW.

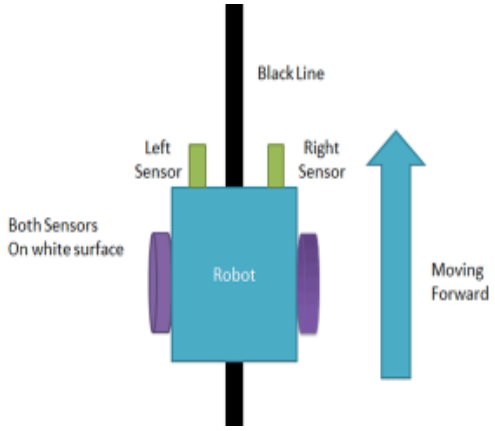

Figure 6: Forward movement

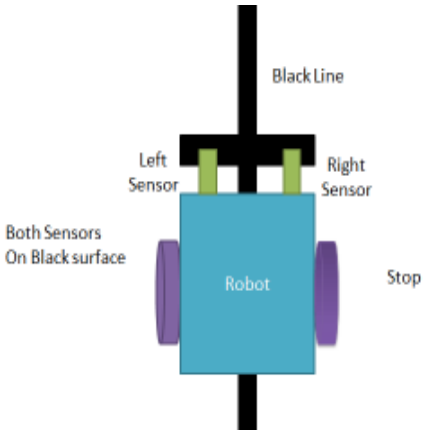

Figure 7: Stop the robot

When both the sensors are on white surface then the robot moves forward and when both the sensors are on black surface then the robot stops. In this case both the sensors will detect the black line but the position where the sensors are located decides whether the robot will stop or will move forward.[6]

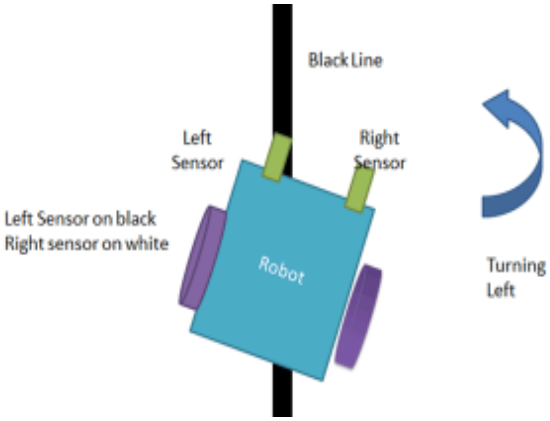

Figure 8: Turning left

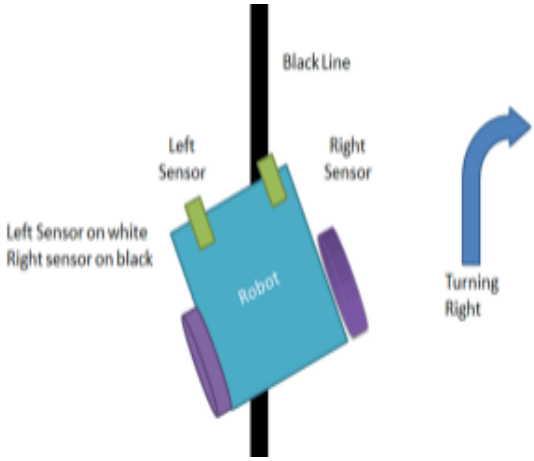

Figure 9: Turning right

When the left sensor detects the black line and right sensor is not able to detect the black line then the robot has to turn left. When the right sensor detects the black line and left sensor is not able to detect the black line then the robot has to turn right.

At any case if there is a black line then rotor has to stop.[7]

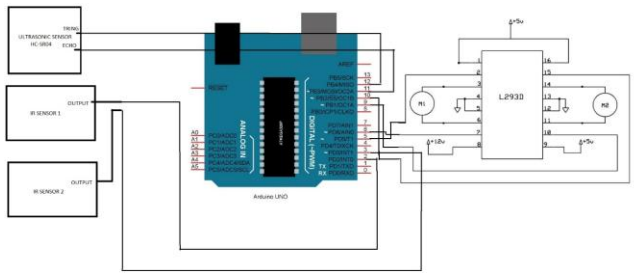

Figure 10: Complete block diagram of the designed robot

V FUTURE SCOPE

This smart and intelligent robot can be modified and controlled using Bluetooth, WIFI module and other type of sensors. The movement of the line follower can be controlled either by using a Bluetooth or a WIFI module. By using any of these modules, the line follower robot can be stopped, can be turned right and can be turned left. This makes the line follower robot more intelligent and useful. The line follower cannot be stopped on its path if a Bluetooth or WIFI module is not used. So to stop the robot without placing any other obstacle this idea can be implemented to stop the robot or even to change its path. One more idea which can be implemented on the line follower is to make it a RGB color following robot. The robot will be able to differentiate between these three colors and according to the given instruction it will follow the particular colored path. By using this the path of the line follower can be modified in many different ways making it easier to use it in different directions. The robot will be able to detect three colors so the robot can reach a particular position. This will not be possible by a conventional line follower robot.

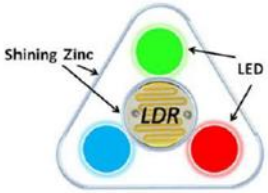

Figure 11: RGB with LDR

The RGB color detection sensor can be designed using a Light Dependent Resistor(LDR) and three Light emitting diodes namely red LED, green LED, and blue LED.[8] When red light falls on a green and a red object, the red object will reflect more light to the sensor than the green object to the LDR sensor, so the color that will be detected by the LDR sensor will be the red color.

VI HARDWARE RESULT

Left Motor	Right Motor	Robot Movement
Straight	Straight	Straight
Stop	Straight	Left
Straight	Stop	Right
Stop	Stop	Stop

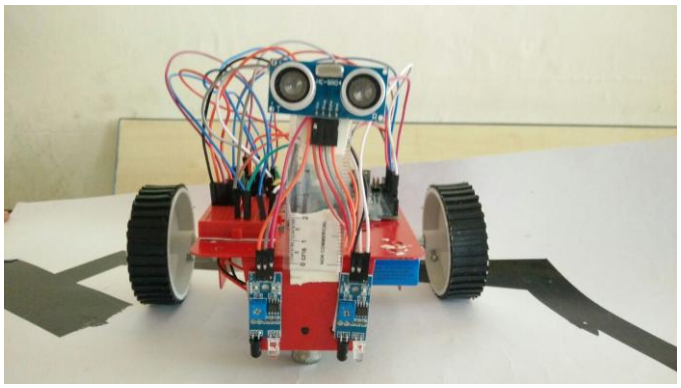

Figure 12

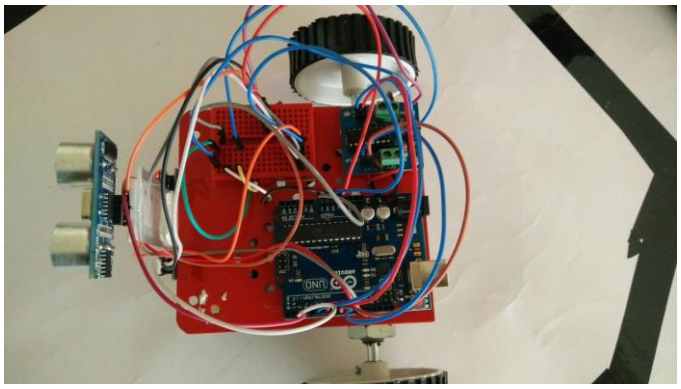

Figure 13

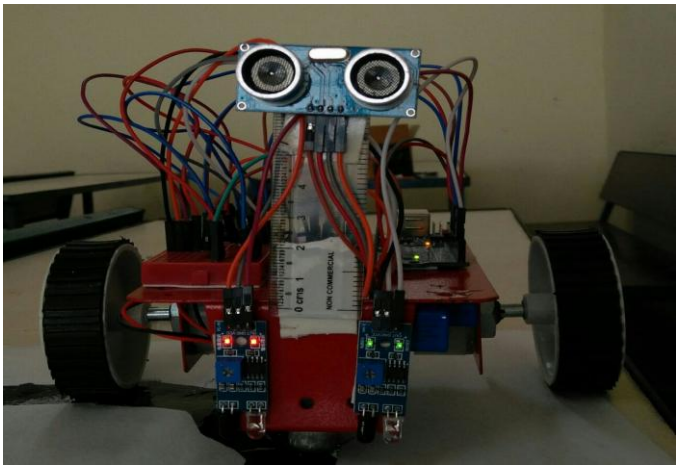

Figure 14: Smart and Intelligent Line Follower Robot

VII.CONCLUSION

The applications of the line follower are limited because it cannot be controlled. The only way to control the line follower is to change the path. Using WIFI module to control the line follower robot will not be helpful because more power will be consumed, so the battery will drain out quickly. Apart from these limitations smart and intelligent line follower robot can be used for long distance applications with a predefined path.

This smart and intelligent robot has more benefits because it doesn't consume much power. This robotic system can provide an alternative to the existing system by replacing skilled labor, which in turn can perform better tasks with accuracy and lower per capita cost.[9]

REFERENCES

[1]. Inteligent Line Follower Mini-Robot System Román Osorio C., José A. Romero, Mario Peña C., Ismael López-Juárez, International Journal of Computers, Communications & Control Vol. I (2006), No. 2, pp. 73-83.

[2]. Development and Applications of Line Following Robot Based Health Care Management System by Deepak Punetha, Neeraj Kumar, Vartika Mehta, International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 2, Issue 8, August 2013.

[3]. HCSR04 Ultrasonic Sensor Elijah J. Morgan Nov. 16 2014.

[4]. SIMPLE DELIVERY ROBOT SYSTEM BASED ON LINE MAPPING METHOD EndrowednesKuantama, Albert Brian Lewis Lukas and Pono Budi Mardjoko Electrical Engineering, Universities PelitaHarapan, Jl. M.H. Thamrin Boulevard, Lippo Karawaci, Tangerang Indonesia.

[5]. Obstacle Avoiding Robot By Faiza Tabassum, Susmita Lopa, Muhammad Masud Tarek & Dr. Bilkis Jamal Ferdosi, Global Journal of Researches in Engineering.

[6]. Two Wheels Balancing Robot with Line Following Capability NorManiha Abdul Ghani, FaradilaNaim, Tan Piow Yon, World Academy of Science, Engineering and Technology International Journal of Mechanical and Mechatronics Engineering Vol:5, No:7, 2011.

[7]. OBSTACLE AVOIDING ROBOT – A PROMISING ONE Rakesh Chandra Kumar1 , Md. Saddam Khan2 , Dinesh Kumar3 ,Rajesh Birua4 ,Sarmistha Mondal5 , ManasKr. Parai6

[8]. Design and implementation of RGB color line following robot GADHVI SONAL PUNIT RANINGA HARDIK PATEL, Proceedings of the IEEE 2017 International Conference on Computing Methodologies and Communication (ICCMC)

[9]. Colak, I., Yildirim, D.,"Evolving a Line Following Robot to use in shopping centers for entertainment", Industrial Electronics, 2009. IECON '09. 35th Annual Conference of IEEE,pp.3803 - 3807,3-5 Nov. 2009