Industrial Line Follower Robot

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***Abstract*—This paper shows design and implementation of the Line Follower Robot and its ability to select the desired line among black and white line. This can be combined with different colours. Since each colour has its own distinct property, robot can therefore easily differentiate among different colours and posses the ability to detect the presence of an obstacle and choose the other path to find its target. It is programmed in such a way that instructions are given to the robot which senses a line and attempts to move towards the target. The robot can easily move along very congested curves as it continuously data from the sensors. This robot avoids collision and it can detect collision with an obstacle sensor and hence reaching the target. The proposed system can be implemented in any commercial, industrial, medical and also in educational labs.**

***Keywords*- Arduino, IR sensor, Ultrasonic Sensor, Motor**

I. Inroduction

The Line Following Robot is an autonomous robot that detects a path and according to the path drawn, it follows the path with the help of an IR sensor attached to the robot. The path can be either a Blackline drawn over a white surface or a white line drawn over a black surface thus avoiding any detection error. Line follower robot also consists of an obstacle sensor that detects any obstacle in front of the Robot thus avoiding any unnecessary accidents. Line follower robot is designed and programmed in such a way that it does its job perfectly without any error and detects it's given path. It operates in such a way that it detects and reads the path and transmits the signal to Arduino UNO. The microcontroller decides to to make any changes (if needed) in the directions or speeds of the robot according to the inputs received. Thus, it sends the control signal to the speed and directions of the line follower robot. This way the line follower robot operates without any error. To makealine follower robot with object detection ability it is attached with an ultrasonic sensor, which is a device that can measures the distance between an object and robot by using sound waves. It calculates the distance between the line following robot and the object obstructing it by sending a sound wave of a specific frequency and detecting the bounced sound wave at receiver. It is important to understand that some objects might not be detected by ultrasonic sensor. This can be applied for military purposes, delivery services, transportation system, blind assisting applications.

II. Motivation

In time of automation advances to reduce human efforts, it is necessary to develop colour line following robot, this robot can be used in airports to carry equipment and baggage from one place to another place, and it can be used for home automation, in restaurant it is used as robotic waiter like in Robot Restaurant in Asad Gate, Mohammadpur, Dhaka. It was opened in 2020. Advantage of such robots is that they can operate efficiently for 6-7 long hours with a single charge. Thus, it is profitable for the business itself. Therefore, for a largely populated country like Bangladesh, it is necessary to use the line following robot in restaurants, industries etc. Such Robots come into play when large and heavy machineries are to be transferred from one place to another within industries. This technology can be implemented in running buses or other mass transit systems.

III. Related Works

In robotics there are many systems invented which has different applications in different fields. Robotics is very popular field for research and manufacturing. Pakdaman M, et.al has design a small line following robot which used IR sensors to detect the line drawn on floor[1]. Priyank Patil has developed an AVR line following robot which can detect the line drawn on the floor with the help of sensor array. When its sensor is passing through the line drawn on the way then it reads 0 an vice versa[2]. That system has designed for the robot competittion. Colak I.et.al has design a line following robot to use int the shopping malls for entertainment. That system used 4.8cm wide balancing robot has developed by Nor Maniha Abdul Ghani et.at, which has the line following capability and for balancing it, they used infrared distance sensor to solve the problem in inclination[3], They also used a manual control with the help of remote controller[4]. A

physical robot with 50 individual controls is generated by Gomi T. et.al from which the ability and gait to lift the body can be improved. That robot can move its legs in forward motion and tested in different conditions[5]. Roman Osorio C. et.a; designed an intelligent line following robot, which can modify the performance of the movement with the help of different type of magnetic sensors. That robot was based on the V2X sensor which is a type of digital compass[6]. This system is used an array of 8 IR sensors and several LEDs. M. Zafri Baharuddin et.al designed a mobile robot which can be used as the navigation purpose[7]. An intelligent robot system is designed by Bajestani S. E. M. which can give corrective feedback in different colours of light[8]. They used a comparator circuit to improve the sensitivity of the system. That comparator compares the voltage with the predetermined amounts from which a robot can move in accurate real time. Kazi Mahmud Hasan et.al designed sensor based autonomous color line following robot with obstacle avoidance, this robot can follow not only black and white colors but also some other different colors. This robot includes electronic logic gates as brain instead of microcontroller[9].

IV. Methodology

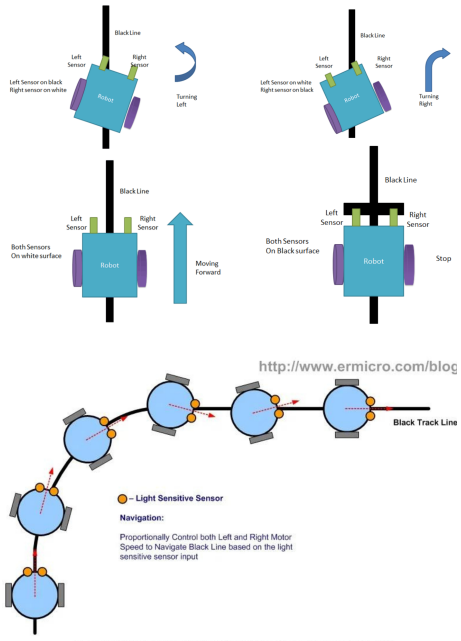

Fig. 1. Line tracking Navigation priciple on the line follower Robot (LFR)

The line follower robot consists of two IR sensors and an Ultrasonic sensor attached to it. When the left sensor comes on the black line, then the robot turns the left side in the black line (Fig. 1) and if the right sensor senses a black line (Fig. 2), then the robot turns the right side until both the left and right sensor senses white then only the robot moves forward (Fig. 3). If the robot comes across a path where there is another black strip lying perpendicular to the path then the robot stops at that instant (Fig. 4).

A. Flowchart

Flowchart for Industrial line follower Robot is Shown in the Figure below.

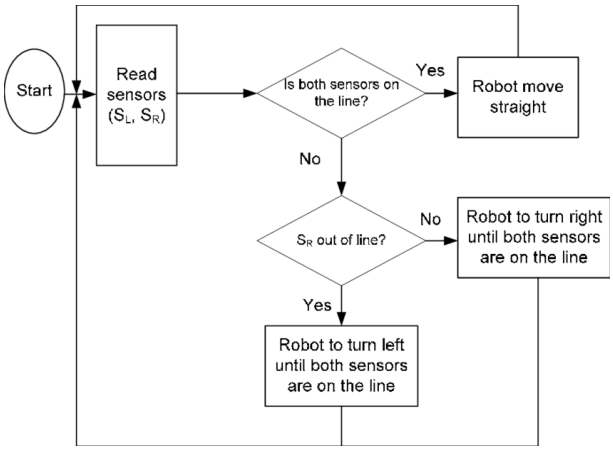

Fig. 2. Flowchart

B. Algorithm

Building and working function of the line follower Robot follows a specific algorithm.

1. Initialize the robot's sensors, actuators, and control system. 2. Read sensor's data to detect line and any obstacle in the robot's path. 3. Process the sensor data to determine the position of the robot and detects if any obstacle is presence. 4. check for the presence of any obstacle. 5. Generate obstacle detection command. 6. Execute the command and determine the robot's trajectory and if any obstacle finds, immediately stops the robot within 0.3 seconds. 7. Repeat steps 2-6 in a loop to execute the algorithm again and again.

V. Required Materials/Hardwares

A. Arduino UNO

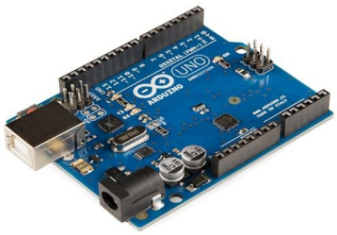

Fig. 3. Arduino UNO

The Arduino UNO is a microcontroller board based on the datasheet For More

further information about Arduino UNO, you can read it on Click me

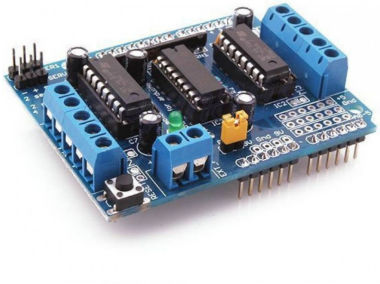

Fig. 4. L293D Motor Driver

B. L293D(Motor Driver)

This is a Motor Driver that can drive four motors simultaneously. Motors are arranged in a fashion called H-Bridge. H-Bridge-It is an electronic circuit which enables a voltage to be applied across a load in either direction.It allows a circuit full control over a standard electric DC motor with an H-Bridge, a microcontroller, logic chip, or remote control can electronically command the motor to go forward, reverse, brake, and coast. [10]

C. HC-SR04 Ultrasonic Sensor

Fig. 5. HC-SR04 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. [11]

D. IR Sensor

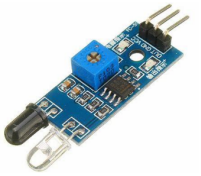

Fig. 6. IR sensor

The Infrared (IR) sensor consist of Infrared (IR) LED and Infrared (IR) photodiodes. The IR LED is called photoemitter and IR photodiode is called receiver. The light emitted by the LED strikes the surface and gets reflected back to the photodiodes.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.[12]

E. Jamper Wire

Fig. 7. Jamper Wires

Jumper wires are simply wire 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.[13]

F. Chassis

Fig. 8. 4 wheeler chassis

Basic chassis for building your own Arduino robot car etc. The acrylic base is pre-drilled and routed to mount the gear motor-Tire assemblies, a 4 “AA” cell battery holder and a small caster for the rear wheel. Motors: 5-10VDC with Tach disks

G. 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. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons

Fig. 9. Battery

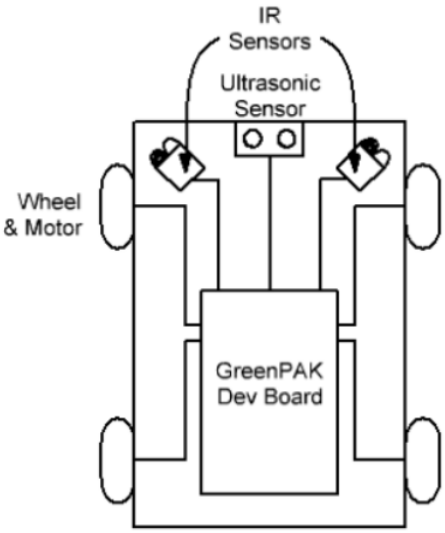

Fig. 10. Block Diagram

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 electrical energy. Historically the term "battery" specifically reffered to a device composed of multiple cells, however, the usage has evolved to include devices composed of a single cell. [14]

VI. Block Diagram

Below is the block diagram for Line Follwer Robot. The Arduino UNO microcontroller sends a set of signals to the L293D and uses the motor sheild L293D. All kinds of processing take place in the Arduino UNO microcontroller. Four DC motors are connected with the motor sheild as well as two IR sensors and one ultrasonic sensors are connected to the motor sheild. They send signals through the L293D to the Arduino. The 3.7v Lithium Polymer battery powers the whole system.

VII. Architechture of the System

VIII. Result

The result of a line follower robot depends on its design, implementation, and the specific tasks it is intended to perform. Here are some outcomes or results that have achieved with this well-functioning line follower robot:

1. Line Tracking: The robot successfully detects and tracks the line, maintaining its position and following the line accurately. It can navigate curves, corners, and intersections without deviating from the line.

2. Precision and Stability: The robot demonstrates precise control and stability, minimizing oscillations or erratic movements while following the line. It maintains a consistent distance from the line, avoiding unnecessary swaying or overshooting.

3. Speed and Efficiency: The line follower robot can operate at an optimal speed while still accurately following the line. It can efficiently traverse the entire length of the line or navigate through complex paths in a timely manner.

4. Robustness to Environmental Factors: The robot is capable of functioning reliably in various environmental conditions. It can handle variations in line color, thickness, or texture, as well as changes in lighting conditions or floor surfaces.

5. Adaptability: The line follower robot can adapt to different line patterns or layouts. It can handle straight lines, curves, intersections, forks, or even complex line networks with multiple paths.

6. Obstacle Detection and stop: If equipped with obstacle detection capabilities, the robot can detect and Stop.

7. Integration with Other Systems: The line follower robot can be integrated into larger automated systems or workflows. For example, it can be synchronized with other robots or machinery to perform coordinated tasks or participate in industrial automation processes.

The actual result of this line follower robot will depend on the quality of its design, construction, sensor accuracy, control algorithms, and the ability to handle real-world challenges.

TABLE I
Connection Between Motor Driver and Arduino

Motor Driver	Arduino
N1	10
IN2	9
IN3	6
In4	5
VCC/12v	Vin/5v
GND	GND
5v	5v

TABLE II
Connection Between IR and Arduino

IR Sensor	Arduino
sensor1:	
VCC	VCC
GND	GND
OUT	A3
sensor2:	
VCC	VCC
GND	GND
OUT	A5

TABLE III
CONNECTION BETWEEN ULTRASONIC SENSOR AND ARDUINO

Ultrasonic Sensor	Arduino
GND	GND
ECHO	A2
TRIG	A0
VCC	VCC

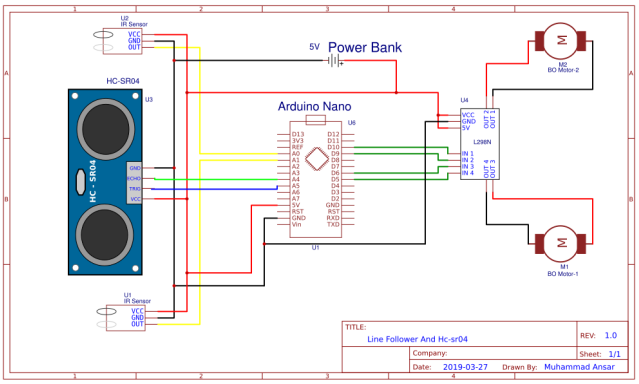

Fig. 11. Architecture

Continuous testing, calibration, and optimization would be required to achieve the more desired performance and outcomes.

we have tasted our robot number of times. And it runs accurately about 18 out of 20 times. It means that its accuracy is about 90 percent. Its reliability is also very impressive. We can relay on it in different conditions.

Its maximum delay on any command is 2 to 3 ms(miliseconds).

IX. CONCLUSION

Thus the line follower robot is successfully designed and implemented. The advanced version of these robot can be used in public transports and other means or public transit. These can be operated easily without any use of other devices such as smartphones, remote control, WiFi etc. This will run automatically with following a given line using Arduino microcontroller.

X. PHYSICAL PROTOTYPE

Physical prototype of our Robot is shown in the figure no. 12

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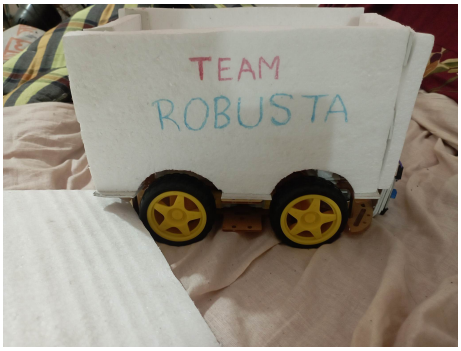

Fig. 12. Physical Prototype

[7] Chatgpt"http://chat.openai.com"

[8] Stackoverflow." http://www.stackoverflow.com"

[9] Chatgpt"http://chat.openai.com"

[10] Stackoverflow." http://www.stackoverflow.com"

[11] Chatgpt"http://chat.openai.com"