VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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A PROJECT REPORT
ON

"Design and Fabrication of Novel Multipurpose Robot "

Project report submitted in partial fulfillment of the requirement for the award of the degree of

BACHELOR OF ENGINEERING
IN
MECHANICAL ENGINEERING

Submitted by

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2019-20

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CERTIFICATE

It is certified that the Project work entitled **"Design and Fabrication of Novel Multipurpose Robot"** carried out by **ABHISHEK KUMAR (1NH18ME006), AKSHAY KUMAR (1NH18ME015), AMITOJ SINGH SETHI (1NH18ME017), ANUBHAV GUPTA (1NH18ME018),** the bonafide students of **New Horizon College of Engineering, Bengaluru**, in partial fulfillment for the award of **Bachelor of Engineering in Mechanical Engineering** of the **Visvesvaraya Technological University, Belagavi** during the year **2019-2020**. It is further certified that all corrections/suggestions indicated for internal assessment has been incorporated in the report deposited in the department library. The Project has been approved as it satisfies the academic requirements in respect of Project Work prescribed for the **Bachelor of Engineering** degree.

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Abstract

Sensor Guided Robotics (commonly known as autonomous robotics) comprises of robots which function depending on inputs from sensors and are controlled with the help of microcontrollers. To allow a faster deployment of industrial robots and therefore to enable an economic deployment, more intelligent robot movements are required. In this project we present a generalized concept of sensor integration into the robot motion control. As part of this project, two different basic autonomous robots which are guided using sensors will be designed. The first robot will be a line follower which is programmed to follow a line. This robot detects the path using infra-red sensors which work on the principle of reflection of light. Using similar kind of sensors, robots that can avoid obstacles can be developed.

This paper presents the implementation of a Line Following Robot together with an Obstacle Avoiding Robot. Line Following is one of the most important aspects of robotics. A Line Following Robot is an autonomous robot which is able to follow either a black line that is drawn on the surface consisting of a contrasting color. It is designed to move automatically and follow the line. The robot uses arrays of IR sensors to identify the line, thus assisting the robot to stay on the track. The array of two sensor makes its movement precise and flexible. The robot is driven by DC gear motors to control the movement of the wheels. The Arduino Uno interface is used to perform and implement algorithms to control the speed of the motors, steering the robot to travel along the line smoothly.

Obstacle avoiding robot was designed, constructed and programmed which may be potentially used for educational and research purposes. The developed robot will move in a particular direction once the infrared (IR) sense a signal while avoiding the obstacles in its path. The robot can also perform desired tasks in unstructured environments without continuous human guidance. The hardware was integrated in one application board as embedded system design. The main objective of this project is to provide simple guidelines to the engineering students and beginners who are interested in this type of research.

This project aims to implement the algorithm and control the movement of the robot and thus achieve better performance. It can be used industrial automated equipment carriers, small household applications, tour guides in museums and other similar applications, etc.

Acknowledgement

We thank the Lord Almighty for showering His blessings on us.

It is indeed a great pleasure to recall the people who have helped us in carrying out this project. Naming all the people who have helped us in achieving this goal would be impossible, yet we attempt to thank a selected few who have helped us in diverse ways.

We wish to express our sincere gratitude to Dr. Manjunatha, Principal, NHCE, Bangalore, for providing us with facilities to carry out this project.

We wish to express our sincere gratitude to Dr. M S Ganesha Prasad Dean, Prof. & HoD-Mechanical Engineering., for his constant encouragement and cooperation.

We wish to express our sincere gratitude to our teacher and guide Mr. Sujeeth Swami, Assistant Professor in the Department of Mechanical Engineering., NHCE, for his valuable suggestions, guidance, care & attention shown during the planning, conduction stages of this project work.

We express our sincere thanks to project coordinators, all the staff members and non-teaching staff of Department of Mechanical Engineering., for the kind cooperation extended by them.

We thank our parents for their support and encouragement throughout the course of our studies.

Contents

CHAPTER-1
INTRODUCTION

Introduction

These days Robotics has become part of today's communication & communication in return is a part of technological advancement, so we have decided to work in the field of ROBOTICS, and design something which can make human life easier.

As technology becomes increasingly important in today's world, it is invaluable to not only learn how to use technology, but also to understand how to create it. Since being the engineer one should have sound knowledge of the other discipline. Most of the projects have limited scope to only specific discipline .This would limit ones innovation and creativity. This project inspires to make connections across several disciplines rather than learning topics in isolation as it combines mechanical, electronic, electrical and programming skills.

The robot designed in a such way that it not only track the path and follow it but also detect the obstacles it encounters in its path towards its operation goal.

Line follower is a machine that can follow a path. The path can be visible like a black line on a white surface. Sensing a line and maneuvering the robot to stay on course, while constantly correcting wrong moves using feedback from the sensor forms a simple yet effective system. It can be used in automobile, industrial automations, guidance, etc.

Obstacle avoiding robot was designed, constructed and programmed to develop the robot to move in a particular direction once the infrared (IR) sensors sense a signal while avoiding the obstacles in its path. The robot can also perform desired tasks in unstructured environments without continuous human guidance.

The objectives of the project are:

- The robot must be capable of following a line.
- It should be capable of detecting obstacles it encounters in its path.
- The robot must be insensitive to environmental factors such as lighting and noise.
- It must allow calibration of the line's darkness threshold.
- Scalability must be a primary concern in the design.

Due to the reliability, accessibility and cost effectiveness of using mobile robot in industry and technical applications, this next generation sensor guided robot is very important on factory floor. In the industry carriers are required to carry products from one manufacturing plant to another which are usually in different buildings or separate

blocks. Conventionally, carts or trucks were used with human drivers. Unreliability and inefficiency in this part of the assembly line formed the weakest link. The project is to automate this sector, using carts to follow a line instead of laying railway tracks which are both costly and an inconvenience and to detect any obstacles in its path.

The application of the project is range from the individual domestic appliance to automation and control aspect of large industry. Human are intelligent natural machine but it has serious limitation of efficiency and reliability. Robots are made to replace dependency of human force partially. The project is somehow designed to perform the similar task.

CHAPTER-2

LITERATURE SURVEY

Literature Survey

- **2.1 [1] S.H.Sushmitha, Uma Priyadarsini P.S :- Design And Implementation Of a Sensor Guided Pick And Place Robot (2018)**
  To allow a faster deployment of industrial robots and therefore to enable an economic deployment, more intelligent robot movements are required. In this project a generalized concept of sensor integration into the robot motion control. As part of this project, three different basic autonomous robots which are guided using sensors are designed. The first robot is a line follower which is programmed to follow a line. This robot detects the path using infra-red sensors which work on the principle of reflection of light. Using similar kind of sensors, robots that can either follow or avoid obstacles can be developed.

- **2.2 [2] Hossain MI, Islam SMR, Rahman MM and Quamrul Hasan :- A Novel Design for the Autonomous Line Follower Robot Using Microcontroller (2017)**
  The following paper proposes a new model for line follower robots built using a single microcontroller and this new model is not in existence before. This new proposed model uses IR sensors to enable the robot to be able to detect its path in the real time operation time, reasonably faster compared to line follower robots of similar types, operational model build with available components on the market and most importantly very economic considering making cost.

- **2.3 [3] Abhijit Pathak, Refat Khan Pathan, Amaz Uddin Tutul, Nishat Tahsin Tousi, Afsari Sultana Rubaba, Nahida Yeasmin Bithi :- Line Follower Robot for Industrial Manufacturing Process (2017)**
  Line follower robot is autonomous that means it automatically follows a line which is pre-defined. Line follower robot can be used in many industrial purposes. It can be used in carrying heavy and risky products. In this paper, the authors explained about the robot design, implementation, coding and testing.

- **2.4 [4] R Ismail, Z Omar, S Suaibun :- Obstacle-avoiding robot with IR and PIR motion sensors (2016)**
  The developed robot will move in a particular direction once the infrared (IR) and the PIR passive infrared (PIR) sensors sense a signal while avoiding the obstacles in its path. The robot can also perform desired tasks in unstructured environments without continuous human guidance. Due to the reliability, accessibility and cost effectiveness of using mobile robot in industry and

technical applications, the obstacle avoiding robots are very important on factory floor.

- **2.5 [5] Ebiesuwa O.O , Adekunle Y.A , Akinyemi L.A , Oyerinde O.D :- Line Follower Robot Using A Sophisticated Sensor Approach (2013)**
  All existing models of the line follower robot have had the limitation of speed in detecting their path and executing tasks due to their design. In this paper, the problem of the speed with which the line follower robot detects its path has been addressed with the introduction of sophisticated sensors which enable the line follower robot detect its path in the shortest possible time after the order of nanoseconds and this speed outpaces that of all the other existing line follower robots.

CHAPTER-3

LITERATURE SUMMARY

Literature Summary

The novel multipurpose robot is automobile system that has ability to recognize its path, move and change the robot's position toward the line in the best way to remain in track.

This project report presents a photodiode sensor based multipurpose robot design of 200gm weigh which always directs along the black line on white surface and also detects the obstacle in its path.

The developed robot platform was not designed for specific task but as a general wheeled autonomous platform. It can therefore be used for educational, research or industrial implementation. Students can use it to learn the microcontroller programming using Arduino Uno 1.6.5 compiler, IR sensors characteristics, motor driving circuit and signal condition circuit design. Research on sensor guided robot at the bachelor level can help students to develop communication, technical skills and teamwork. The design of such robot is very flexible and various methods can be adapted for another implementation.

The novel multipurpose robot project challenged the group to cooperate, communicate, and expand understanding of electronics, mechanical systems, and their integration with programming. The successful completion of every task demonstrated the potential of mechatronic systems and a positive group dynamic.

CHAPTER-4

METHODOLOGY

Methodology

4.1 Existing System

In simple robot, steering algorithm is used for robotic actions in which driver or a human being is controlling the robot using remote. Here driver is present, who can see the obstacle and navigate robot accordingly. While this proposal process creates robots that are respectable at resolving the problem, they are luxurious, time overwhelming to create and do not incline to be very malleable. Typical resolutions practice models of the atmosphere and the robot in mandatory to achieve the anticipated task. These representations necessitate precise evidence about the format of the robot and the atmosphere and thus entail substantial dealing out resources to preserve these models. The foremost source of the expenditure of these robots is the sensors and supercomputers mandatory to apprise these models. The price of the additional resources to build the robots is not as noteworthy.

4.2 Proposed System

The proposed model will be in no need of remote to control the vehicle but will purely depend on the internal coding that is set up in the robot to detect obstacle and to avoid it in the moving path. In this paper, we design a project to avoid the obstacle and detection and also maneuver by following a line . If any obstacle is on the path then the ultrasonic sensors detect the obstacle and the robot will flow off the obstacle on one side. If obstacle is on the side of the robot then the speed of the robot is increased and it will travel quick in that path before the obstacle hit the robot. By doing so we can easily safeguard the robot as well as we can avoid the obstacle. This will used in industry for goods carrying.

4.3 Architecture

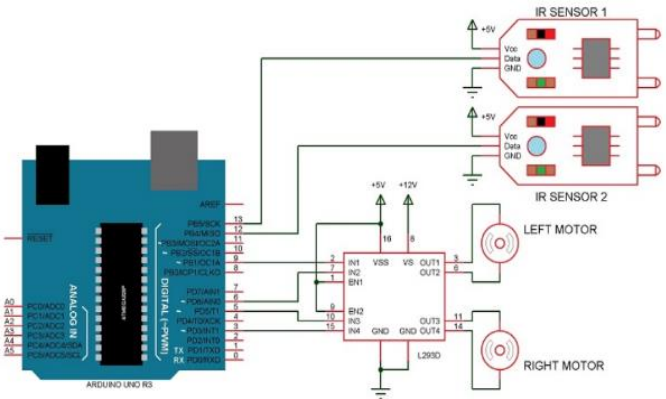

Fig.1 Architecture diagram

The line follower is a self-operating robot that detects and follows a line that is drawn on the floor .The line follower robot using Arduino is a self-operating system that detects and follows track drawn on the floor. The track consists of a black path drawn on white surface.

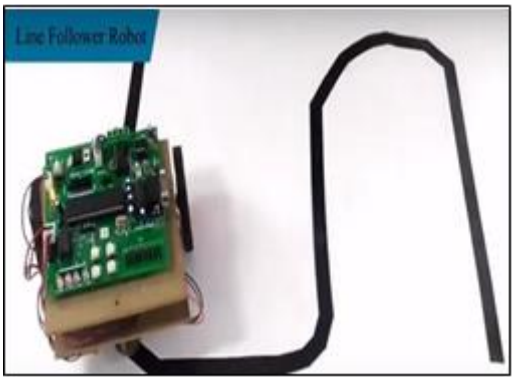

Fig.2 Line Following Robot

An obstacle avoiding robot, in other terms known as a photophobic robot is an intellectual robot planned and encoded in such an approach that it eludes collision. The robot fundamentally moves in a forward way and every time it notices obstacle in its path it takes a diversion and dodges the collision.

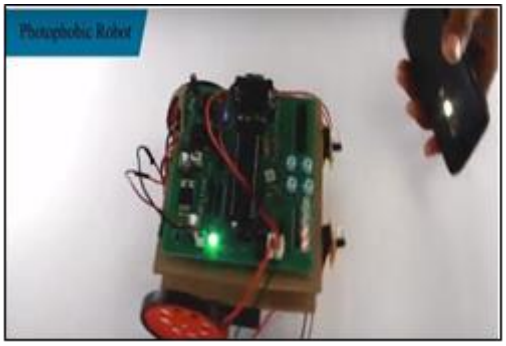

Fig.3 Obstacle Avoider Robot

4.4 Hardware Components

4.4.1 Arduino Uno

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.[1] The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 12 volts.

Fig.4 Arduino Uno

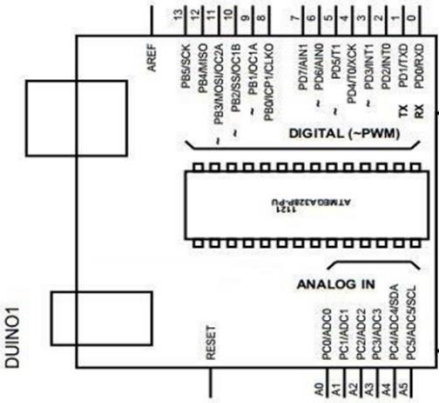

Fig.5 Arduino Uno Schematic

General Pin Functions Of Arduino

LED: There is a built-in LED driven by digital pin 13. When the pin is high value, the LED is on, when the pin is low, it is off.

VIN: The input voltage to the Arduino board when it is using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

5V: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.

3V3: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.

GND: Ground pins.

IOREF: This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source, or enable voltage translators on the outputs to work with the 5V or 3.3V.

Reset: Typically used to add a reset button to shields that block the one on the board.

4.4.2 L293D Motor Driver IC

Motor driver is a current enhancing device; it can also be act as Switching Device. Thus, after inserting motor driver among the motor and microcontroller.

Motor driver taking the input signals from microcontroller and generate corresponding output for motor.

L293D is a motor driver IC that can drive two motor simultaneously. Supply voltage (Vss) is the voltage at which motor drive. Generally, 6V for dc motor and 6 to 12V for gear motor are used, depending upon the rating of the motor. Logical Supply Voltage deciding what value of input voltage should be considered as high or low. So if the logical supply voltage equals to +5V, then -0.3V to 1.5V will be considered as Input low voltage and 2.3V to 5V is taken into consider as Input High Voltage. The Enable 1 and Enable 2 are the input pin for the PWM led speed control for the motor L293D has 2 Channels .One channel is used for one motor.

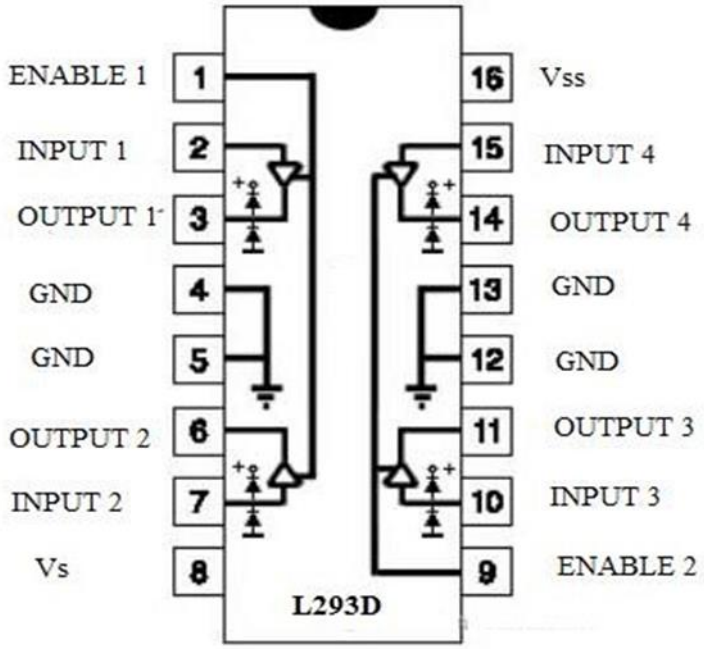

Fig.6 Pin Configuration IC293D

4.4.3 Digital IR Sensors

Infrared Obstacle Sensor Module has built in IR transmitter and IR receiver that sends out IR energy and looks for reflected IR energy to detect presence of any obstacle in front of the sensor module. The sensor has very good and stable response even in ambient light or in complete darkness. Accuracy with low cost is the constraint of this research, hence the IR sensor was selected for the design

Specifications

- Operating Voltage: 3.0V – 5.0V.
- Detection range: 2cm – 30cm (Adjustable using potentiometer).
- Current Consumption : at 3.3V : ~23 mA ,at 5.0V: ~43 mA.
- Active output level: Outputs Low logic level when obstacle is detected.
- On board Obstacle Detection LED indicator.

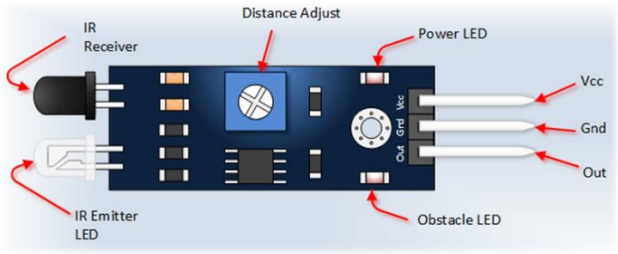

Fig.7 Digital IR Sensor

Working Principle of IR Obstacle Sensor

An IR sensor consists of an IR LED and an IR Photodiode; together they are called as Photo–Coupler or Opto-Coupler. As said before , the Infrared Obstacle Sensor has built in IR transmitter and IR receiver. Infrared Transmitter is a light emitting diode (LED) which emits infrared radiations. Hence, they are called IR LED's. Even though an IR LED looks like a normal LED, the radiation emitted by it is invisible to the human eye. Infrared receivers are also called as infrared sensors as they detect the radiation from an IR transmitter. IR receivers come in the form of photodiodes and phototransistors. Infrared Photodiodes are different from normal photo diodes as they detect only infrared radiation. When the IR transmitter emits radiation, it reaches the object and some of the radiation reflects back to the IR receiver. Based on the intensity of the reception by the IR receiver, the output of the sensor is defined.

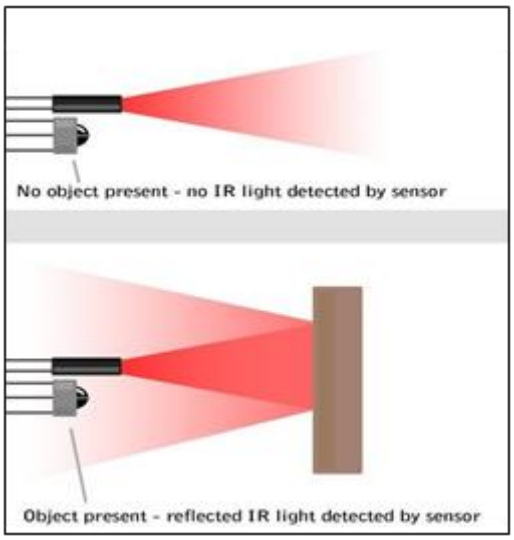

Fig.8 IR Sensor Working Principle

4.4.4 DC Motors

Motor is a device that converts any form of energy into mechanical energy or imparts motion. In constructing a robot, motor usually plays an important role by giving movement to the robot. In general, motor operating with the effect of conductor with current and the permanent magnetic field. The conductor with current usually producing magnetic field that will react with the magnetic field

produces by the permanent magnet to make the motor rotate. There are generally three basic types of motor, DC motor, even servomotor and stepper motor, which are always being used in building a robot.

DC motors are most easy for controlling. One DC motor has two signals for its operation. Reversing the polarity of the power supply across it can change the direction required. Speed can be varied by varying the voltage across motor.

Fig.9 DC Motor

4.4.5 Breadboard

A breadboard is a construction base for prototyping of electronics. Because the solderless breadboard does not require soldering, it is reusable. This makes it easy to use for creating temporary prototypes and experimenting with circuit design. For this reason, solderless breadboards are also popular with students and in technological education.

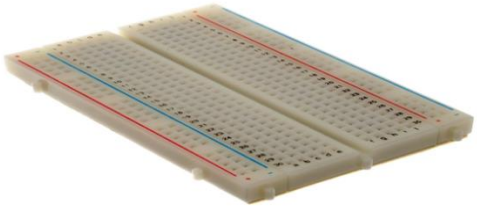

Fig.10 Breadboard

4.4.6 M3 Screws and Nuts

60mm-M3,45mm-M3,30mm-M3 and 6mm-M3 screws are used in sensor guided robot for supporting and fixing the parts. M3-NUT is used for tightening the M3-SCREW used in the model , so that the parts used in the model shall be fixed in the desired place while the model being in the working position.

Fig.11 M3 Screws

Fig.12 M3 Nuts

4.4.7 Wheels

These wheels give optimized design for your application or robot.

Caster for general robotic application .The Ball diameter is 11 mm. Use this as support wheel which does not require any control. This is light weight ball castor.

Fig.13 Wheel for Motors

Fig.14 Castor Wheel

4.4.8 Connecting Wires

To make all the required connections. These include Male to Female Single Pin Connector, Female to Female Single Pin Connector, Male to Male Single Pin Connector, Barrel Connector, Arduino USB Cable.

Fig.15 Connecting Wires

4.5 Working

4.5.1 Working of Arduino Line Follower Robot

In this project, we have designed an Arduino based Line Follower Robot. The working of the project is pretty simple: detect the black line on the surface and move along that line. The detailed working is explained here.

As mentioned in the block diagram, we need sensors to detect the line. For line detection logic, we used two IR Sensors, which consists of IR LED and Photodiode. They are placed in a reflective way i.e. side – by – side so that whenever they come in to proximity of a reflective surface, the light emitted by IR LED will be detected by Photo diode.

The following image shows the working of a typical IR Sensor (IR LED – Photodiode pair) in front of a light colored surface and a black surface. As the reflectance of the

light colored surface is high, the infrared light emitted by IR LED will be maximum reflected and will be detected by the Photodiode.

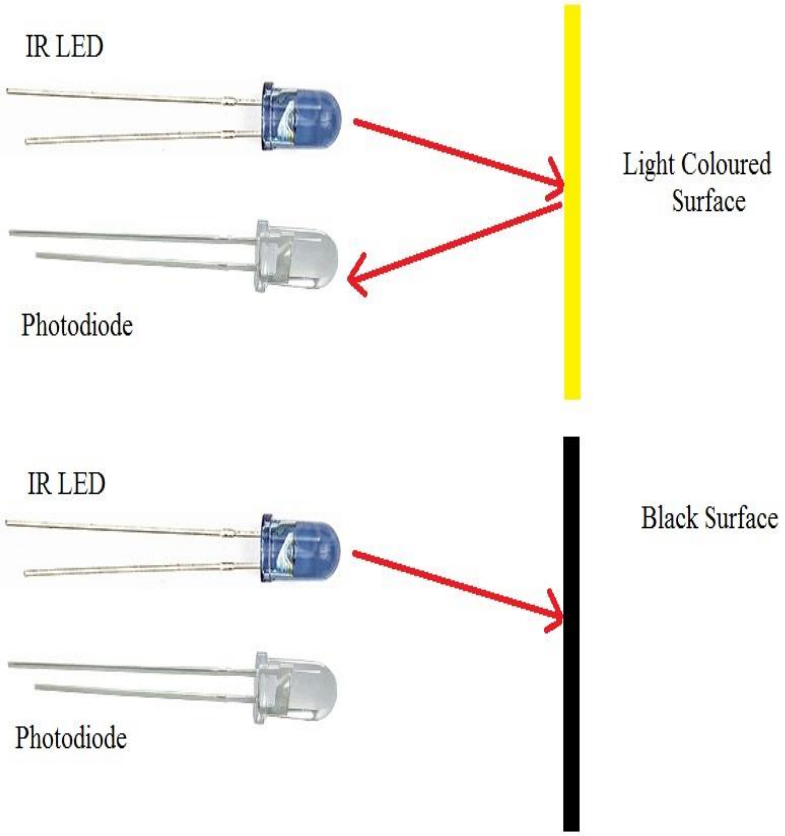

Fig.16 a typical IR Sensor (IR LED – Photodiode pair) in front of a light colored surface and a black surface.

In case of black surface, which has a low reflectance, the light gets completely absorbed by the black surface and doesn't reach the photodiode.

Using the same principle, we will setup the IR Sensors on the Line Follower Robot such that the two IR Sensors are on the either side of the black line on the floor. The setup is shown below.

Fig.17 Setup of Black Line on White Surface

When the robot moves forward, both the sensors wait for the line to be detected. For example, if the IR Sensor 1 in the above image detects the black line, it means that there is a right curve (or turn) ahead.
Arduino UNO detects this change and sends signal to motor driver accordingly. In order to turn right, the motor on the right side of the robot is slowed down using PWM, while the motor on the left side is run at normal speed.

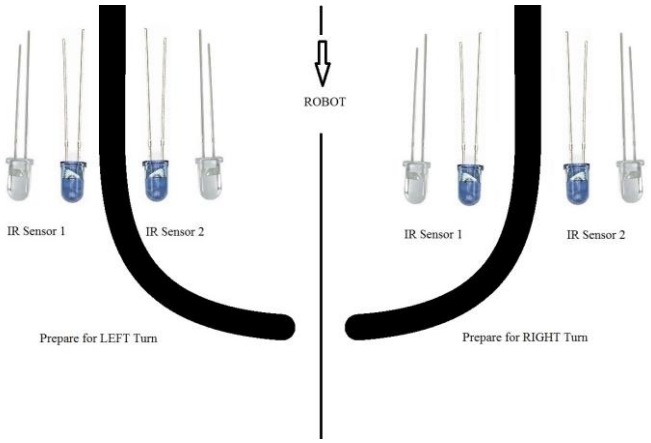

Fig.18 Setup

Similarly, when the IR Sensor 2 detects the black line first, it means that there is a left curve ahead and the robot has to turn left. For the robot to turn left, the motor on the left side of the robot is slowed down (or can be stopped completely or can be rotated in opposite direction) and the motor on the right side is run at normal speed.
Arduino UNO continuously monitors the data from both the sensors and turns the robot as per the line detected by them.

Programming and Simulation

The program code acts as the decision-maker embedded in the micro-controller deciding about the outputs for particular set of inputs. The program is coded using Arduino® 1.65.and is then compiled to form a ".hex" file which can then be burnt into the Arduino. The output is also checked in simulation using Proteus® .

4.5.2 Working of Obstacle Avoiding Robot using Arduino

The aim of this project is to implement an obstacle avoiding robot using infrared sensor and Arduino. All the connections are made as per the circuit diagram. The working of the project is explained below.
When the robot is powered on, both the motors of the robot will run normally and the robot moves forward. During this time, the infrared sensor continuously calculate the distance between the robot and the reflective surface.
This information is processed by the Arduino. If the distance between the robot and the obstacle is less than 15cm, the Robot stops and scans in left and right directions for new distance using Infrared Sensor. If the distance towards the left side is more than that of

the right side, the robot will prepare for a left turn. But first, it backs up a little bit and then activates the Left Wheel Motor in reversed in direction.
Similarly, if the right distance is more than that of the left distance, the Robot prepares right rotation. This process continues forever and the robot keeps on moving without hitting any obstacle.

Programming and Simulation

The software is written using Arduino Integrated Development Environment or Arduino Software (IDE). It contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them. Once the compile file (Hex code) is obtained, it can be downloaded into microcontroller.

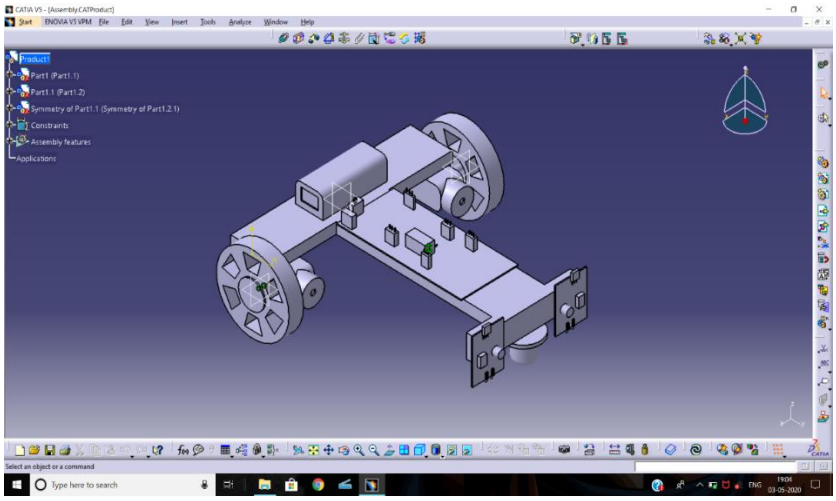

Fig.19 Isometric View of 3-D Model

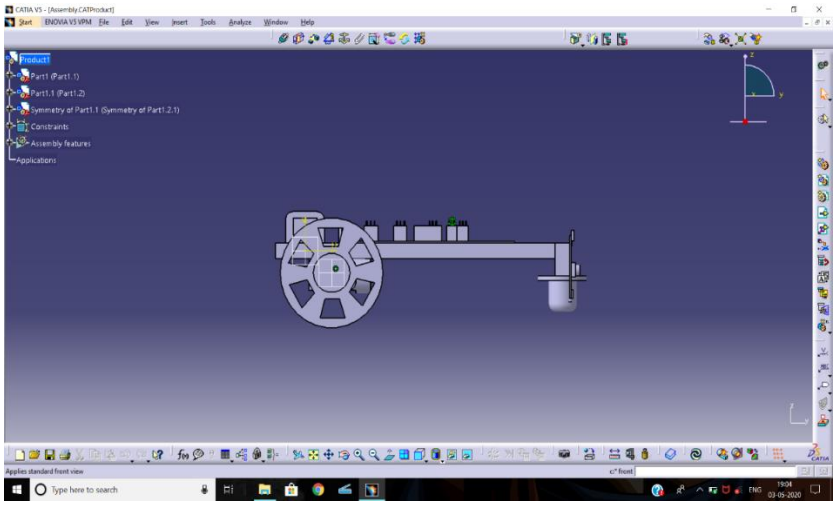

Fig.20 Side View of 3-D Model

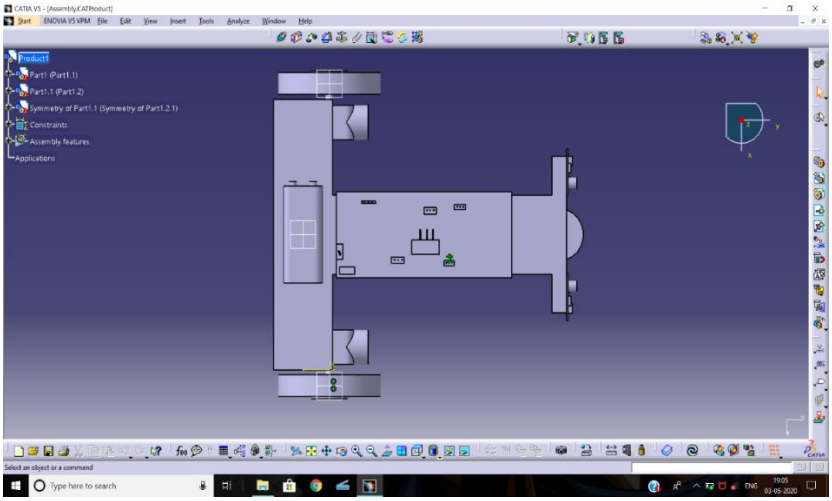

Fig.21 Top View of 3-D Model

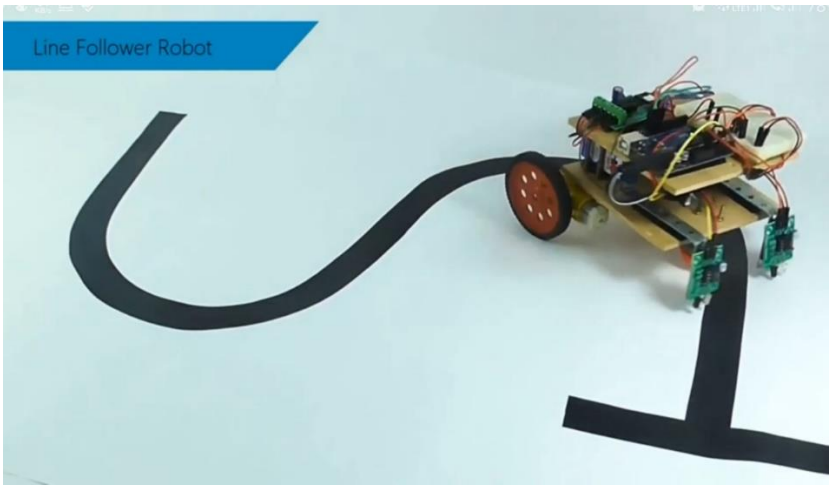

Fig.22 Line Following Robot Fabrication

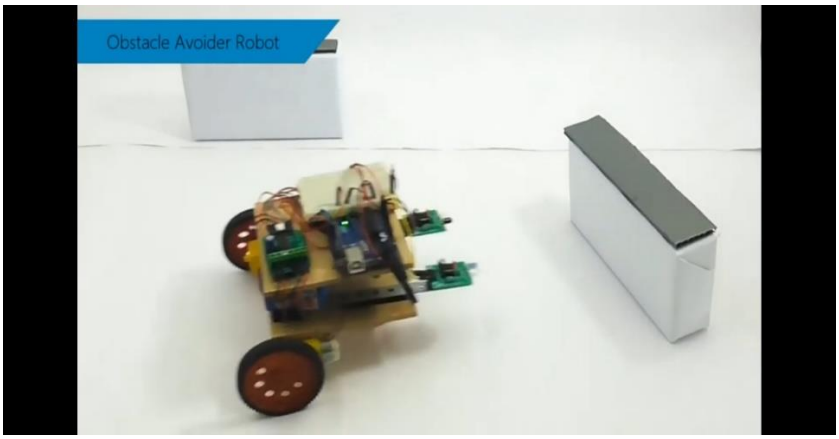

Fig.23 Obstacle Detecting Robot

CHAPTER-5

APPLICATIONS AND SCOPE OF FUTURE WORK

Applications

5.1 Existing Applications

5.1.1 They can be used in industries as automated equipment carriers.

In the industry carriers are required to carry products from one manufacturing plant to another which are usually in different buildings or separate blocks. Conventionally, carts or trucks were used with human drivers. Unreliability and inefficiency in this part of the assembly line formed the weakest link. The project is to automate this sector, using carts to follow a line instead of laying railway tracks which are both costly and an inconvenience**.**

Example – Automated Guiding Vehicle - An automated guided vehicle or automatic guided vehicle (AGV) is a portable robot that follows along marked long lines or wires on the floor, or uses radio waves, vision cameras, magnets, or lasers for navigation. They are most often used in industrial applications to transport heavy materials around a large industrial building, such as a factory or warehouse.

5.1.2 They can be used for household work like automatic vacuum cleaning

Robot vacuum cleaners that make use of anti-collision and obstacle avoidance sensors. The original design included manual operation via remote control and a "self-drive" mode which allowed the machine to clean autonomously without human control. Robotic vacuums can be kept under beds or desks or in closets, whereas a regular vacuum cleaner requires a larger amount of space.

5.1.3 They can also be used in dangerous environments, where human penetration could be fatal.

In space robots have been used as rovers that travel to a distant planets and take data from its surroundings, such as Mars Pathfinder.

5.2 Novel Application

5.2.1 Guidance Application

Tour Guides in Museums and other similar applications. It can also be used for visually impaired people to make them cross the road without any human interference and difficulty.

Scope of Future Work

In the process of development of the sensor guided robot, most of the useful features are identified and many of them were implemented . But due to the time limitations and other factor some of these cannot be added.

So the development features in brief:

- Use of Color Sensor.
- Use of CCD Camera for better recognition and precise tracking the path.
- The laser based (LIDAR) sensor system is robust especially in off-road outdoor environments. LIDAR based mapping gives most accurate scheme for generating information about the shape and surface characteristics of any object.

CHAPTER-6

REFERENCES

Reference

- 2.1 [1] S.H.Sushmitha, Uma Priyadarsini P.S :- Design And Implementation Of a Sensor Guided Pick And Place Robot (2018)
- 2.2 [2] Hossain MI, Islam SMR, Rahman MM and Quamrul Hasan :- A Novel Design for the Autonomous Line Follower Robot Using Microcontroller (2017)
- 2.3 [3] Abhijit Pathak, Refat Khan Pathan, Amaz Uddin Tutul, Nishat Tahsin Tousi, Afsari Sultana Rubaba, Nahida Yeasmin Bithi :- Line Follower Robot for Industrial Manufacturing Process (2017)
- 2.4 [4] R Ismail, Z Omar, S Suaibun :- Obstacle-avoiding robot with IR and PIR motion sensors (2016)
- 2.5 [5] Line Follower Robot Using A Sophisticated Sensor Approach Ebiesuwa O. O 1, Adekunle Y. A 2, Akinyemi L. A 3, Oyerinde O. D 4 1, 2, 4 Computer Science Department, Babcock University Ilishan-Remo, Ogun, Nigeria 3Lagos State University, Ojo, Lagos, Nigeria, International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 7, July – 2013 IJERT ISSN: 2278-0181

- Obstacle detection using ultrasonic sensor for a mobile robot Joseph Azeta, Christian Bolu, Daniel Hinvi and Abiodun A Abioye Published 1 November 2019 Published under license by IOP Publishing Ltd.
- Jim, "PWM/PID/Servo Motor Control," 2005. [Online]. Available: http://www.uoxray uoregon.edu. [Accessed 15 December 2015].
- [11] Hubballi P, Bannikoppa S, Bhairi V and Jahagirdar R G Indian J. Sci. Res. 12 155-8
- Zhu, D.Q., Yan, C.M.: Survey on technology of mobile robot path planning. Control and Decision 25(7), 961–967 (2010)MATH Google Scholar
- Han, Y., Liu, G.D.: Dynamic motion planning for mobile robots based on potential field method. Robot (1), 45–49 (2006)Google Scholar
- https://iopscience.iop.org/article/10.1088/1757-899X/152/1/012064/pdf