LINE FOLLOWING ROBOT USING ARDUINO SOFTWARE

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***Abstract*—This paper describes about line following robot is an autonomous vehicle that detects black line to move over the white surface or bright surface. In this Mini Project, the line following robot is constructed by using Arduino microcontroller as a main component and consists of one infrared (IR) sensor, one simple DC motor, three wheels and a PCB frame of robot chassis. The infrared sensors are used to sense the black line on white surface. When the infrared signal falls on the white surface, it gets reflected and it falls on the black surface, it is not reflected. In this system, two simple DC motor attached with two wheels is used to move the robot car's direction that is left, right and forward.**

***Keywords* – Arduino Uno, Black Path, IR sensors.**

I. INTRODUCTION -

A Robot is any machine which is completely automatic i.e. it starts on its own, decides its own way of work and stops on its own. In reality, it is a human replica created to lessen the stress on humans. It can be managed pneumatically, hydraulically, or with basic electrical controls. In the late 1950s and the beginning of the 1960s, George Devol and Joe Engelberger created the first industrial robot.

Stationary robots and moving robots. Robots having a mobile foundation that allow them to move around freely in the surroundings are called mobile robots. The Line Follower Robot is one of the more sophisticated mobile robots. It is essentially a robot that chooses its own course of action while following a predetermined trajectory.

II. Literature survey

This type of robot was originally created for industrial automation in the transportation sector. This type of robot is used in Amazon's warehouse management thanks to technological advancements. It is hardly unexpected that Amazon has introduced "SCOUT," a delivery robot that does home deliveries. Although it is not a robot that follows lines, it uses a similar mechanism. In Abu Dhabi (Masdar City), this transportation robot took on a new life. It was used to convey goods, but it was also a mode of personal transportation for people. Unfortunately, there hasn't been much advancement in the automation of restaurants and shopping malls. This essay seeks to suggest an autonomous robot for restaurants, shopping malls, and other places where moving products and delivering food are easy.

Sampat Kr. Ghosh et.al.,discussed about Rubbish management is a critical problem that needs to be handled due to the world's population of over seven billion people and the over two billion metric tonnes of waste it produces annually. All of this material needs to be managed to prevent an overflow at the neighborhood's trash cans, which could result in dangerous infections and contamination. In order to solve this issue, we suggest in this study a method for automatically gathering the waste using a line follower robot and disposing of it in the disposal site.

Yiran Wang et.al.,according to him An intelligent robot with automatic line patrol, positioning and parking, real-time range, colour recognition, and object block transmission capabilities is introduced in this study. The Arduino MCU controls the H bridge drive motor, enabling the intelligent automobile to perform steering, forward, and backward motions. The article describes the circuit test, hardware debugging, PCB designing, code enhancement, and overall structure design in the design process. The robot is able to carry out standard line patrol, parking, range, colour identification, and block delivery, it is concluded.

Haneen Abdulhussein Hadi et.al., discussed about We had to create a robot in the shape of a special bed to transport the patient because the Corona pandemic is spreading quickly throughout the world, there aren't enough medical personnel in hospitals to handle the growing number of terrifying cases, and we want to minimize contact between the medical personnel and those who are infected. The sickness cannot infect this robot. This robot's job is to travel along the lines that have been put on the hospital floor and move the patient from the ambulance to the stone room using an Arduino application.

Sourav Sutradhar et.al.,he discussed about This tutorial uses the MSP430G2ET controller, an industry standard controller with far more sophisticated libraries, to develop and implement an intelligent line follower.Using infrared sensors on a white surface with a highly contrasting colour, it locates a black line that the robot must follow. In contrast to a typical black line follower, this robot has an obstacle recognition capability that allows it to pause until the obstruction is removed from the black line, which is a predefined path for it. By doing this, it avoids being injured by the obstacle on the predefined path. In contrast to this, if any wireless protocol is utilized to stop upon finding an impediment, system efficiency suffers along with battery depletion.

D. Vijendra Babu, et.al.,discussed about The key component of mobile robot applications is navigation. There are several navigational aids available, varying in accuracy and complexity. A line follower robot is designed using a PID controller. Multiple sensors in an array find the black surface and move along the line. The Arduino Uno continually analyses the sensor signal and

controls the robot when a line is spotted. Ultrasonic sensor is used to identify obstacles. Robots that follow lines are useful in the military, burglar alarm systems, and other applications.

Mr. Sagat Shetty, et.al.,according to him A line-following robot is an automated machine with a predetermined path to follow. The use of IR sensors, LDR sensors, and other known techniques for commanding line-following robots are some examples. The goal of this research project is to create a robot that follows lines using image processing. A camera is used to capture a track image, which is subsequently transformed into a bitmap image. The predetermined path is followed using the least squares method. The robot's turning angle is calculated using the line's slope. Line following robot is therefore directed along desired path using image processing technique.

Hasan U. Zaman, et.al.,discussed about In this study, the design and execution of a robot that follows a line—specifically, a black line on a white surface—are described. There are two distinct modes for this line-following robot, including line-following mode and obstacle detecting mode. It is comparable to a self-driving robot car. While following its intended path on its pathway, this robot can detect impediments to the right, left, and in front of it. Overall, it can be claimed that the robot has the ability to move along a black line while sensing impediments from three directions. The development of the design using Arduino Uno requires knowledge of Arduino programming, the integration of electrical circuits with the planned code, as well as certain architectural and fundamental mechanical engineering expertise.

Deepak Punetha, et.al.,he discussed about The methods for assessing, creating, regulating, and upgrading the health care management system are described in this paper report. A line-following robot that carries medication has been created to provide the patient their medication whenever they need it. A robot that can recognize and follow a line drawn on the floor is called a line follower.The line typically has a predetermined route that can be seen as a black line on a white surface or as a highly contrasted colour.

Mehran Pakdaman, et.al.,discussed about A mobile device that can recognize and follow a line drawn on the floor is called a "line follower robot." The course is typically predetermined and either visible—like a black line on a white surface with a high contrasted color—or invisible—like a magnetic field. As a result, the Infrared Ray (IR) sensors that are positioned beneath the robot should be able to detect the line. The data is then sent to the processor via particular transition buses after that. Therefore, the processor will choose the appropriate orders, send them to the driver, and the line follower robot will then follow the path.

Regi Cahaya Ginting, et.al.,according to him The World Health Organization (WHO) has deemed the corona virus disease outbreak (COVID-19) a public health emergency because the virus has spread to numerous nations and areas. COVID-19, which was spread through direct contact with sick people, has claimed the lives of numerous victims. Residents must take action to stop further spread, lessen the effects of the outbreak, and support government initiatives to combat the Corona Virus. where implementing the COVID-19 health regimen is one of the government's programmes to combat the virus. The government's health regimen makes several key points, including maintaining a safe distance and maintaining the cleanliness of locations like homes, workplaces, schools, and others.

Huseyin Yildiz, et.al.,discussed about Robots that follow a line can follow a path on their own by applying feedback systems. Typically, the path is either a white line on a black surface or a black line on a white surface. Today, the medical, industrial, and automotive industries all use line-following robots. As a result, research into line-following robots has expanded recently. An effective, non-chattering sliding mode control (SMC) is created and used in this study for a line-following robot. With its installed infrared sensors, the mobile robot is made to detect a straight or curved path. Therefore, by turning on the motors on the right wheel or/and left wheel, these infrared sensors continuously stream the set path to steer or direct changes in the robot.

Alfian Ma'arif et.al.,according to him One of the well-liked robots frequently employed in schools is the line-following robot. Photoelectric sensors are the ones that robots utilise the most frequently. Along with the advancement of robotic vision and autonomous vehicles, it is irrelevant. Robotic vision refers to the ability of a robot to acquire information through image processing by a camera. The line-following robot's camera is designed to find lines in images and guide the machine along the course. The method of picture preprocessing and associated robot action for line-following robots were proposed in this paper. This involves using image preprocessing techniques including dilation, erosion, Gaussian filtering, contour search, and centerline definition on the image in order to find path lines and choose the appropriate robot action.

Alexia Toumpa et.al.,discussed about Robots that follow lines are becoming more and more common in both household and industrial settings. In these real-world settings, noisy or unreliable data produce nebulous results on the robot's position in relation to the path. This study introduces a finite state machine that can spot anomalies in measurements coming from a variety of reflectance sensors. The proposed variable-gain PD controller for line following and an open loop controller for managing exceptional scenarios are switched between by the FSM based on the projected state.

Ilknur Colak et.al.,he discussed about The design of a Line Following Robot, which is frequently employed to take kids around amusement centres in shopping malls, is discussed in this paper as a new commercial product in this industry. The robot can follow a black line that is 4.8 cm broad and 400 lb in weight at five different speeds. Line Following Mode and Service Mode are the two control modes available for the robot. In the Manual Mode, it may be manually manoeuvred forward, backward, left, and right free from the black lined path by a remote controller while in the Line-Following Mode it follows the path of the black line in a suitable ground. Two permanent magnet DC motors on the left and right sides of the robot are used to move it. Two H-Bridge circuits control the front and rear movement, as well as the left and right side motors. The batteries can be charged using either a DC supply from a solar panel or an AC feed from an outside source.

Surya Prakash. M et.al.,discussed about This research offered a method for industrial supply chains to be automated. A robot is used to symbolise the cars in an industrial manufacturing plant that has been designed as a multicoloured zone for demonstration purposes. Through the use of line-following algorithms and intelligent image processing, the robot can navigate inside the defined area. A laptop, a line follower, a USB camera, serial connectivity, node counting, and the transmission of navigation signals are the components employed.

S. G. M. Hossain et.al.,according to him Recently, industrial systems have leaned toward using every automation tool at their disposal in order to increase accuracy and improve time management. However, the construction of such complex systems is not always economical for the manufacturers in developing nations like Bangladesh. This concept was kept in mind when a low cost group of robotic guided vehicles were designed and constructed to execute logistics in a quasi-industrial setting. Two robotic vehicles that could transport certain cargo to a predetermined unloading place made comprised the group. In the lab, a fictitious industrial setting was set up, and the robots successfully completed a number of test runs to confirm their effectiveness and potential.
Suman Kumar Das et.al.,discussed about The improvement of material handling techniques in the engineering sectors over the past year has been greatly aided by the development of autonomous guided vehicles. The design and various methodologies of line follower automated guided vehicle (AGV) systems are the main topics of this study. An overview of line follower AGV technology is given in this study, along with current technological advancements. This paper describes the basic parts of a line follower robot and how they can be modified.
Nakib Hayat Chowdhury at.al.,he discussed about In this research, a method is shown that enables a line-following robot to autonomously follow a path with straight lines, curves, 90-degree bends, T-intersections, and + junctions with the least amount of sensors. Typically, a line follower robot achieves this capability via a matrix of sensors. This paper discusses the algorithm that a line follower can use to perform the same task with the fewest possible sensors in an array of sensors. Because the complexity of the robot can be reduced if we are able to reduce the number of sensors. Additionally, it lowers the expense. However, here, ensuring efficiency is the key challenge. As we all know, it is challenging for a line-following robot to detect and track grid intersections, 90-degree curves, and T-junctions.
Smit Mittal et.al.,discussed about Rapid progress is being made in the transition of medical robots from laboratory workbenches to patient bedsides. These are employed for modest services to diagnostic as well as therapeutic purposes thanks to technological improvements.A The robots are intended to reduce the need for human resources while simultaneously enhancing hospital services. An information-based decision-making system can come to a conclusion regarding the navigation path planning. The distribution of patients in the hospital determines it. These robots can be used in a variety of capacities. A few systems use ultrasonic sensors, sensors, or appearance-based approaches. A few systems used IR sensors to find their routes. In this essay, we contrast these robots and suggest a brand-new medical robot that utilises an IR sensor.
Santhosh Kumar et.al.,according to him In this paper, new developments in patient monitoring are proposed. The healthcare programme has placed a strong emphasis on the continuous monitoring of patient health metrics like body temperature and pulse using a web server so that a doctor can check on the patient's condition on his cell phone while online. If any sensor value reaches a fundamental abnormal value, the doctor can get the data whenever needed from any location without having to be physically there.

III. Materials Used

1. Arduino UNO
2. Motor Driver module L293D
3. DC Motors.
4. Robot Chassis
5. IR Sensor Module
6. Insulation Tape
7. 9v battery
8. Battery Caps

IV. Working Principle

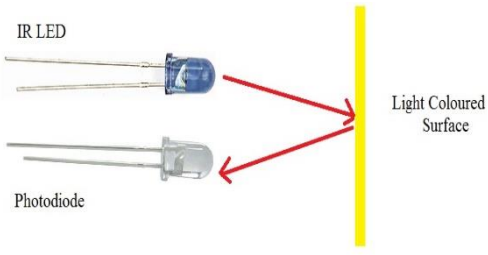

Fig.1.a IR sensors Reflection on colored surface.

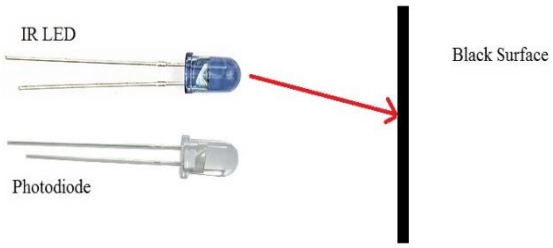

Fig.1.a IR sensors Reflection on black surface.

The concept of working of line follower is related to light. We use here the behavior of light at the black and white surfaces. When light falls on a white surface it is almost fully reflected and in the case of a black surface light is completely absorbed. This behavior of light is used in building a line follower robot.
In this line follower robot, we use IR transmitters and receivers (photodiodes). They are used to send and receive the lights. When IR rays fall on a white surface, it is reflected towards IR receiver as shown in fig .1a to generating some voltage changes.
When IR rays fall on a black surface, it is absorbed by the black surface as shown in fig.1b and no rays are reflected; thus, the IR receiver doesn't receive any rays. In this project, when the IR sensor senses a white surface, an Arduino gets 1 (HIGH) as input, and when it senses a black line, an Arduino gets 0 (LOW) as input. Based on these inputs, an Arduino Uno provides the proper output to control the bot.

V. Fabrication

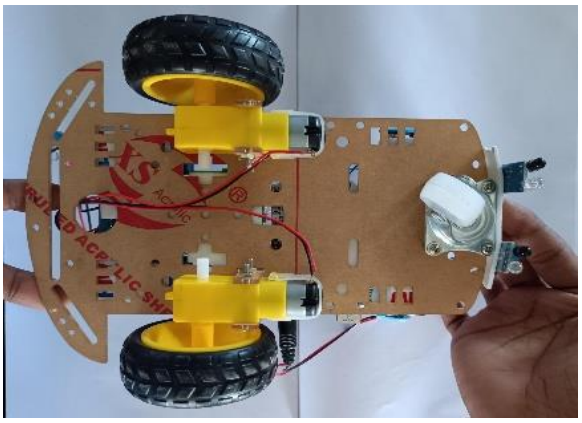

Fig.2a Before Assemble

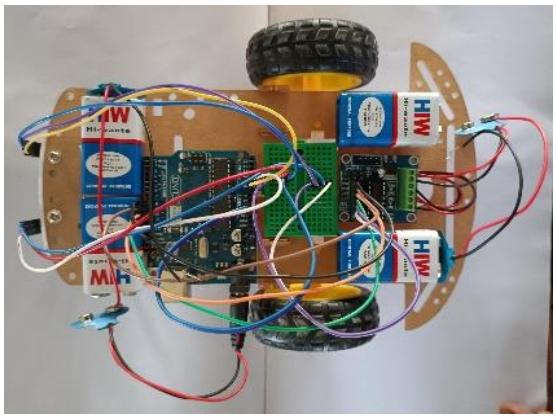

Fig.2b After Assemble

- In this project we make a line following robot , first we arranged the 2 motors and inner wheel on the one side (bottom) of the chassis board by using the screws and the connectors as shown in fig.2a
- And on the other side (Top) of the chassis board placed the L293D motor driver , Arduino Uno microcontroller, Breadboard, switch, and batteries -12v(2no's) by using the double sided tape as shown in fig.2b
- In front of the chassis (at the inner wheel side) Ir sensors (2no's) are placed .Distance between the 2 sensors is depends on tape width.
- And then given the circuit connection to the motor driver and Arduino Uno by using the jumper wires.
- And then motor cables and battery cables are connected into motor driver and the IR sensor cables are connected into the Arduino Uno.
- And totally switch is connected to the battery and motor driver for control the power to the robot.
- The whole circuit connection is as shown in fig.2c

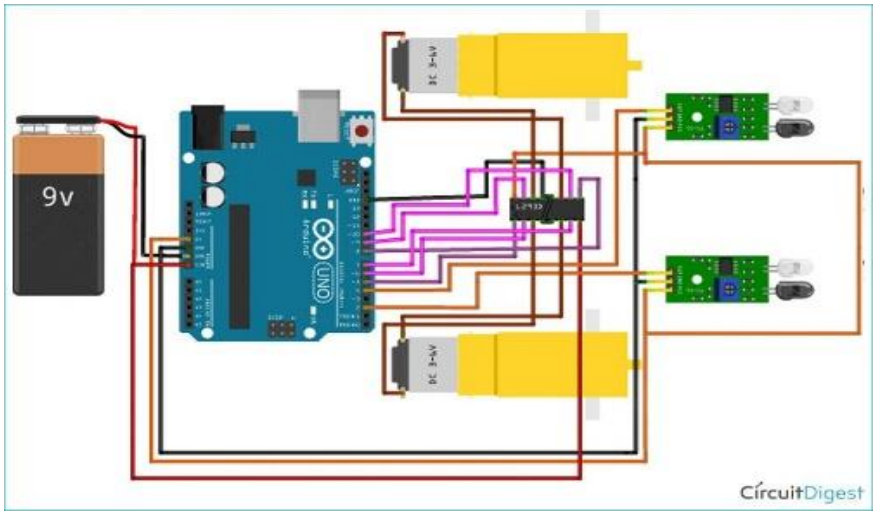

Fig.2c Circuit diagram

VI. Working of Robot

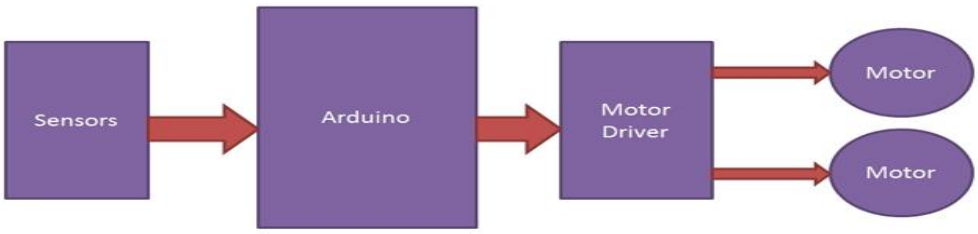

Fig.3 Working of Robot Flow chart

The line follower robot senses a black line by using a sensor and then it sends the signal to Arduino Uno. Then Arduino sends the signals to motor driver according to sensors output. Motor driver drives the two motors according to the Arduino Unosignals as shown in fig.3. Motor shafts are connected with wheels hence wheels are rotated. By this process robot car can drives forwards direction and takes turns also.

A. Forward Direction

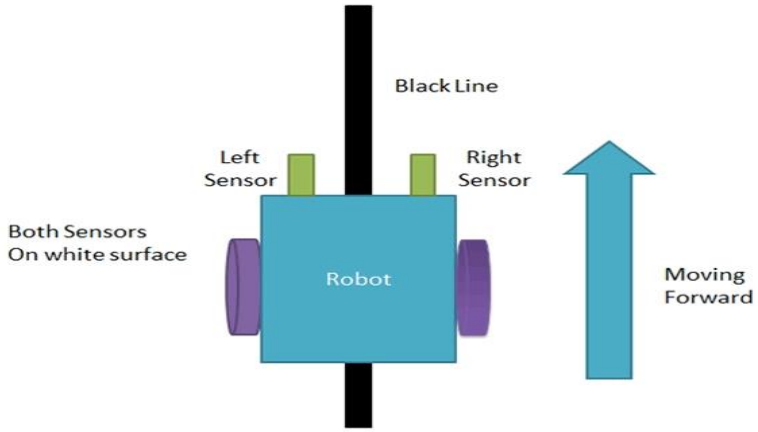

Fig.3a Forward movement

The two IR sensor modules namely the left sensor and the right sensor. When both the sensors are on a white surface and the line is between the two sensors, the robot should move forward, i.e., both the motors should rotate such that the robot moves in forward direction as shown in fig.3a.

B. Left Turn

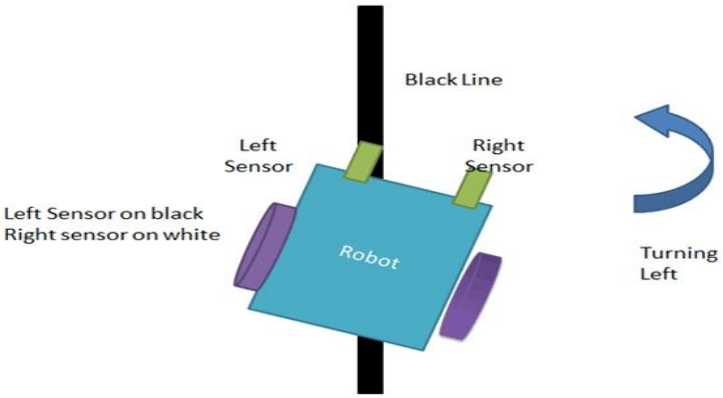

Fig.3b Left movement

In this case, the left sensor is on top of the dark line, whereas the right sensor is on the white part, hence the left sensor detects the black line and gives a signal, to the microcontroller. Since, signal comes from the left sensor, the robot should turn to the left direction. Therefore, the left motor rotates backwards and the right motor rotates in forward direction. Thus, the robot turns towards left side as shown in fig.3b.

C. Right Turn

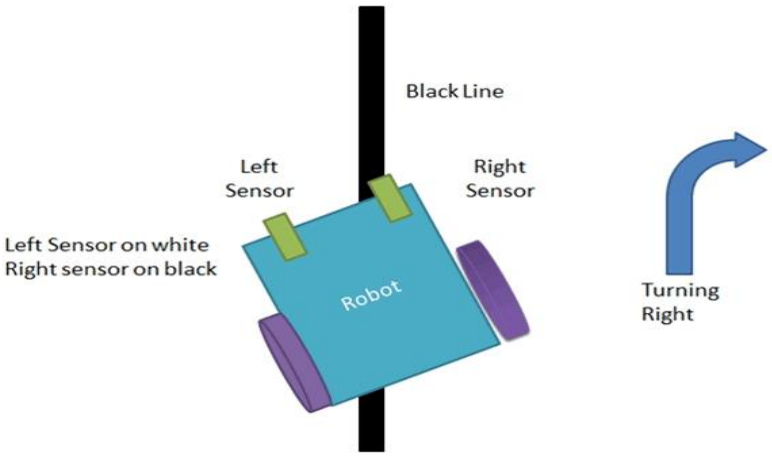

Fig.3c Right movement

This case is similar to the left case, but in this situation only the right sensor detects the line which means that the robot should turn in the right direction as shown in fig.3c To turn the robot towards the right direction, the left motor rotates forward and the right motor rotates backwards and as a result, the robot turns towards the right direction.

D. Stopping the Robot

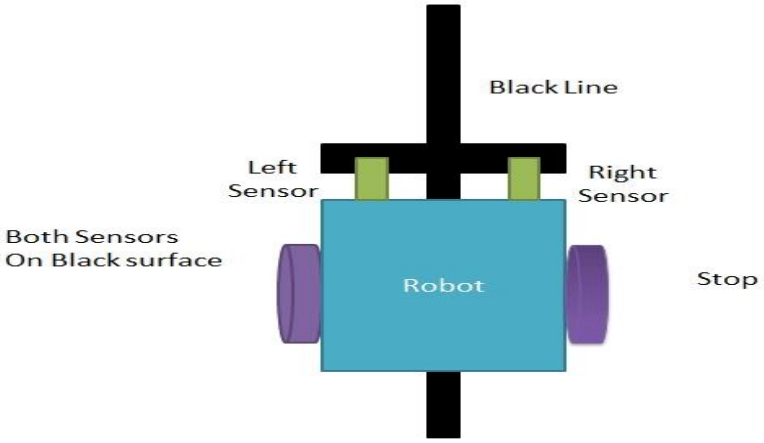

Fig.3d Stopping of Robot

In this case, both the sensors are on top of the line and they can detect the black line simultaneously, the microcontroller is fed to consider this situation as a process for halt. Hence, both the motors are stopped, which causes the robot to stop moving as shown in fig.3d.

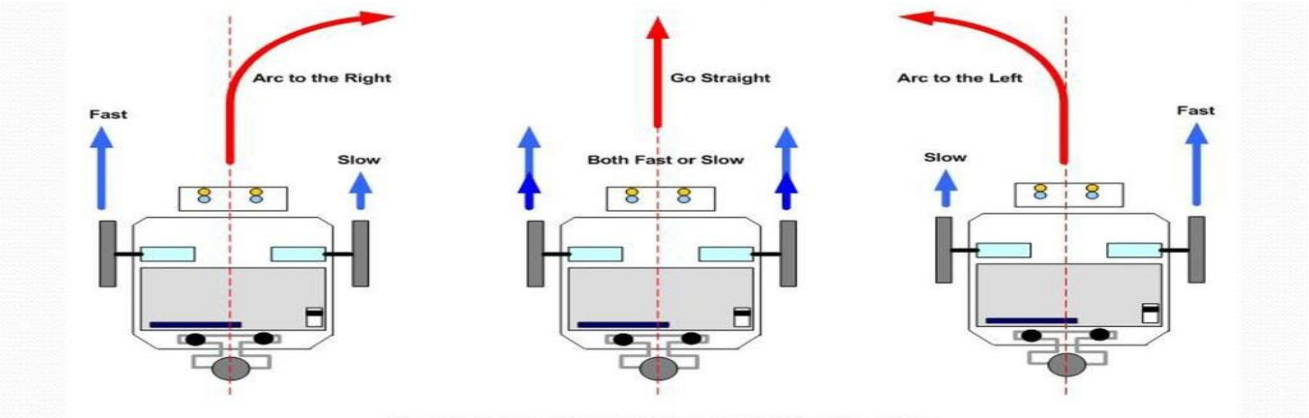

Fig.4 Line Follower Robot Differential Drive Steering

These are the four conditions of the line following robot that we read by using Arduino. We have used two sensors namely the left sensor and the right sensor as shown in fig.4 and table .1

Table.1 Motor Logic

Left IR Sensor	Right IR Sensor	Motion
1	1	Forward
1	0	Right
0	1	Left
0	0	Reverse

VII. Estimation of cost

Table. 2 Components

S.No	Name Of Material	Cost
1	Arduino Uno	1200
2	IR Sensors	180
3	Chassis board and tyres	180
4	Tiny Bread Board	100
5	Motor Driver	80
6	Batteries and caps	60
7	Jumper wires & cables	60

VIII. Experimental Setup

We conducted an experiment in which the robot was set up along the path (forward and curved) we created, and we tracked the amount of time it took for the robot to travel the predetermined distance.
For better understanding the working of this robot consider the following cases:

CASE 1: Straight path

Table. 3 Time taken for straight path with respect to distance

S.No	Distance	Time Requried
1	1.2m	18sec
2	2.4m	36sec
3	3.6m	54sec

CASE 2: Curved Path

Table. 4 Time taken for Curved Path with respect to distance

S.No	Distance coverd	Time required
1	1.2m	24sec
2	2.4m	32sec
3	3.6m	41sec

IX. Results and Discussions

This chapter describes about the Results and Discussion that are involved in LINE FOLLOWING ROBOT USING ARDUINO SOFTWARE.
By comparing the experiment's results with those of a typical robot, we can see that my project took longer to finish the path since we only employed a tiny amount of power, or 9 volts of battery power and the graph is drawn between our robot and standard robot as shown in fig.5

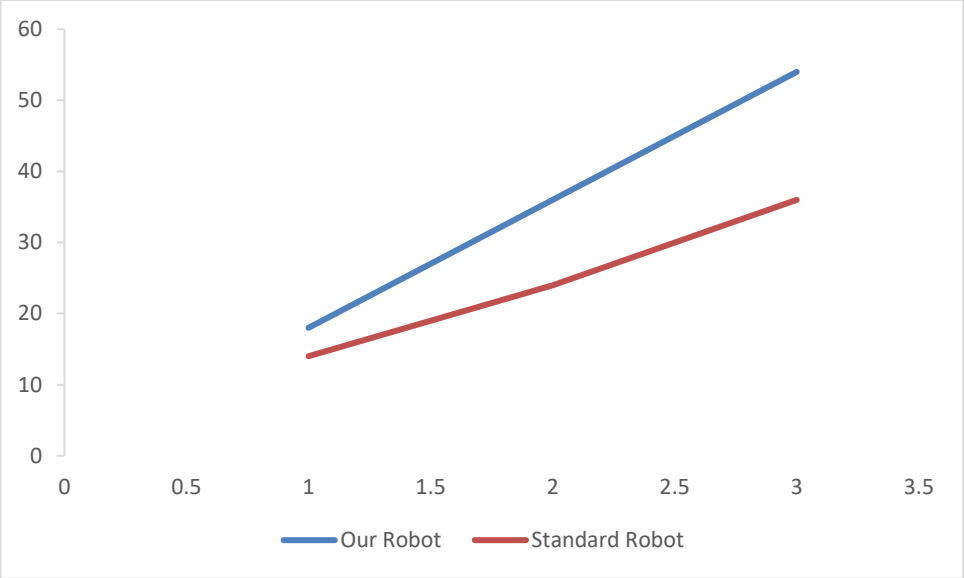

Fig.5 Graph representation of path following robot compared to ordinary robot.
X-Axis:-Time
Y-Axis:-Distance

X. CONCLUSION

These types of Robots are used in Industries as AGV's and the application of these type of robots are not to be limited for Industries but also should be used in other technical field also.

We observe that the robot is travel in straight direction and takes turns it takes more time to cover the whole path it is caused by the sensors continuously transmits the signals to Arduino. It causes the robot car is slows if we arrange the advanced sensors in place of it makes the robot more reliable

From the following experimentation it is observed that during the curves the robot is taking more time than when it is moving in the straight path this is due to the time taken by the sensor while turning in the curves. So, this can be reduced by using advanced sensors that can limit the time of receiving signals.

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