LINE FOLLOWER & OBSTACLE AVOIDER ROBOT

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Abstract - *Line follower is an 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.*

Key Words: **Robot, line follower, sensors, obstacles, industries**

1. 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, 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. Considering this factor 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. 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.

2. PRODUCT DETAILS

2.1 Arduino

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. This board uses Atmel microcontroller series. There are many Arduino hardware models that you can use. Further information about Arduino products, you can visit on website http://arduino.cc/en/.

You must one Arduino hardware to follow practices in this book. I recommend to obtain one of the following Arduino hardware:

Arduino Uno

Arduino Leonardo

Arduino Mega 2560

Arduino Due

You can buy this product on your local electronic store. You also can order it by online.

Find it on http://arduino.cc/en/Main/Buy. The following is the list of Arduino store you can buy

Arduino store, http://store.arduino.cc/

Amazon, http://www.amazon.com

Cooking-hacks, http://www.cooking-hacks.com/index.php/shop/arduino.html

RS Components, http://www.rs-components.com

Element 14, http://www.element14.com

EXP-Tech, http://www.exp-tech.de

Because Arduino is an open-source hardware, people can build it. It's called Arduinocompatible. Generally it's sold in low prices

2.2 Arduino Uno

The Arduino Uno is a microcontroller board based on the datasheet file,

http://www.atmel.com/dyn/resources/prod_documents/doc8161.pdf

Further information about Arduino Uno, you can read it on http://arduino.cc/en/Main/ArduinoBoardUno

Fig -2.1.1: Arduino Uno

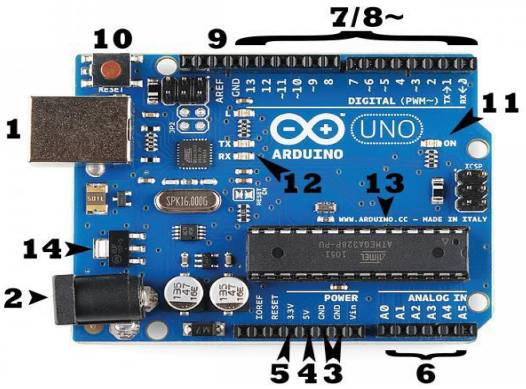

Fig -2.1.2: Quaduino Uno R3

What's on the board?

There are many varieties of Arduino boards that can be used for different purposes. Some boards look a bit different from the one below, but most Arduino have the majority of these components in common:

Power

(USB / Barrel Jack)

Every Arduino board needs a way to be connected to a power source. The Arduino UNO can be powered from a USB cable coming from your computer or a wall power supply that is terminated in a barrel jack. In the picture above the USB connection is labeled (1) and the barrel jack is labeled (2).

NOTE: Do NOT use a power supply greater than 20 Volts as you will overpower (and thereby destroy) your Arduino. The recommended voltage for most Arduino models is between 6 and 12 Volts.

Pins (5V, 3.3V, GND, Analog, Digital, PWM, AREF)

The pins on your Arduino are the places where you connect wires to construct a circuit (probably in conjuction with a breadboard and some wire. They usually have black plastic 'headers' that allow you to just plug a wire right into the board. The Arduino has several different kinds of pins, each of which is labeled on the board and used for different functions.

• GND (3): Short for 'Ground'. There are several GND pins on the Arduino, any of which can be used to ground your circuit.

• 5V (4) & 3.3V (5): As you might guess, the 5V pin supplies 5 volts of power, and the 3.3V pin supplies 3.3 volts of power. Most of the simple components used with the Arduino run happily off of 5 or 3.3 volts.

• Analog (6): The area of pins under the 'Analog In' label (A0 through A5 on the UNO) are Analog In pins. These pins can read the signal from an analog sensor (like a temperature sensor) and convert it into a digital value that we can read.

• Digital (7): Across from the analog pins are the digital pins (0 through 13 on the UNO). These pins can be used for both digital input (like telling if a button is pushed) and digital output (like powering an LED).

• PWM (8): You may have noticed the tilde (~) next to some of the digital pins (3, 5, 6, 9, 10, and 11 on the UNO). These pins act as normal digital pins, but can also be used for something called Pulse-Width Modulation (PWM). We have a tutorial on PWM, but for now, think of these pins as being able to simulate analog output (like fading an LED in and out).

• AREF (9): Stands for Analog Reference. Most of the time you can leave this pin alone. It is sometimes used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins.

Reset Button

Just like the original Nintendo, the Arduino has a reset button (10). Pushing it will temporarily connect the reset pin to ground and restart any code that is loaded on the Arduino. This can be very useful if your code doesn't repeat, but you want to test it multiple times. Unlike the original Nintendo however, blowing on the Arduino doesn't usually fix any problems.

Power LED Indicator

Just beneath and to the right of the word "UNO" on your circuit board, there's a tiny LED next to the word 'ON' (11). This LED should light up whenever you plug your Arduino into a power source. If this light doesn't turn on, there's a good chance something is wrong. Time to re-check your circuit!

TX RX LEDs

TX is short for transmit, RX is short for receive. These markings appear quite a bit in electronics to indicate the pins responsible for serial communication. In our case, there are two places on the Arduino UNO where TX and RX appear – once by digital pins 0 and 1, and a second time next to the TX and RX indicator LEDs (12). These LEDs will give us some nice visual indications whenever our Arduino is receiving or transmitting data (like when we're loading a new program onto the board).

Main IC

The black thing with all the metal legs is an IC, or Integrated Circuit (13). Think of it as the brains of our Arduino. The main IC on the Arduino is slightly different from board type to board type, but is usually from the ATmega line of IC's from the ATMEL company. This can be important, as you may need to know the IC type (along with your board type) before loading up a new program from the Arduino software. This information can usually be found in writing on the top side of the IC. If you want to know more about the difference between various IC's, reading the datasheets is often a good idea.

Voltage Regulator

The voltage regulator (14) is not actually something you can (or should) interact with on the Arduino. But it is potentially useful to know that it is there and what it's for. The voltage regulator does exactly what it says – it controls the amount of voltage that is let into the Arduino board. Think of it as a kind of gatekeeper; it will turn away an extra voltage that might harm the circuit. Of course, it has its limits, so don't hook up your Arduino to anything greater than 20 volts.

2.3 Motor Driver Module:

You can control two DC motor with a single L293D IC. The L293D works on the concept of typical H-bridge, a circuit which allows the high voltage to be flown in either direction. In a single L293D IC there are two H-bridge circuits which can rotate two DC motors independently. You can Buy L293D IC in any electronic shop very easily and it costs around 70 Rupees

The module consists two pairs of pins for connecting the two motors, a Vcc to supply external 5 Volts electricity to drive the motors, a GND for negative terminal. The motor driver consists of 4 pins p1, p2, p3 & p4 (which is input to this module & output from arduino). If pin p1 is HIGH (having 5 Volts and other 3 pins having 0 Volts) motor M1 rotates clockwise, if p2 is HIGH (having 5 Volts and other 3 pins having 0 Volts) then motor M1 rotates anti clockwise, if p3 is HIGH (having 5 Volts and other 3 pins having 0 Volts) then motor M2 rotates clockwise, if p4 is HIGH (having 5 Volts and other 3 pins having 0 Volts) then motor M2 rotates anti clockwise.

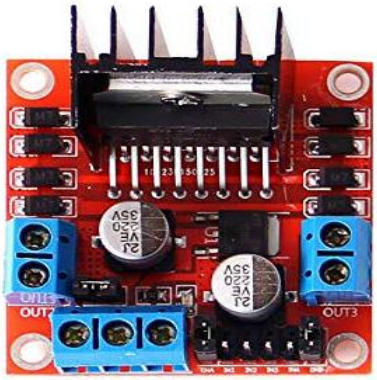

Fig -2.3.1: Motor Driver Module

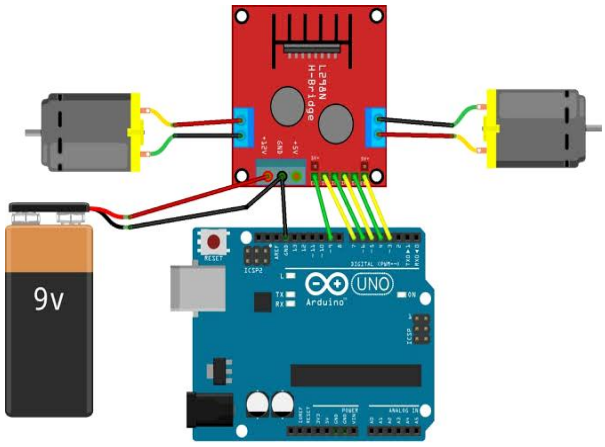

Fig -2.3.2: Assembly

2.4 Ultrasonic Sensor:

Fig -2.4.1: 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 ave 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. 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.

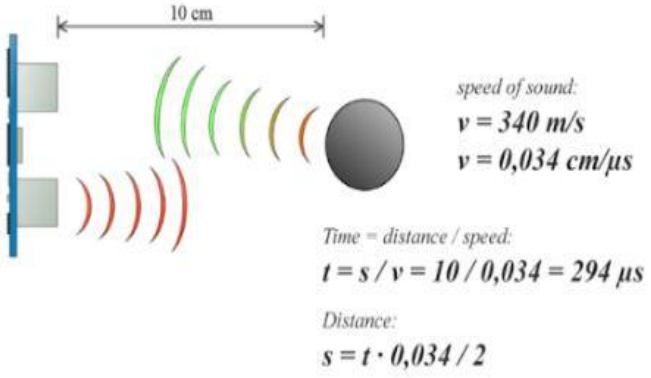

Fig -3.1: Conceptual Diagram

3.2 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

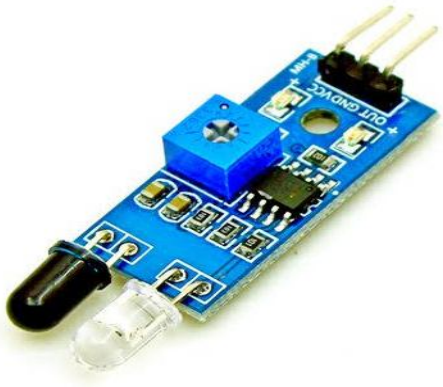

Fig -3.2: IR Sensor

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.

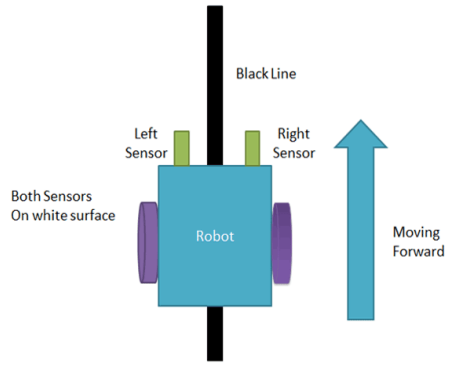

Fig -3.3: Forward movement

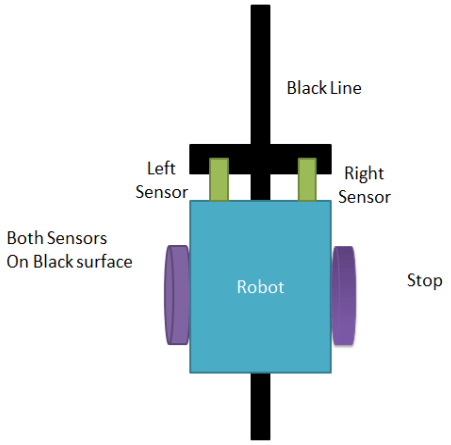

Fig -3.4: Stop the robot

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] 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.

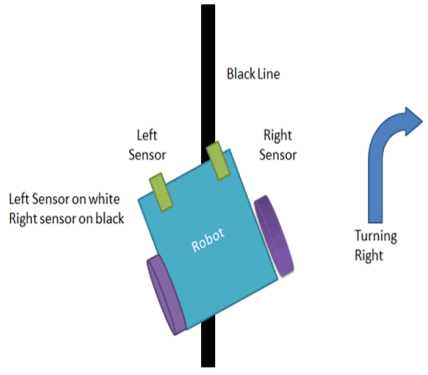

Fig -3.5: Turning left

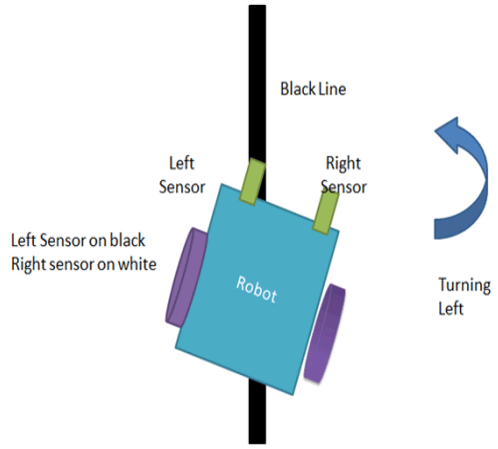

Fig -3.6: Turning right

3.3 JUMPER WIRES

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed. Fairly simple. In fact, it doesn't get much more basic than jumper wires

Fig -3.3.1: JUMPER WIRES

3.4 CASTOR WHEEL

A caster (or castor) is an undriven, single, double, or compound wheel that is designed to be mounted to the bottom of a larger object (the "vehicle") so as to enable that object to be easily moved. They are available in various sizes, and are commonly made of rubber, plastic, nylon, aluminum, or stainless steel.

Fig -3.4.1: Castor Wheel

3.5 BATTERIES

A battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices such as flashlights, mobile phones, and electric cars.[1] When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode.[2] The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. When a battery is connected to an external electric load, a redox reaction converts high-energy reactants to lower-energy products, and the free-energy difference is delivered to the external circuit as FIG:2.9 electrical energy.[3] Historically the term "battery" specifically referred to a device composed of multiple cells, however the usage has evolved to include devices composed of a single cell.

Fig -3.5.1: Batteries

3.6 SWITCH BUTTON

In electrical engineering, a switch is an electrical component that can "make" or "breaK" an electrical circuit, interrupting the current or diverting it from one conductor to another.[1][2] The mechanism of a switch removes or restores the conducting path in a circuit when it is operated. It may be operated manually, for example, a light switch or a keyboard button, may be operated by a moving object such as a door, or may be operated by some sensing element for pressure, temperature or flow. A switch will have one or more sets of contacts, which may operate simultaneously, sequentially, or alternately. Switches in high-powered circuits must operate rapidly to prevent destructive arcing, and may include special features to assist in rapidly interrupting a heavy current. Multiple forms of actuators are used for operation by hand or to sense position, level, temperature or flow

Fig -3.6.1: Switch Button

3.7 BO MOTOR

DC motor (BO) Battery Operation. Dc motor converts electrical energy into mechanical energy. Why DC gear motor used in robot Motor control circuit. DC MOTOR concept is where gears reduce the speed of the vehicle but increase its torque is known as gear reduction. In DC motor is assembled with multiple gear setup. Speed of motor is counted in terms of rotations of the soft per minute is called RPM. RPM means Revolution Per Minute. The setup assemble helps to increasing the torque and reduce the motor speed. All micro-controller based Robots this type of DC motor can be used.

Fig -3.7.1: BD Motor

3.8 CHASSIS

Basic chassis for building your own Arduino, Raspberry-Pi (Not Included) robot car etc. Acrylic base that is pre drilled & routed to mount the gear motor/Tire assemblies, the switch, a 4 "AA" cell battery holder (Batteries Not Included) and a small caster for rear wheel. Motors: 5-10VDC with Tach disks

Includes: 2 motors/tires, Battery Holder, Caster, Switch and Mounting hardware

L: 8-1/4" W: 6-1/8" H: 2-3/4" WT: .62

Fig -3.8.1: Chasis

4. WORKING

These robots are pretty cheap and easy to design. Infrared Sensor is used to detect the black line on the path and Ultrasonic Sensor is used to detect obstructions on the path. The robot then responds to the sensor's reading and does something.

This robot can follow a thick line of at least of 1 inch width perfectly and even follow the most complex path consisting of obtuse/acute angled turns and intersection of those black lines.

When the two Infrared sensors connected at both sides of robot senses white path then the two motors rotate clockwise and the robot moves forward. Similarly, when both the Infrared sensors senses black path (signifying intersection of black lines) then also the two motors rotate clockwise and the robot moves forward.

When one of the Infrared sensors (say the one located at the right side) senses a black path while the other one (left one) senses a white path, then the path is turning towards right, hence the robot turns right. To make the robot move right, the right motor stays stationary and left motor rotates clockwise, hence robot takes a right turn.

When one of the Infrared sensors (say the one located at the left side) senses a black path while the other one (right one) senses a white path, then the path is turning towards left, hence the robot moves left. To make the robot move left, the left motor stays stationary and right motor rotates clockwise, hence robot takes a left turn.

To take a sharp right turn, make the left motor rotate clockwise while making the right motor rotate anticlockwise. To take a sharp left turn, make the right motor rotate clockwise while making the left motor rotate anticlockwise.

When the ultrasonic sensor in front of the robot senses any obstruction (in programmed range) while moving forward then the motors stops rotating and the robot stops. The robot starts moving as soon as the obstruction is removed.

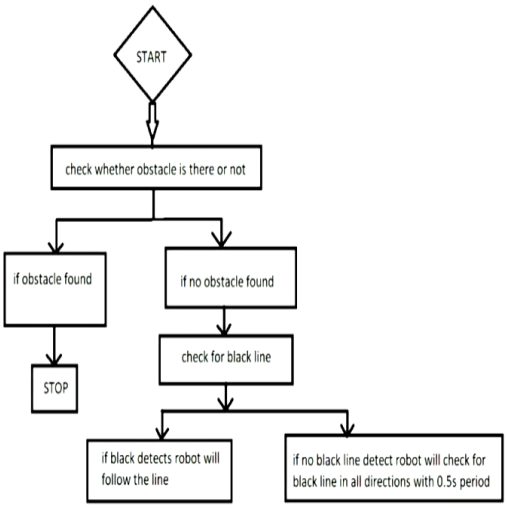

Fig -4.1: Flow Diagram

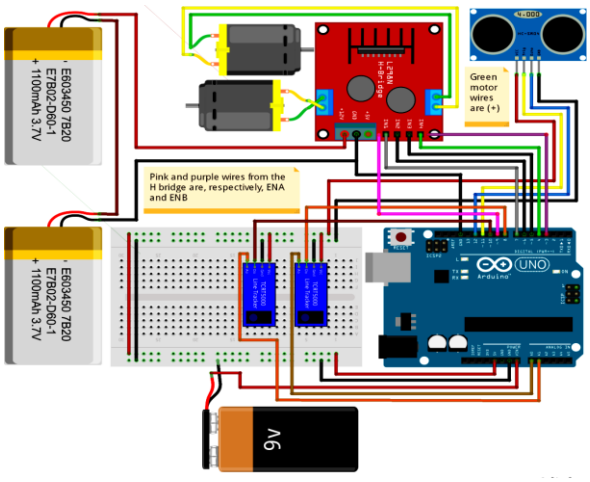

Fig -4.2: Assembly

5. RESULT

Following figures are the results of specimen. It was working fine by avoiding obstacles and following the path.

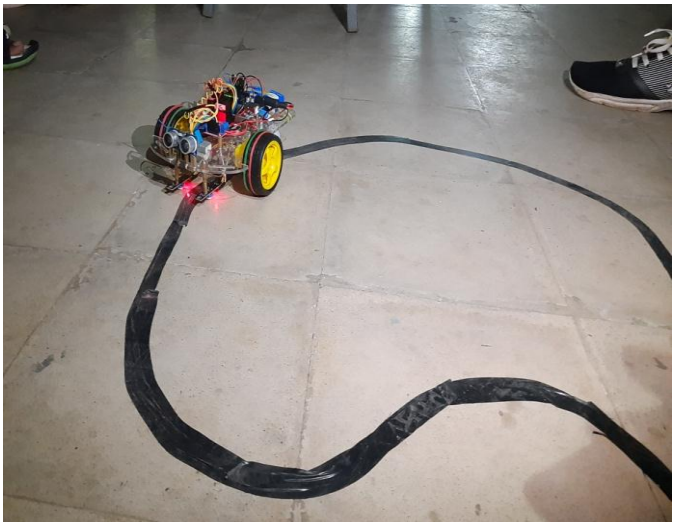

Fig -5.1: Demo1

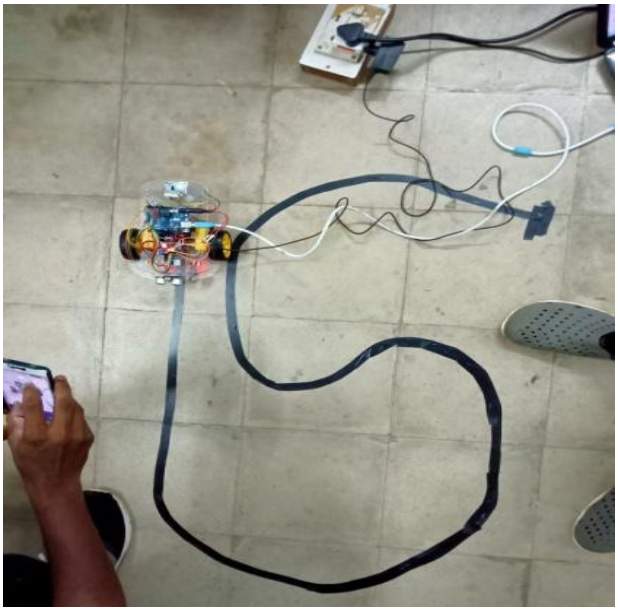

Fig -5.2: Demo2

6. ESTIMATE OF PROJECT

Table 6.1: Project Estimate

Sr.No.	Name of object	Cost
1	DIY 2WD LINE FOLLOWING ROBOT	1299/-
2	MOTOR DRIVER	187/-
3	ULTRASONIC SENSER WITH SERVO MOTOR	270/-
4	JUMPER WIRES	94/-
5	BATTERIES	110/-
6	CELLO TAPE	20/-
TOTAL COST		2000/-

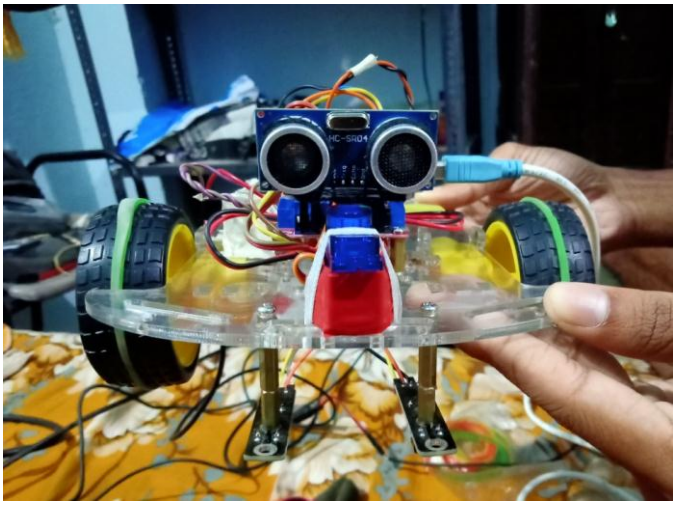

Fig -5.3: Model

CONCLUSIONS

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.

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