CENTRAL INSTITUTE OF TOOL DESIGN

PROJECT REPORT

ON

"LINE FOLLOWER"
(USING 8051 MICROCONTROLLER)

PROJECT DONE BY

NAME

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DIPLOMA IN AUTOMATION AND ROBOTICS ENGINEERING

CENTRAL INSTITUTE OF TOOL DESIGN
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2022-2023

Central Institute of
Tool Design

CENTRAL INSTITUTE OF TOOL DESIGN

Certificate

This is to certify that the project titled

"LINE FOLLOWER ROBOT USING 8051 MICROCONTROLLER"

is a bonafide record of the project work done by

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in partial fulfillment of the requirement for the award of **Diploma in "AUTOMATION AND ROBOTICS ENGINEERING"** under the institution Central Institute of Tool Design, Hyderabad
during the academic year 2022-2023.

PROJECT GUIDE **DEPUTY DIRECTOR**

ACKNOWLEDGEMENT

It gives us immense pleasure to express our sincere gratitude to our Project Guides **MRS. BHAGYAMMA** for their valuable ideas, guidance, constructive and motivating suggestions from time to time during the course of this project.

We express our heart full gratitude for his guidance in completing the mechanical parts of our project.

It will be our privilege to express our deepest sense of gratitude to **Mr. A. SAIKUMAR** & **MRS. E SHOBHA RANI** for valuable guidance in completing of our projects.

We express our heart full gratitude to **MRS.K. NEERAJA** for her guidance in completing the hardware parts of our project

We are greatly indebted to all the Diploma Faculties **of CITD** for their genuine help to complete this project work.

Above all we express our sincere thanks to our beloved deputy director **SHRI SUGYAN RANJAN DALAI,** head of the AUTOMATION AND ROBOTICS ENGINEERING department for permitting us to carry on the project work.

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SYNOPSIS

Line follower is a machine that can follow a path. The path can be visible like a black line on a white surface or it can be invisible like a magnetic field.

As the name suggests, the line follower robot is an automated vehicle that follows a visual line embedded on the surface. This visual line is a path on which the line follower robot runs. Generally, it uses a black line on a white surface, or you can adjust it as a white line on a black surface. Usually, beginners and students would get their first robotic experience with this type of robot. In this project-based article, we have informed about how to make a line follower robot using Arduino.

In industries, giant line follower robots are used for assisting the automated production process. They are also used in military applications, human assistance purposes, delivery services, etc.

When robot is placed on the fixed path, it follows the path by detecting the line. The robot direction of motion depends on the two sensors outputs. When the two sensors are on the line of path, robot moves forward. If the left sensor moves away from the line, robot moves towards right. Similarly, if right sensor moves away from the path, robot moves towards its left.

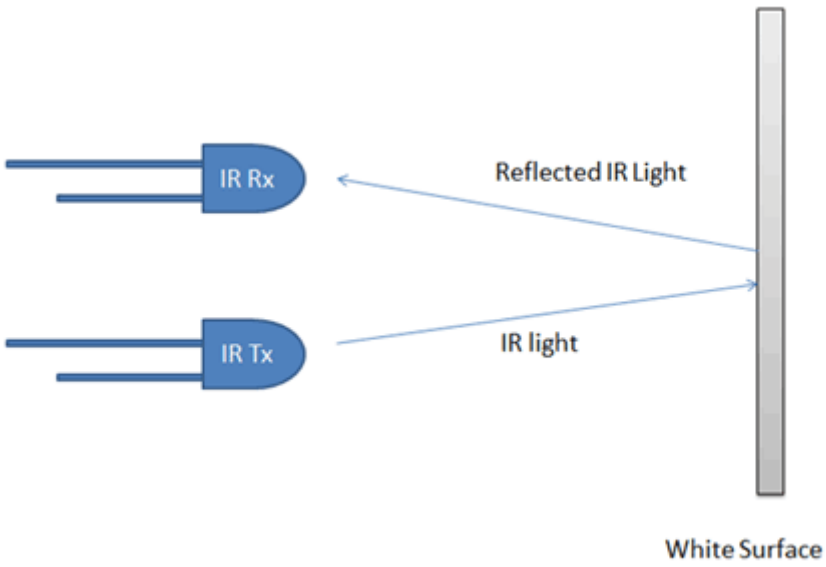
CONTENTS

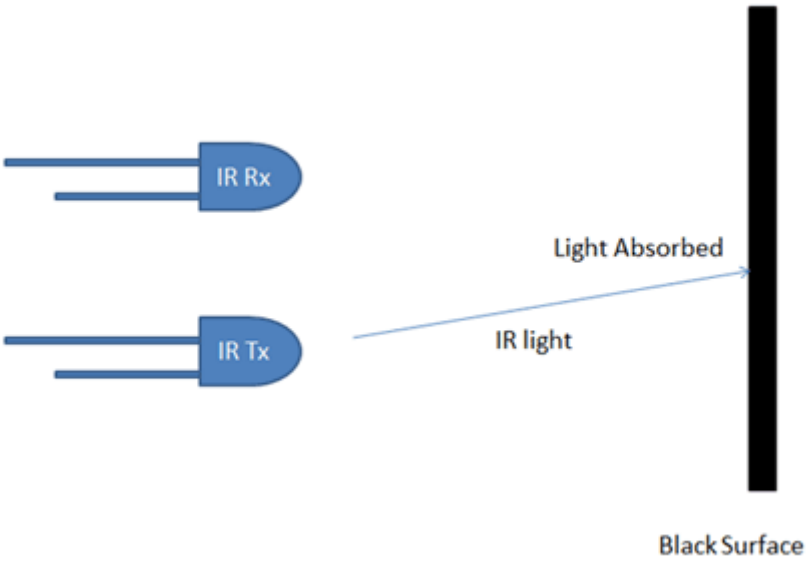
1. INTRODUCTION:

Line follower robots were one of the earliest automatic guided robots. They are able to follow a line marked on a contrasting background, usually a black line on a white surface or a white line on a black surface. Usually, the line follower robot works on a closed loop feedback algorithm where the feedback from the line sensor is used by the controller for correcting the path of the robot. The sensors are IR sensors usually pairs and the controller is an electronic circuit which executes the desired feedback algorithm. Gear motors are used for driving the robotic wheels.

1.1 INTRODUCTION:

Concept of line follower is related to light. We have used the behaviour of light at black and white surface. When light fall on a white surface it will almost full reflects and in case of black surface light is absorbed by black surface. This explained behaviour of light is used in this line follower robot.





In this line follower robot project we have used IR Transmitters and IR receivers also called photo diodes for sending and receiving light. IR transmits infrared lights. When infrared rays falls on white surface, it is reflected back and catched by photodiode and generates some voltage changes. When IR light falls on black surface light is absorbed by the black surface and not rays reflect back, so photo diode did not received any light or rays. Here in this line follower robot when sensor senses white surface then microcontroller gets 0 as input and when senses black line microcontroller gets 1 as input.

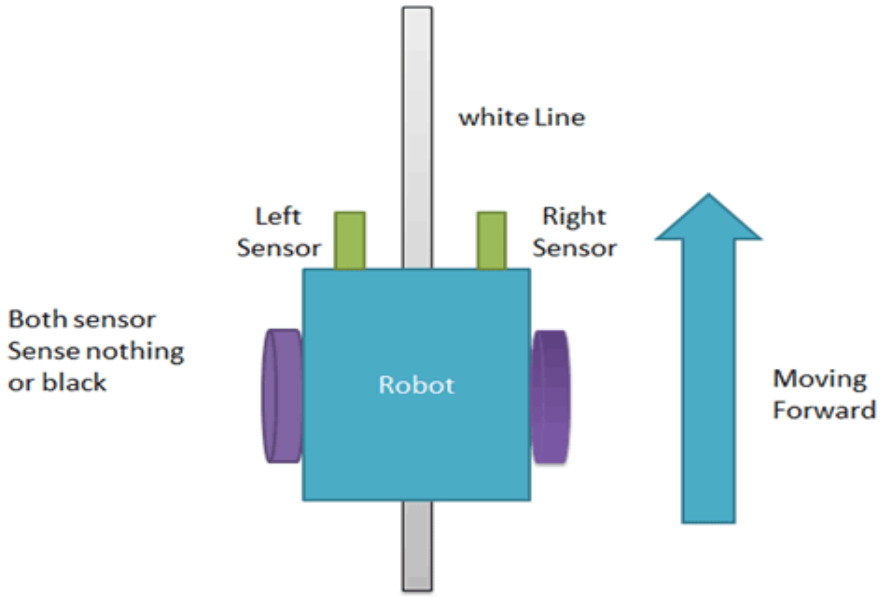
1.2 Working of Line Follower Robot using 8051:

The concept of the line follower robot is related to light. Here, we use the behaviour of light on the black and white surface. The white colour reflects all the light that falls on it, whereas the black colour absorbs the light.

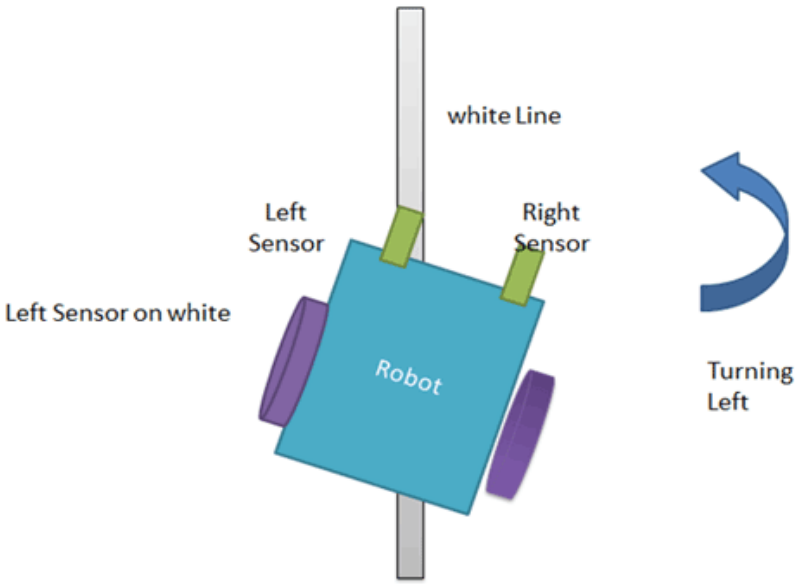
In this line follower robot, we use IR transmitters and receivers (photodiodes). They are used to send and receive the lights. When IR rays fall on a white surface, it is reflected towards IR receiver, generating some voltage changes.

When IR rays fall on a black surface, it is absorbed by the black surface, and no rays are reflected; thus, the IR receiver doesn't receive any rays.

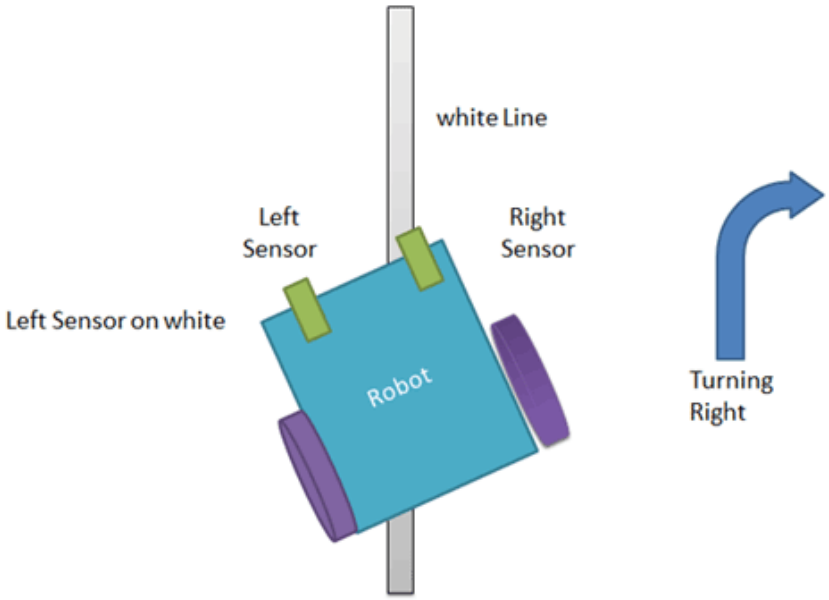
In this project, when the IR sensor senses a white surface, an Arduino gets 1 (HIGH) as input, and when it senses a black line, a microcontroller gets 0 (LOW) as input. Based on these inputs, a microcontroller provides the proper output to control the bot.



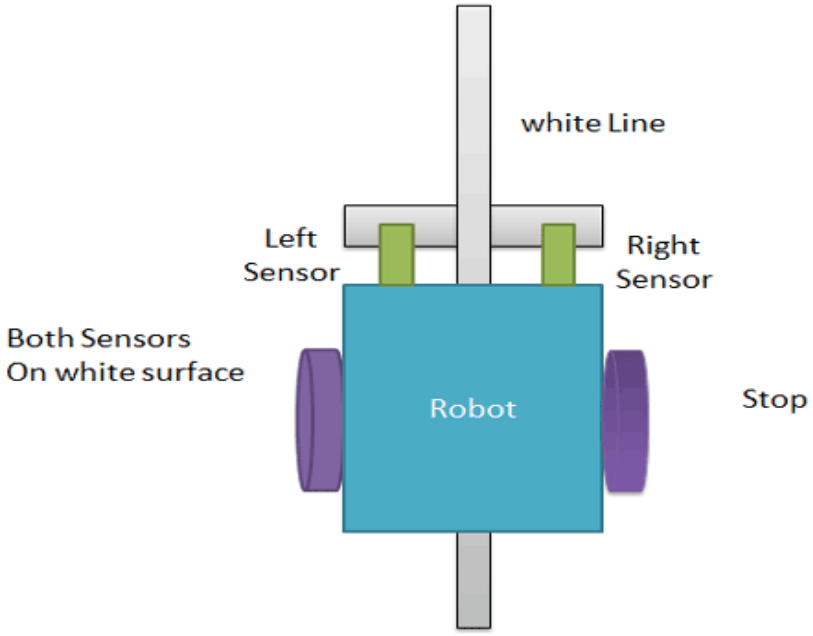
And when left sensor senses white line then robot turn left side.



And when left sensor sense white line then robot turns to right side until both sensor comes at black line or senses nothing surface.



And when both sensors come on white line, the robot stops.



2. PROJECT DESCRIPTION

2.1 BILL OF MATERIALS

SL.NO.	DESCRIPTION	SPECIFICATION	VALUE	QUANTITY	PRICE
1	Microcontroller	U1	AT89S52	1	100
2	L293D Motor Drive	U5		1	120
3	DC Motor			2	40
4	IR Sensors	IR1, IR3		2	160
5	Power Supply	BAT3	5V, 7V, 9V	1	200
6	Regulator	U2	7805	1	20
7	Car Body Kit			1	350
8	Total				990

2.2 PIN CONFIGURATION

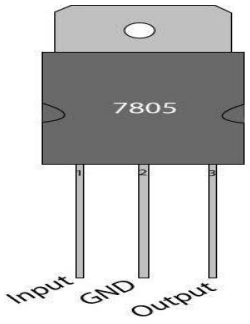
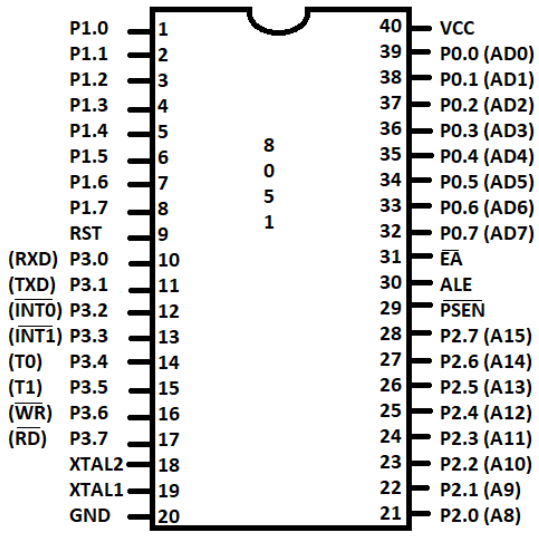
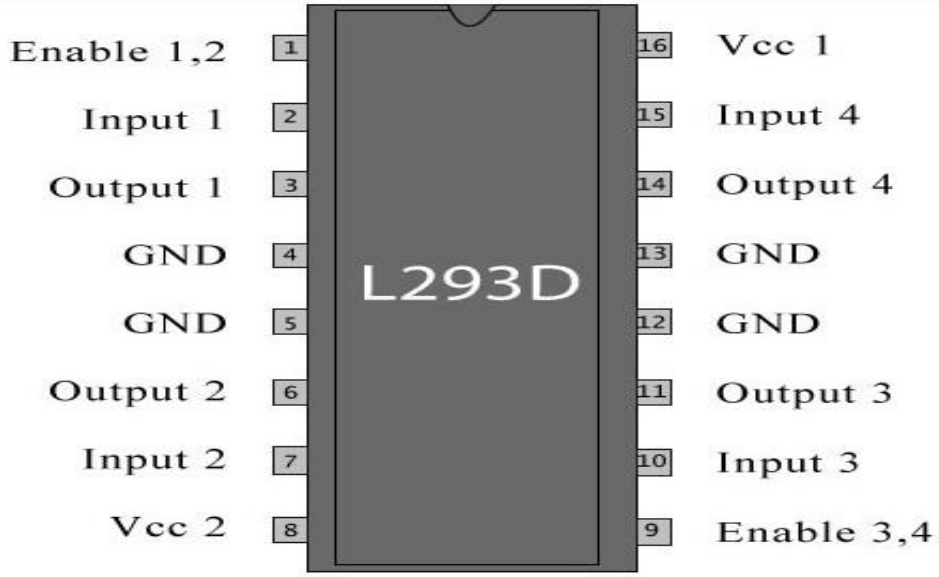


Fig-2.2.1 Pin Configuration Of 7805



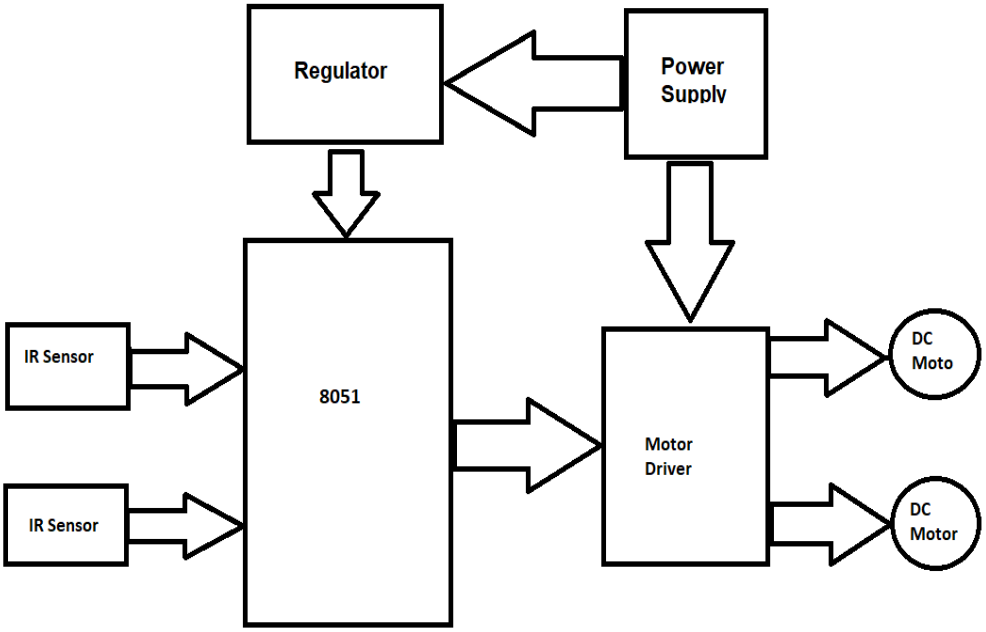
8051 MICROCONTROLLER

Pin configuration of 8051

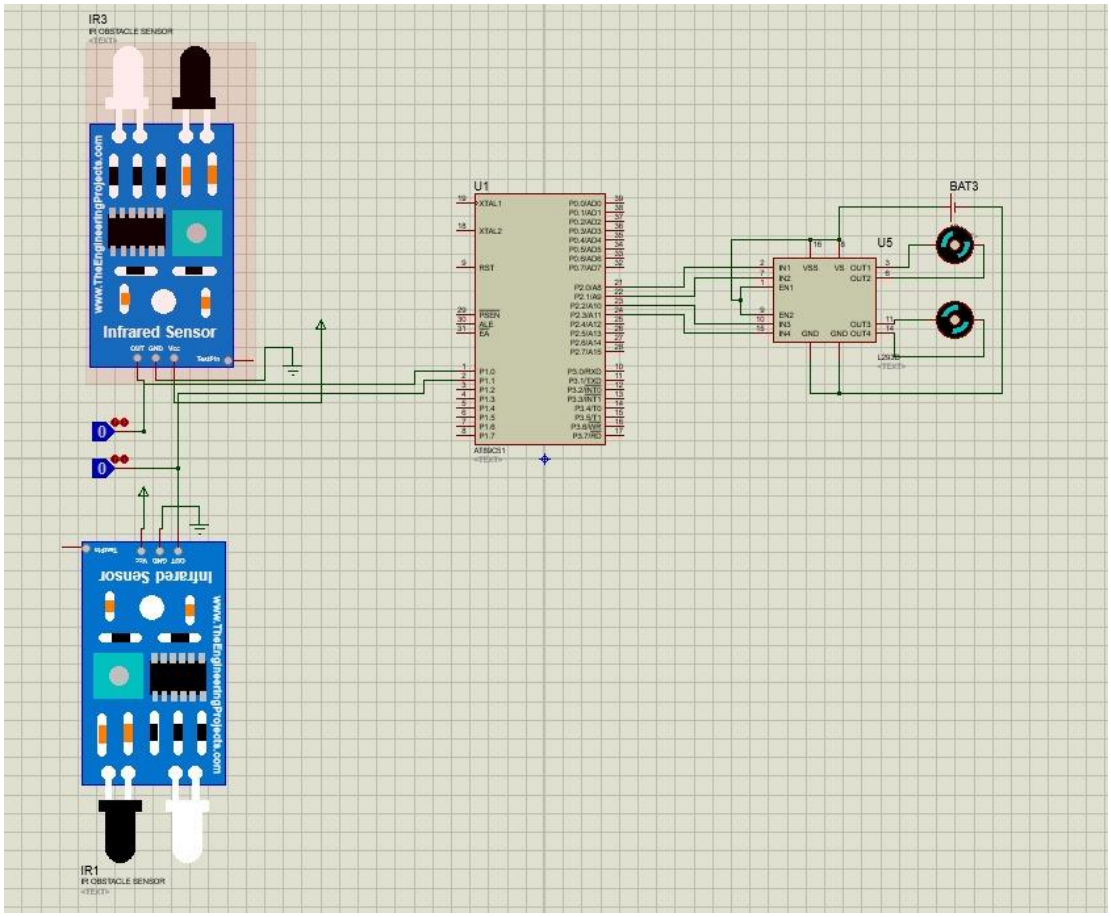


Pin configuration of L293D

2.3 BLOCK DIAGRAM



2.4 CIRCUIT DIAGRAM AND DESCRIPTION



2.5 COMPONENT DESCRIPTION

2.5.1. MICROCONTROLLER

The **AT89C51** is **a low-power, high-performance CMOS 8-bit microcomputer** with 4K bytes of Flash programmable and erasable read-only memory (PEROM). The device is manufactured using Atmel's high-density non-volatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional non-volatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer that provides a highly-flexible and cost-effective solution to many embedded control applications.

AT89C51 FEATURES:

• Compatible with MCS-51™ Products 14

• 4K Bytes of In-System Reprogrammable Flash Memory – Endurance: 1,000 Write/Erase Cycles

• Fully Static Operation: 0 Hz to 24 MHz

• Three-level Program Memory Lock

• 128 x 8-bit Internal RAM

• 32 Programmable I/O Lines • Two 16-bit Timer/Counters

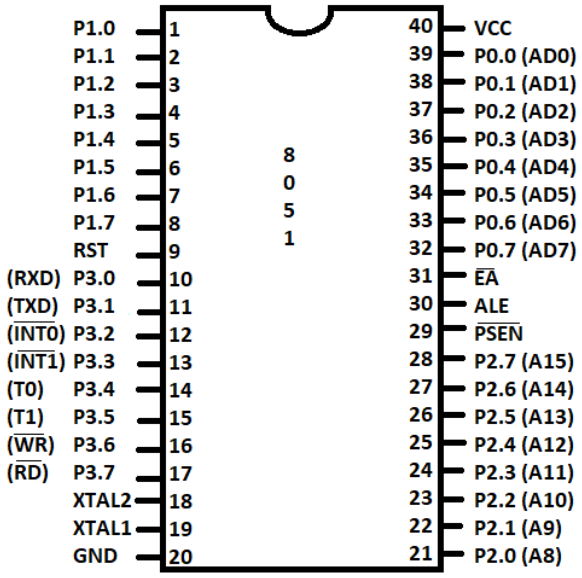
• Six Interrupt Sources

• Programmable Serial Channel

• Low-power Idle and Power-down Modes

AT89C51 SPECIFICATIONS:

- No of Pins: 40
- Operating Voltage 2V to 5.5V
- Program Memory: 4Kb FLASH memory
- External Oscillator 3 to 24 MHz
- Ram: 128×8 bits
- Communication Protocols UART
- Available in PDIP package
- CPU speed 24MHz



8051 MICROCONTROLLER

VCC

Supply voltage.

GND

Ground.

Port 0

Port 0 is an 8-bit open-drain bi-directional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as high impedance inputs.

Port 0 may also be configured to be the multiplexed low order address/data bus during accesses to external program and data memory. In this mode P0 has internal pullups.

Port 0 also receives the code bytes during Flash programming, and outputs the code bytes during program verification. External pullups are required during program verification.

Port 1

Port 1 is an 8-bit bi-directional I/O port with internal pullups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pullups.

Port 1 also receives the low-order address bytes during Flash programming and verification.

Port 2

Port 2 is an 8-bit bi-directional I/O port with internal pullups. The Port 2 output buffers can sink/source four TTL inputs.

When 1s are written to Port 2 pins they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 2 pins that are externally being pulled low will source current (IIL) because of the internal pullups.

Port 2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that use 16-bit addresses (MOVX @ DPTR). In this application, it uses strong internal pullups when emitting 1s. During accesses to external data memory that use 8-bit addresses (MOVX @ RI), Port 2 emits the contents of the P2 Special Function Register.

Port 2 also receives the high-order address bits and some control signals during Flash programming and verification.

Port 3

Port 3 is an 8-bit bi-directional I/O port with internal pullups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pullups.

Port 3 also receives some control signals for Flash programming and verification.

RST

Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device.

ALE/PROG

Address Latch Enable output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during Flash programming.

In normal operation ALE is emitted at a constant rate of 1/6 the oscillator frequency, and may be used for external timing or clocking purposes.

If desired, ALE operation can be disabled by setting bit 0 of SFR location 8EH. With the bit set, ALE is active only during a MOVX or MOVC instruction. Otherwise, the pin is weakly pulled high. Setting the ALE-disable bit has no effect if the microcontroller is in external execution mode.

PSEN

Program Store Enable is the read strobe to external program memory. When the AT89C51 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

EA/VPP

External Access Enable. EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH. Note, however, that if lock bit 1 is programmed, EA will be internally latched on reset.

EA should be strapped to VCC for internal program executions.

This pin also receives the 12-volt programming enable voltage (VPP) during Flash programming, for parts that require 12-volt VPP.

XTAL1

Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

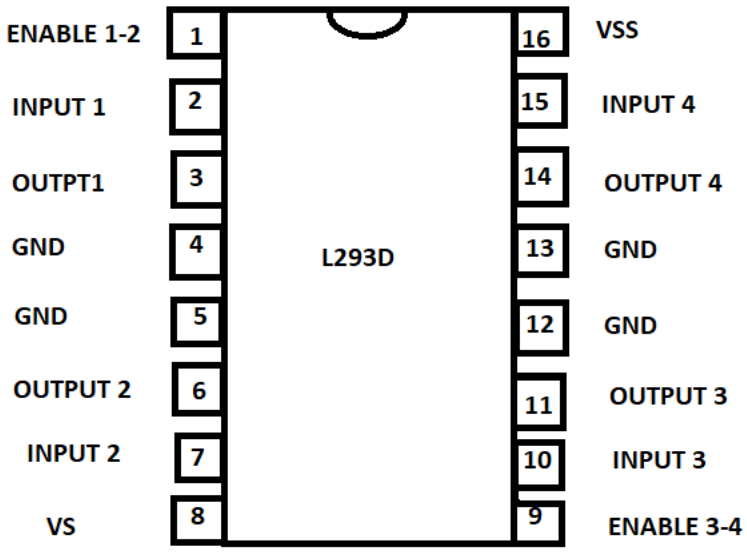
XTAL2

Output from the inverting oscillator amplifier.

2.5.2 MOTOR DRIVER

L293d IC is known as a motor driver. It is a low voltage operating device like other ICs. The other ICs could have the same functions like L293d but they cannot provide the high voltage to the motor. L293d provides the continuous bidirectional Direct Current to the Motor. The Polarity of current can change at any time without affecting the whole IC or any other device in the circuit. L293d has an internal H-bridge installed for two motors. H-Bridge is an electrical circuit that enables the load in a bidirectional way. L293d bridge is controlled by external low voltage signals. It may be small in size, but its power output capacity is higher than our expectation. It could control any DC motor speed and direction with a voltage range of 4.5 – 36 Volts. Its diodes also save the controlling device and IC from back EMF. To control the max 600mA amount of current an internal “Darlington transistor sink” installed in it, which could be used to control a large amount of current by providing a small amount of current. It has also internal “pseudo-Darlington source” which amplifies the input signal to control the high voltage DC motor without any interception.

L293D PIN DIGRAM:



PIN CHARACTERISTICS:

• Enable 1-2, when this is HIGH the left part of the IC will work and when it is low the left part won’t work. So, this is the Master Control pin for the left part of IC • INPUT 1, when this pin is HIGH the current will flow though output 1.

• OUTPUT 1, this pin should be connected to one of the terminals of motor • GND, ground pins • OUTPUT 2, this pin should be connected to one of the terminal of motor • INPUT 2, when this pin is HIGH the current will flow though output 2 • VC, this is the voltage which will be supplied to the motor. So, if you are driving 12 V DC motors then make sure that this pin is supplied with 12 V • VSS, this is the power source to the IC. So, this pin should be supplied with 5 V • INPUT 4, when this pin is HIGH the current will flow though output 4 • OUTPUT 4, this pin should be connected to one of the terminal of motor • GND, ground pins • OUTPUT 3, this pin should be connected to one of the terminal of motor • INPUT 3, when this pin is HIGH the current will flow though output 3 • Enable 3-4, when this is HIGH the right part of the IC will work and when it is low the right part won't work. So, this is the Master Control pin for the right part of IC

L293D SPECIFICATIONS:

• Wide Supply-Voltage Range: 4.5 V to 36 V
• Separate Input-Logic Supply
• Internal ESD Protection
• High-Noise-Immunity Inputs
• Output Current 1 A Per Channel (600 mA for L293D)
• Peak Output Current 2 A Per Channel (1.2 A for L293D)
• Output Clamp Diodes for Inductive Transient Suppression (L293D)

2.5.3 DC MOTOR

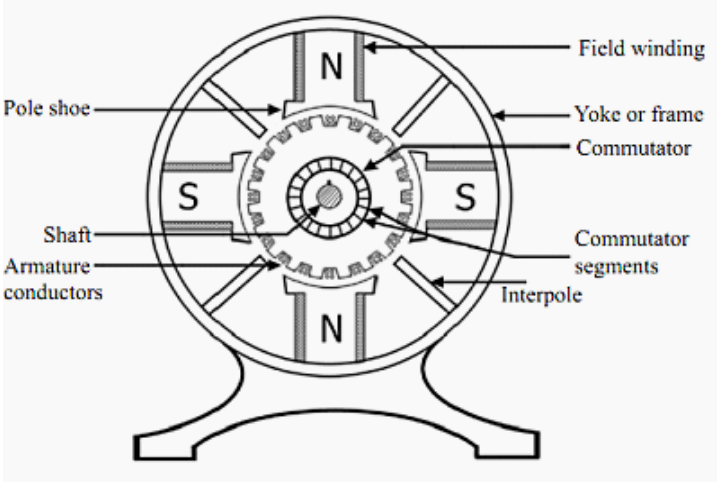
DC MOTOR:

A DC motor is an electrical machine that converts electrical energy into mechanical energy. In a DC motor, the input electrical energy is the direct current which is transformed into the mechanical rotation. In this session, let us know what is a DC motor, types of DC motor and their applications.

A DC motor is defined as a class of electrical motors that convert direct current electrical energy into mechanical energy.

Electrical motors are everywhere around us. Almost all the electro-mechanical movements we see around us are caused either by an AC or a DC motor.

Here we will be exploring DC motors. This is a device that converts DC electrical energy to a mechanical energy.



PARTS OF DC MOTOR:

A DC motor is composed of the following main parts:

Armature or Rotor

The armature of a DC motor is a cylinder of magnetic laminations that are insulated from one another. The armature is perpendicular to the axis of the cylinder. The armature is a rotating part that rotates on its axis and is separated from the field coil by an air gap.

Field Coil or Stator

A DC motor field coil is a non-moving part on which winding is wound to produce a magnetic field. This electro-magnet has a cylindrical cavity between its poles.

Commutator and Brushes

The commutator of a DC motor is a cylindrical structure that is made of copper segments stacked together but insulated from each other using mica. The primary function of a commutator is to supply electrical current to the armature winding.

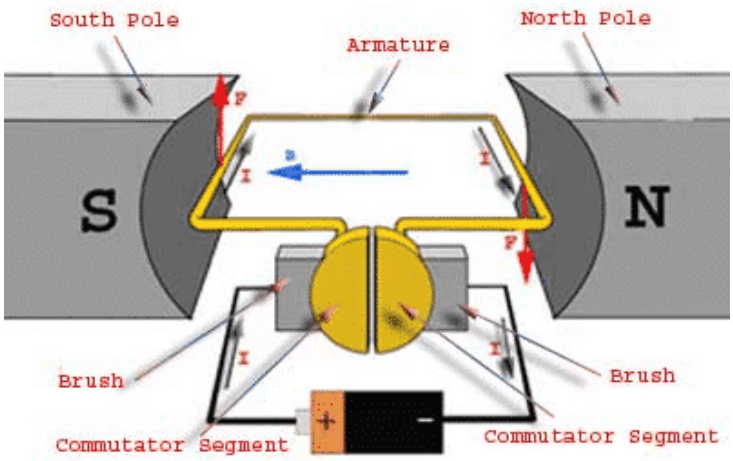
The brushes of a DC motor are made with graphite and carbon structure. These brushes conduct electric current from the external circuit to the rotating commutator. Hence, we come to understand that the commutator and the brush unit are concerned with transmitting the power from the static electrical circuit to the mechanically rotating region or the rotor.

WORKING OF DC MOTOR:

In the previous section, we discussed the various components of a DC motor. Now, using this knowledge let us understand the working of DC motors.

A magnetic field arises in the air gap when the field coil of the DC motor is energised. The created magnetic field is in the direction of the radii of the armature. The magnetic

field enters the armature from the North pole side of the field coil and “exits” the armature from the field coil’s South pole side.



The conductors located on the other pole are subjected to a force of the same intensity but in the opposite direction. These two opposing forces create a torque that causes the motor armature to rotate.

WORKING PRINCIPLE OF DC MOTOR:

When kept in a magnetic field, a current-carrying conductor gains torque and develops a tendency to move. In short, when electric fields and magnetic fields interact, a mechanical force arises. This is the principle on which the DC motors work.

An electrical machine that is used to convert the energy from electrical to mechanical is known as a DC motor. The DC motor working principle is that when a current-carrying conductor is located within the magnetic field, then it experiences a mechanical force. This force direction can be decided through Flemming’s left-hand rule as well as its magnitude.

If the first finger is extended, the second finger, as well as the left hand’s thumb, will be vertical to each other & primary finger signifies the magnetic field’s direction, the next finger signifies the current direction & the third finger-like thumb signifies the force direction which is experienced through the conductor.

Whenever an armature winding is given toward a DC supply, then the flow of current will be set up within the winding. Field winding or permanent magnets will provide the magnetic field. So, armature conductors will experience a force because of the magnetic field based on the above-stated principle. The Commutator is designed like sections to attain unidirectional torque or the path of force would have overturned each time once the way of the conductor’s movement is upturned within the magnetic field. So, this is the working principle of the DC motor.

Types of DC Motors:

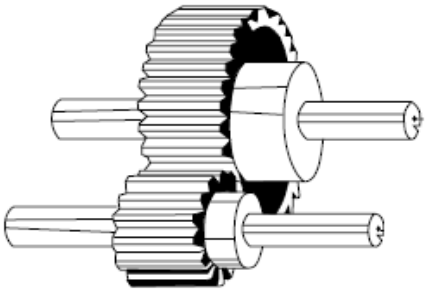
GEARED DC MOTOR

Geared motors tend to reduce the speed of the motor but with a corresponding increase in torque. This property comes in handy, as DC motors can rotate at speeds much too fast for an electronic device to makes use of. Geared motors commonly consist of a DC brush motor and a gearbox attached to the shaft. Motors are distinguished as geared by two connected units. It has many applications due to its cost of designing, reduces the complexity, and constructing applications such as industrial equipment, actuators, medical tools, and robotics.

- No good robot can ever be built without gears. All things considered, a good understanding of how gears affect parameters such as torque and velocity is very important.
- Gears work on the principle of mechanical advantage. This implies that by using distinctive gear diameters, we can exchange between rotational velocity and torque. Robots do not have a desirable speed to torque ratio.
- In robotics, torque is better than speed. With gears, it is possible to exchange the high velocity with better torque. The increase in torque is inversely proportional to the reduction in speed.

Speed Reduction in Geared DC Motor

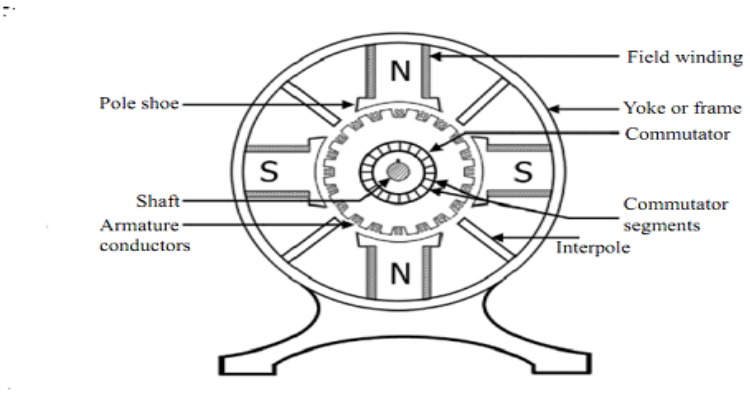
Speed reduction in gears comprises of a little gear driving a larger gear. There may be few sets of these reduction gear sets in a reduction gearbox.



Speed Reduction in geared DC Motor

Sometimes the objective of using a gear motor is to reduce the rotating shaft speed of a motor in the device being driven, for example in a small electric clock where the tiny synchronous motor may be turning at 1,200 rpm however is decreased to one rpm to drive the second hand and further reduced in the clock mechanism to drive the minute and hour hands. Here the amount of driving force is irrelevant as long as it is sufficient to overcome the frictional impacts of the clock mechanism.

CONSTRUCTIN OF DC MOTOR MACHINE



Both the DC machines i.e. DC generator and DC motor have the same construction. Therefore, either machine can be used as a motor or a generator. A DC motor or machine consists of two windings namely field winding and armature winding. The field winding is stationary and the armature winding can rotate.

APPLICATIONS OF DC MOTOR:

The applications of different types of DC motors are listed below:

Shunt DC Motors

Owing to the fairly constant speed and medium starting torque of shunt DC motors, they are used in the following applications:

1. Centrifugal and reciprocating pumps
2. Lathe machines
3. Blowers and Fans
4. Drilling machines
5. Milling machines
6. Machine tools

Series DC Motors

Owing to the high starting torque and variable speed of series DC motors, they are used in the following applications:

- Conveyors
- Hoists, Elevators
- Cranes
- Electric Locomotives

Cumulative Compound DC motors

Owing to the high starting torque of cumulative compound DC motors, they are used in the following applications:

- Shears
- Heavy Planers
- Rolling mills
- Elevators

2.5.4 IR SENSOR

IR SENSOR

IR sensor is very useful if you are trying to make a obstacle avoider robot or a line follower. In this project we are going to make a simple IR sensor which can detect a object around 6-7 cm. IR sensor is nothing but a diode, which is sensitive for infrared radiation. This infrared transmitter and receiver are called as IR TX-RX pair.

Fig. IR Sensor

FEATURES

- Fast response time
- Because it has good range which is fulfill our requirements.

- It is very low cost and can be constructed on general purpose.
- It is of very small size.
- You can increase numbers of transmitter as you want for good result
- Good immunity to ambient light and waves are invisible to eyes.

WORKING OF IR

Working of IR sensor is very simple and working principle is totally based on change in resistance of IR receiver. Here in this sensor we connect IR receiver in reverse bias so it give very high resistance if it is not exposed to IR light. the resistance in this case is in range of Mega ohms, but when IR light reflected back and fall on IR receiver. The resistance of Rx it comes in range between Kilo ohms to hundreds of ohms. We convert this change in resistance to change in voltage. Then this voltage is applied to a comparator IC which compare it with a threshold level. if voltage of sensor is more than threshold then output is high else it is low which can be used directly for microcontroller.

Applications

Infrared radiation is the region of the electromagnetic spectrum between microwaves and visible light. In infrared communication an LED transmits the infrared signal as bursts of non-visible light. At the receiving end a photodiode or photoreceptor detects and captures the light pulses, which are then processed to retrieve the information they contain. Some common applications of infrared technology are listed below.

1. Augmentative communication devices
2. Car locking systems
3. Computers
   a. Mouse
   b. Keyboards
   c. Floppy disk drives
   d. Printers
4. Emergency response systems
5. Environmental control systems
   a. Windows
   b. Doors
   c. Lights
   d. Curtains

e. Beds
f. Radios

6. Headphones
7. Home security systems
8. Navigation systems
9. Signage
10. Telephones

2.5.5. POWER SUPPLY

The power supply section is the section which provides +5V for the components to work. IC LM7805 is used for providing a constant power of +5V.

The AC voltage, typically 220V, is connected to a transformer, which steps down the ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also retains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

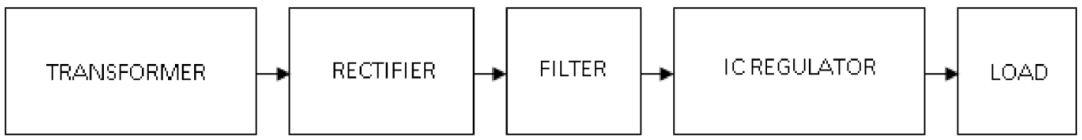


Figure7: Block Diagram of Power Supply

2.5.6 TRANSFORMER

Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC.

Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in India) to a safer low voltage.

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up.

The transformer will step down the power supply voltage (0-230V) to (0- 6V) level. Then the secondary of the potential transformer will be connected to the bridge rectifier, which is constructed with the help of PN junction diodes. The advantages of using a bridge rectifier are it will give peak voltage output as DC.

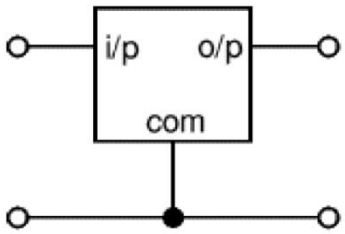
2.5.7 VOLTAGE REGULATORS

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustable set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground.

The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts. Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').

Many of the fixed voltage regulator ICs have 3 leads and look like power transistors, such as the 7805 +5V 1Amp regulator. They include a hole for attaching a heat sink if necessary.



Regulator

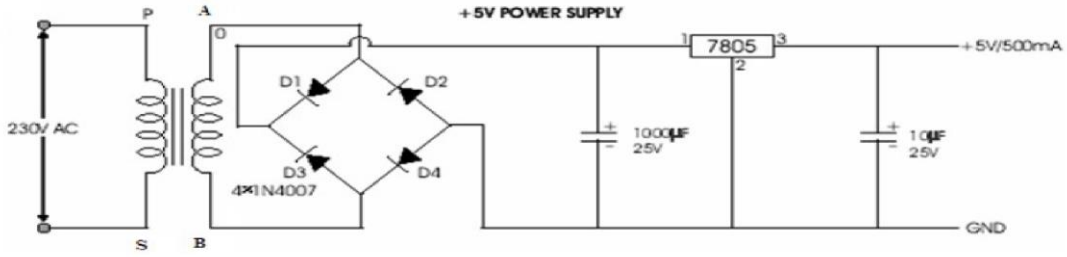


Figure 10: Circuit Diagram of Power Supply

2.6 SOURCE CODE

```
#include<reg51.h>

sbit ir1=P1^0;

sbit ir2=P1^1;

sbit m0_0=P2^0; //right motor

sbit m0_1=P2^1;

sbit m1_0=P2^2; //left motor

sbit m1_1=P2^3;



void goAhead();
```

```
void goBack();

void goRight();

void goLeft();

void stop();

void main()

{

m0_0=m0_1=m1_0=m1_1=0;

ir1=1;

ir2=1;

   while(1)

   {

    if(ir1==0 && ir2==0)

          //motor=forward;

         goAhead();

    else if(ir1==0 && ir2==1

          //motor=turn_left;

          goLeft();

    else if(ir1==1 && ir2==0)

          //motor=turn_right;

          goRight();

  else

      //motor=stop;

          stop();
```

```
 }
}
void goAhead()
{
        m0_0=1;
        m0_1=0;
        m1_0=1;
        m1_1=0;
}
void stop()
{
        m0_0=0;
        m0_1=0;
        m1_0=0;
        m1_1=0;
}
void goBack()
{
        m0_0=0;
        m0_1=1;
        m1_0=0;
        m1_1=1;
 }
```

```
void goRight()

{

        m0_0=1;

        m0_1=0;

        m1_0=0;

        m1_1=1;

 }

void goLeft()

{

        m0_0=0;

        m0_1=1;

        m1_0=1;

        m1_1=0;

}
```

2.7 PRINTED CIRCUIT BOARD

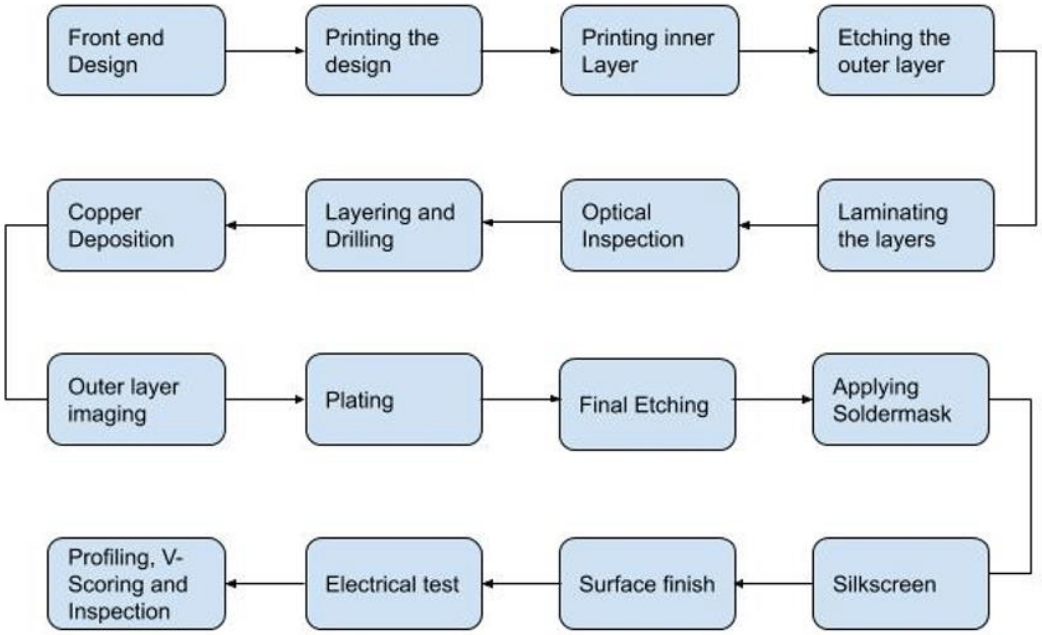
Printed circuit board (PCB) is a highly reliable and durable physical circuit design that has become an essential component of any electronic device. Printed circuit boards are made of a very thin substrate board embedded with electronic components interconnected using thin-layer of copper interconnecting traces. The board substrate is usually made of fiberglass composite epoxy substrate or other laminate materials. The circuit will contain both active and passive components. With more advanced and smaller component availability it is possible to accommodate a very large and complex circuit in a small PCB design.

PCBs are of three types. Single side, Double side, and Multi-layered boards. Single-sided boards have the components on one side of the substrate. Double side have components on both sides. In a multi-layered board, multiple layers of printed circuits are separated by insulation layers. In double-sided and multilayer PCBs components

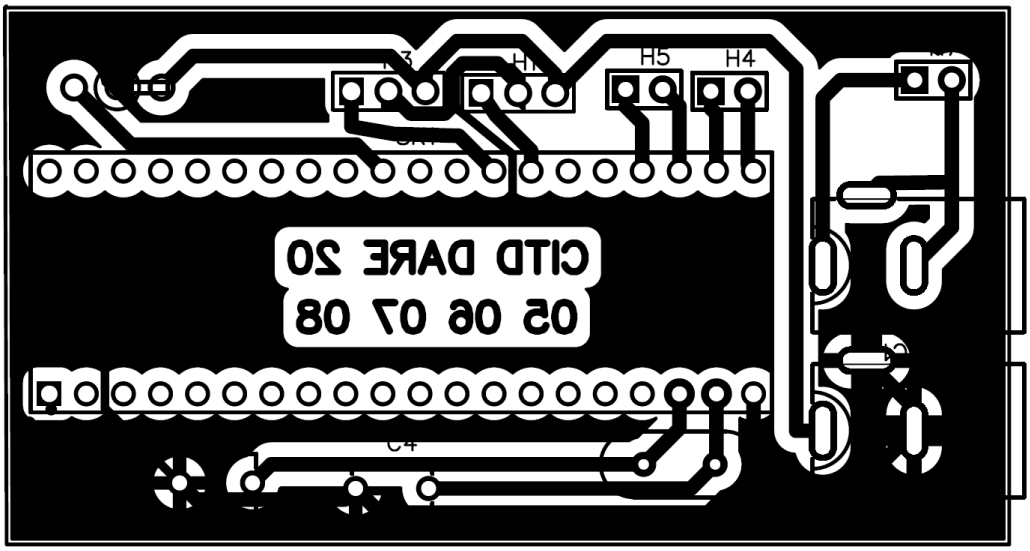
are interconnected by drilling holes at appropriate points and plating them with conducting materials.

Major Advantages of PCB:

1. Smaller and Thinner in size
2. Highly customizable in design and application
3. Durable, Reliable and long life
4. Easy to debug and easy to repair
5. Low cost



Various steps in PCB Design and Manufacturing



FABRICATION OF A PCB

Step 1: Requirement analysis and Component selection

The first step in PCB design is to analyze the requirement and select the appropriate components such as processor, power supply. Create a blueprint that fulfills all the requirements.

Step 2: In-System Front end design

PCB layout is initially designed using a PCB design software. Altium Designer, Autodesk EAGLE, KiCad EDA, OrCAD are some commercially available software used for PCB design. The output of this design is usually in the form of a PCB schematic Gerber file. Gerber file encodes information including copper tracking layers, drill drawing, component notation, and other parameters.

Step 3: Photo tool Initiation

Next step is to run Design for Manufacture (DFM) check before circuit boards fabrication starts. This is to avoid any discrepancies in design. After this, a photo film is made to image the PCB using a laser printer/plotter. Different layers of the PCB photo film are aligned by punching precise registration holes in each sheet of film. The film is created to help in creating a figure of copper path.

Step 4: Printing the inner layers

The substrate, usually a composite epoxy substrate is taken, cut, cleaned and dried. Copper is pre-bonded on both sides of the substrate. Cleanliness of the panel is the most important factor to avoid short or open circuit errors. The copper is coated with a layer of photoresist, which then treated with UV light to harden it. The film formed in the previous step is placed over the copper layer and aligned using pin positions.

Later the panel is again UV treated. The dark areas on the film do not allow UV light, thus the areas below dark areas of the film are not hardened. While the light areas that are meant for copper wiring are hardened.

Step 5: Etching out the unwanted copper

The panel is then washed with an alkaline solution to wash away unhardened copper material. The desired copper layer is fully protected beneath the hardened layer of photoresist. Next, the photoresist that is over the copper layer is also removed. This, in turn, leaves only the required copper layer intact.

Step 6: Register punching for layer alignment

The different layers are aligned and optically punched to create registration holes. This will align the inner layers to the outer layers.

Step7: Automated optical inspection

After lamination, it is impossible to sort out errors in inner layers. Hence the panel is subjected to automatic optical inspection before bonding up and lamination. The machine scans the layers using a laser sensor and compares it with the original Gerber file to list out discrepancies, if any.

Step 8: Layer up and Bond

The layers of the PCB panel are bonded together by aluminium press plate. For double and multi later PCB further copper foils are pressed over original layers with insulating layers placed in between and the etching process is repeated. Finally, all the layers are laminated together to provide the final shape to the PCB panel.

Step 9: Drilling

The PCB stack is then drilled for holes. These holes are where the electronic components of the PCB including via holes are to be placed and interconnected. Holes are drilled with a diameter of approximately 100 to 150 microns. Precision is the key to the drilling process. Laser locator or X-Y coordinate systems are used to achieve precision.

Step 10: Copper Deposition and Platting

This step is to cover the entire panel with a fresh layer of copper after drilling. It bonds the panels and also covers the nonconductive materials opened up after drilling. A chemical electrolysis setup is used for plating. The drill holes are covered with around 25 microns of copper to ensure proper connection.

Step 11: Outer layer imaging and copper etching

Similar to step 3 a photoresist material is applied over the outer copper layer and then they are imaged. Tin guard covering is provided over the required copper area as a protection and the other unwanted copper is removed. PCB connections are established after this step.

Step 12: Solder Mask Application

The board is now cleaned and the solder mask is applied. Solder mask is to protect the board from copper oxidation, damage, and corrosion. An Expoxy is applied along with a solder mask which gives the usual green color to the board. Unwanted solder mask is removed by exposure to UV light. Then the board is oven-baked.

Step 13: Electrical test

Electrical test is done using probe testers. Open and short circuit tests are performed. Electrical tests ensure functional reliability. Durability testing are also performed after functional test.

Step 14: V-Scoring

The actual PCB is cut out from the manufactured panel. PCB is cut out in specific sizes and shapes based upon the customer design and as per the original Gerber file date. V-cuts are made along the sides of the board which permits the board to easily pop out from the panel.

Step 15: Final inspection and packing

PCB is subjected to final visual inspection and quality inspection. Test reports are provided for customer verification. Vacuum sealed or airbag/air pocket packaging is done to prevent any physical damage to the boards.

PCB design process is a requirement driven and highly customizable process enables us to produce specific circuit function whether complex or simple. Cleanliness and precision are the most important precautions to be followed in PCB design and manufacturing

2.8 SOFTWARE SPECIFICATION

KEIL SOFTWARE

Keil compiler is a software used where the machine language code is written and compiled. After compilation, the machine source code is converted into hex code which is to be dumped into the microcontroller for further processing. Keil compiler also supports C language code.

General Introduction

Keil Software is the leading vendor for 8/16-bit development tools (ranked at first position in the 2004 Embedded Market Study of the Embedded Systems and EE Times magazine). Keil Software is represented world-wide in more than 40 countries. Since the market introduction in 1988, the Keil C51 Compiler is the de facto industry standard and supports more than 500 current 8051 device variants. Now, Keil Software offers development tools for ARM.

Keil Software makes C compilers, macro assemblers, real-time kernels, debuggers, simulators, integrated environments, and evaluation boards for the 8051, 251, ARM, and XC16x/C16x/ST10 microcontroller families.

Keil Software is pleased to announce simulation support for the Atmel AT91 ARM family of microcontrollers. The Keil µVision Debugger simulates the complete ARM instruction-set as well as the on-chip peripherals for each device in the AT91 ARM/Thumb microcontroller family. The integrated simulator provides complete peripheral simulation. Other new features in the µVision Debugger include:

- An integrated Software Logic Analyzer that measures I/O signals as well as program variables and helps developers create complex signal processing algorithms.
- An Execution Profiler that measures time spent in each function, source line, and assembler instruction. Now developers can find exactly where programs spend the most time.

"Using nothing more than the provided simulation support and debug scripts, developers can create a high-fidelity simulation of their actual target hardware and environment. No extra hardware or test equipment is required. The Logic Analyzer and Execution Profiler will help developers when it comes time to develop and tune signaling algorithms." said Jon Ward, President of Keil Software USA, Inc.

µVision3 Overview

The µVision3 IDE is a Windows-based software development platform that combines a robust editor, project manager, and makes facility. µVision3 integrates all tools including the C compiler, macro assembler, linker/locator, and HEX file generator. µVision3 helps expedite the development process of your embedded applications by providing the following:

- Full-featured source code editor,
- Device database for configuring the development tool setting,
- Project manager for creating and maintaining your projects,
- Integrated make facility for assembling, compiling, and linking your embedded applications,
- Dialogs for all development tool settings,
- True integrated source-level Debugger with high-speed CPU and peripheral simulator,
- Advanced GDI interface for software debugging in the target hardware and for connection to Keil ULINK,
- Flash programming utility for downloading the application program into Flash ROM,
- Links to development tools manuals, device datasheets & user's guides.

The µVision3 IDE offers numerous features and advantages that help you quickly and successfully develop embedded applications. They are easy to use and are guaranteed to help you achieve your design goals.

The µVision3 IDE and Debugger is the central part of the Keil development tool chain. µVision3 offers a Build Mode and a Debug Mode.

In the µVision3 Build Mode you maintain the project files and generate the application.

In the µVision3 Debug Mode you verify your program either with a powerful CPU and peripheral simulator or with the Keil ULINK USB-JTAG Adapter (or other AGDI drivers) that connect the debugger to the target system. The ULINK allows you also to download your application into Flash ROM of your target system.

STEPS TO WRITE AN ASSEMBLY LANGUAGE PROGRAM IN KEIL AND HOW TO COMPILE IT:

1. Install the Keil Software in the PC in any of the drives.
2. After installation, an icon will be created with the name “Keil uVision3”. Just drag this icon onto the desktop so that it becomes easy whenever you try to write programs in keil.
3. Double click on this icon to start the keil compiler.
4. A page opens with different options in it showing the project workspace at the leftmost corner side, output window in the bottom and an ash coloured space for the program to be written.
5. Now to start using the keil, click on the option “project”.
6. A small window opens showing the options like new project, import project, open project etc. Click on “New project”.
7. A small window with the title bar “Create new project” opens. The window asks the user to give the project name with which it should be created and the destination location. The project can be created in any of the drives available. You can create a new folder and then a new file or can create directly a new file.
8. After the file is saved in the given destination location, a window opens where a list of vendors will be displayed and you have to select the device for the target you have created.
9. The most widely used vendor is Atmel. So click on Atmel and now the family of microcontrollers manufactured by Atmel opens. You can select any one of the microcontrollers according to the requirement.
10. When you click on any one of the microcontrollers, the features of that particular microcontroller will be displayed on the right side of the page. The most appropriate microcontroller with which most of the projects can be

implemented is the AT89C51. Click on this microcontroller and have a look at its features. Now click on “OK” to select this microcontroller.

11. A small window opens asking whether to copy the startup code into the file you have created just now. Just click on “No” to proceed further.
12. Now you can see the TARGET and SOURCE GROUP created in the project workspace.
13. Now click on “File” and in that “New”. A new page opens and you can start writing program in it.
14. After the program is completed, save it with any name but with the .asm extension. Save the program in the file you have created earlier.
15. You can notice that after you save the program, the predefined keywords will be highlighted in bold letters.
16. Now add this file to the target by giving a right click on the source group. A list of options open and in that select “Add files to the source group”. Check for this file where you have saved and add it.
17. Right click on the target and select the first option “Options for target”. A window opens with different options like device, target, output etc. First click on “target”.
18. Since the set frequency of the microcontroller is 11.0592 MHz to interface with the PC, just enter this frequency value in the Xtal (MHz) text area and put a tick on the Use on-chip ROM. This is because the program what we write here in the keil will later be dumped into the microcontroller and will be stored in the inbuilt ROM in the microcontroller.
19. Now click the option “Output” and give any name to the hex file to be created in the “Name of executable” text area and put a tick to the “Create HEX file” option present in the same window. The hex file can be created in any of the drives. You can change the folder by clicking on “Select folder for Objects”.
20. Now to check whether the program you have written is errorless or not, click on the icon exactly below the “Open file” icon which is nothing but Build Target icon. You can even use the shortcut key F7 to compile the program written.
21. To check for the output, there are several windows like serial window, memory window, project window etc. Depending on the program you have written, select the appropriate window to see the output by entering into debug mode.

22. The icon with the letter “d” indicates the debug mode.
23. Click on this icon and now click on the option “View” and select the appropriate window to check for the output.
24. After this is done, click the icon “debug” again to come out of the debug mode.
25. The hex file created as shown earlier will be dumped into the microcontroller with the help of another software called Proload/Topwin.

PROTEUS 8 PROFESIONAL:

Many CAD users dismiss schematic capture as a necessary evil in the process of creating PCB layout but Proteus 6 Professional has always disputed this point of view. With PCB layout now offering automation of both component placement and track routing, getting the design into the computer can often be the most time-consuming element of the exercise. And if you use circuit simulation to develop your ideas, you are going to spend even more time working on the schematic. ISIS has been created with this in mind. It has evolved over twelve years research and development and has been proven by thousands of users worldwide. The strength of its architecture has allowed us to integrate first conventional graph based simulation and now - with PROTEUS VSM - interactive circuit simulation into the design environment. For the first time ever, it is possible to draw a complete circuit for a micro-controller based system and then test it interactively, all from within the same piece of software. Meanwhile, ISIS retains a host of features aimed at the PCB designer, so that the same design can be exported for production with ARES or other PCB layout software.

The Proteus Professional v 8.6, Lab Center Electronics , has been used for the simulation and PCB layout designed purpose in our system. And this software proved to be the most comprehensive tool for testing many microcontroller based circuitry with MCU coding, of course and it has also helped to give professional look to our circuit.

Proteus is a simulation software used to simulate components and is capable of drawing desired citcuit.It is being used for fast checkup of code you have written for microcontrollers.

Proteus have huge list of components and many libraries available which can be added to include more components.

Proteus is a complete development platform from product concept to design completion. Its advantages are intelligent principle layout, hybrid circuit simulation and accurate analysis, single-chip software debugging, single-chip and

peripheral circuit co-simulation, PCB automatic layout and wiring. Labcenter, a British company and Proteus software developer, has been developed around the world for nearly 20 years. It is currently the most powerful and cost-effective EDA tool in more than 50 countries. It has been named the best EDA tool by EWW CAD REVIEW ROUNDUP. It is one step ahead of other competitors in philosophy, continuous model development and software upgrade thus to ensure first-class technology.

Proteus is a complete embedded system software and hardware design simulation platform, Proteus ISIS is an intelligent schematic input system, system design and Simulation of the basic platform to achieve the combination of single-chip microcomputer simulation and pspice circuit simulation. It has the functions of analog circuit simulation, digital circuit simulation, system simulation composed of single chip microcomputer and its peripheral circuit, RS232 dynamic simulation, I2C debugger, SPI debugger, keyboard and LCD system simulation, and various virtual instruments, such as oscilloscope, logic analyzer, signal generator, etc. ARES is a high-level PCB wiring editing software

The schematic diagram designed in ISIS can automatically export the network table after confirming that the device is packaged correctly. PCB layout and wiring can use 2D tools to design the PCB frame in the board Edge board side layer, set the wiring strategy, select the automatic or artificial device layout for wiring, and carry out DRC. (Design Rules Check) and ERC (Electrical Rules Check) can output Gerber files in layers for PCB boarding.

EASYEDA

EASYEDA corresponds to Easy Electronics Design Automation. The name itself indicates that it is easy to design circuits. This is the web-based tool package that allows embedded, hardware, and electrical engineers, and many others to design a circuit, simulate, share and look into the circuit's schematics, printed circuit boards, and simulations through this comprehensive tool. Integrated with LCSC components and JLCPCB PCB service, the tool allows users in turning their ideas into reality.

The title of the article itself mentions that is freely available software where any can use this tool without purchasing. Go with the process of registration and login and a person is ready to create their own circuits. The supported operating systems and browsers are (Windows, Mac, and Linux) and (Chrome, Internet Explorer, Safari, and Firefox). After designing the project, there is no chance of missing the project because it will be saved on the EasyEDA website itself.

Features

Assimilated with multiple features, this tool stands as the best and most utilized circuit development tool for many. A few of the basics/features of EasyEDA are:

- Shows easier and efficient capabilities in circuit designing
- Sharing – publicly and privately
- Can develop numerous open-source projects
- Supports script and provides API
- Embedded with components purchase and PCB fabrication features
- Online sharing of projects
- Recovery of documents at any level
- Exporting documents in PDF, SVG, and PNG forms
- Design rules checking
- BOM/DXF exports
- PCB module
- Access to nearly 10,00,000 public libraries
- Management of various libraries
- Creating and editing symbol/Subpart and Spice symbol/model
- Footprint creation and editing

Step-by-Step Designing

- Open the editor section in the tool
- Select either component/footprints to be created
- Create new components
- Create new footprints
- Schematic capture
- Verify the circuits through simulation procedure

EasyEDA supplies PCBs directly, or one can download the Gerber files and choose other suppliers to provide PCBs.

3. APPLICATIONS:

The line follower robots are one of the most basic robots used to follow black line on white background or vice versa. These robots may be used to in various industrial and domestic applications such as

- Carry goods
- Floor cleaning
- Delivery services
- Transportation

4. ADVANTAGES

Robot movement is automatic.

It is used for long distance applications.

Simplicity of building.

Fit and forget system.

Used in home, industrial automations

5.0 LIMITATIONS

- Line follower robot requires 2-3 inches broad line.
- It may not move properly if the black line drawn is of low intensity.
- The IR sensors may sometimes absorb IR rays from surroundings also. As a result, robots may move in improper way.

6.0 FUTURE ENHANCEMENT

- The knowledge is ever expanding and so are the problems which the mankind strives.
- In this spirit, it is hoped that the current activity will lead to further enhancements.
- We can use this for domestic application as well as commercial application in conjunction.
- For example: Work on future are military purpose by the robot.

7.0 CONCLUSION

The project “LINE FOLLOWING ROBOT” has been successfully designed and tested. It has been developed by integrating features of all the hardware components used.

Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly using highly advanced IC’s and with the help of growing technology the project has been successfully implemented.

8.0 SELF EVALUATION

In this project our achievements were a lot. As this project was under taken during our 5th semester session. It also helped in getting clear idea about interfacing of different IC with the microcontroller. The thing which we learn we can forget but the work which we do will remember forever.

During this project session we came with different problems, and to overcome these problems we worked together, referred many books, discussed with many staffs, browsed over internet and made many experiments as well as took many observations.

In future we would like to increase the application of our project and it can be implemented for domestic as well as commercial applications.

9.0 REFERENCES

- Electronics for you
- www.ijspr.in.com
- www.engineersgarage.com
- www.alldatasheets.com
- www.datasheetcatalog.com
- www.sunrom.com