Skyfi labs
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Roboversity

SENSOR BASED ROBOTICS

BRIEF DESCRIPTION OF ELECTRONIC COMPONENTS IN LINE FOLLOWERS

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SENSORS:

A Sensor is basically defined as a convertor which can sense and measure a physical quantity and then converts them into a signal so that it can be analyzed by an instrument. Infrared sensor is a particular type of a sensor which detects the intensity difference between white and black colour.

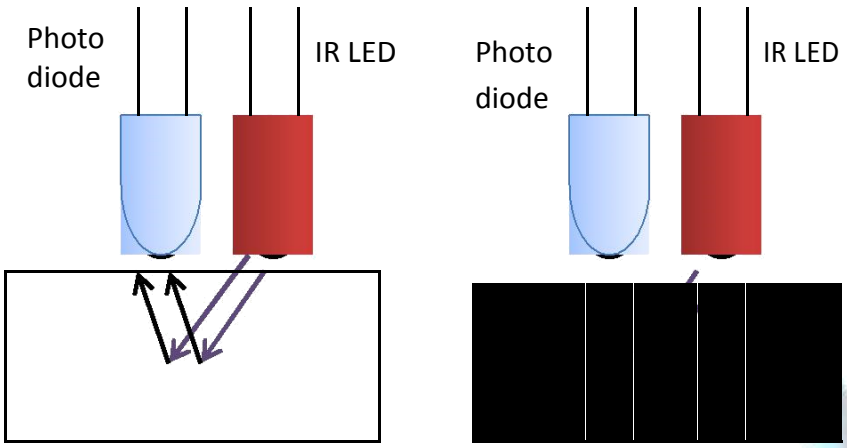


Fig.1. Light Reflected off white surface Fig2. Light absorbed by the black surface

IR reflective sensors have an emitter (IR LED-TX) and a receiver (Photo diode). If white surface is present beneath the IR LED, IR rays are reflected and are sensed by the receiver i.e. photodiode (refer fig1). While in the case of black surface, the light gets absorbed and hence receiver (photodiode) does not sense any IR rays (refer fig2).

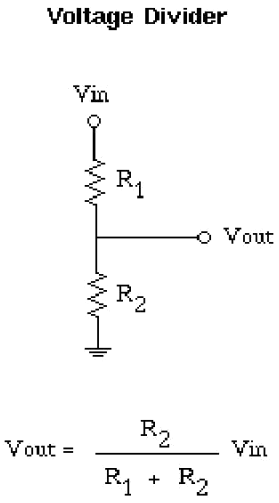
The photo diode is characterized by a property that its electrical resistance decreases when it is illuminated with IR light (i.e. it comes down, say from 150kΩ to 10kΩ). For sensing this change in the resistance we use voltage divider circuit

NOTE:

Voltage Divider is defined as the linear circuit that produces an output voltage which is a fraction of the input voltage.

The two resistor voltage divider is used to supply a voltage different from that of a supply voltage or from available battery. The output voltage depends on the resistance value of the load it drives. We use this two resistor voltage divider in sensors to convert the variation of resistance (with change in light intensity) of the photo diode into a corresponding change in voltage.

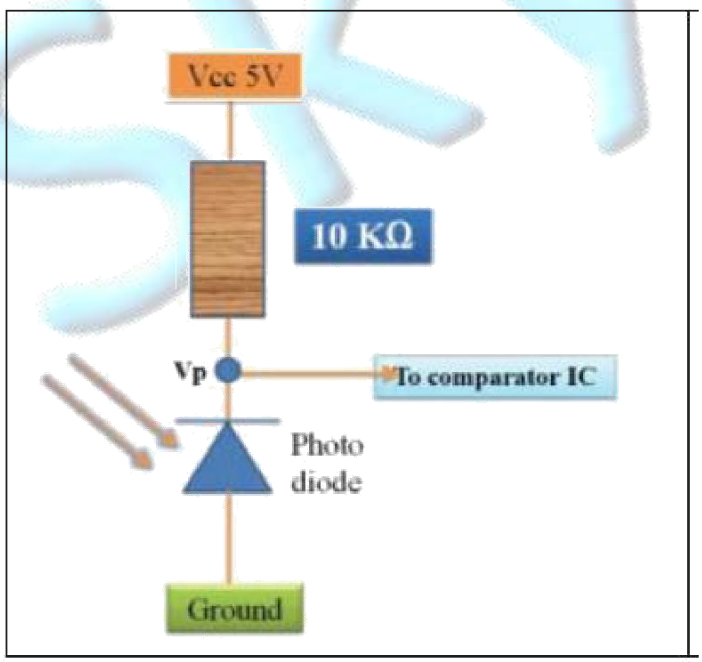
CALCULATION OF OUTPUT VOLTAGE FROM VOLTAGE



$$Vout = \frac{R_2}{R_1 + R_2} Vin$$

DIVIDER:

ILLUSTRATION OF THE SENSOR WORKING MECHANISM:



Let us consider R_s to be the resistance of the receiver (Photo Diode),As discussed earlier the R_s value varies for different intensities falling on the photo diode, let us assume the values of R_s to be ->

R_s=150Ω without light (black surface)

R_s=10kΩ with light (on white surface)

V_{cc}- Supply voltage

Let V_p be the output voltage that will be obtained across the voltage divider circuit,

On black surface-

V_p= [R_s/ (R_s+R)*V_{cc}] = [150/ (150+10)]*5V=4.68V

On white surface-

V_p= [R_s/ (R_s+R)*V_{cc}] = [10/ (10+10)]*5V=2.5V

This voltage change needs to be captured in the digital format for it to be given as an input to the microcontroller and, therefore, the output from the sensors needs to be converted from analog to digital. For this operation we use comparators.

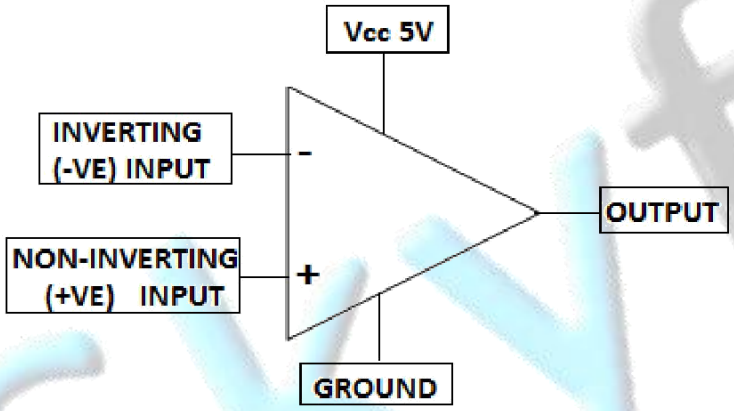
COMPARATOR:

It is an operational amplifier, which compares two input voltages and generates a high/low (binary) output.

Comparators are also used as Null detectors, Zero Crossing Detectors, Relaxation Oscillators, Level Shifters, in addition to its application as an Analog to Digital Converter (ADC).

When a comparator performs the function of deciding if an input voltage is above or below a given threshold, it is essentially performing a 1-bit quantization. This function is used in nearly all Analog to Digital Converters (ADC) and hence we use them to generate digital data from sensors' analog voltage input.

In a circuit diagram it is normally represented by a triangle having Inverting (-) and Non-Inverting (+) inputs, V_{cc}, Ground and Output.



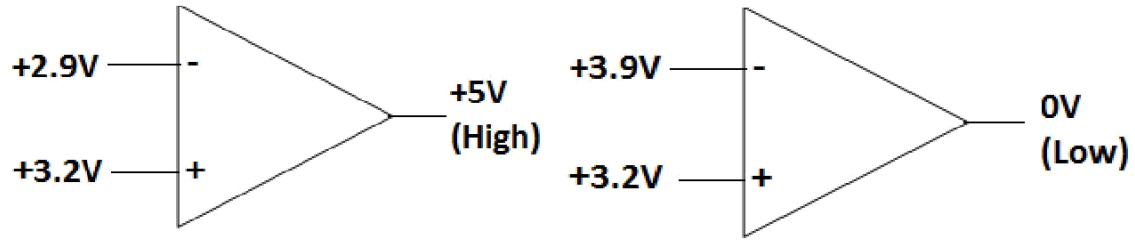
OPERATION OF A COMPARATOR:

CASE1:

Assume

V_{ref}(from Potentiometer) is connected to **Non-Inverting Input**

V_{in} (sensors' voltage) is connected to **Inverting input** then the output will be as follows:

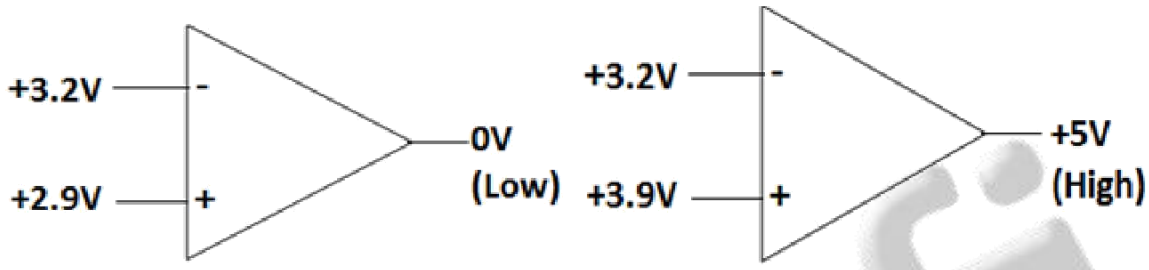


CASE2:

Assume

V_{ref}(from Potentiometer) is connected to **Inverting Input**

V_{in} (sensors' voltage) is connected to **Non- Inverting input** then the output will be as follows:



V_{in}<V_{ref}, output will be **low;** **V_{in}>V_{ref}**, output will be **high.**

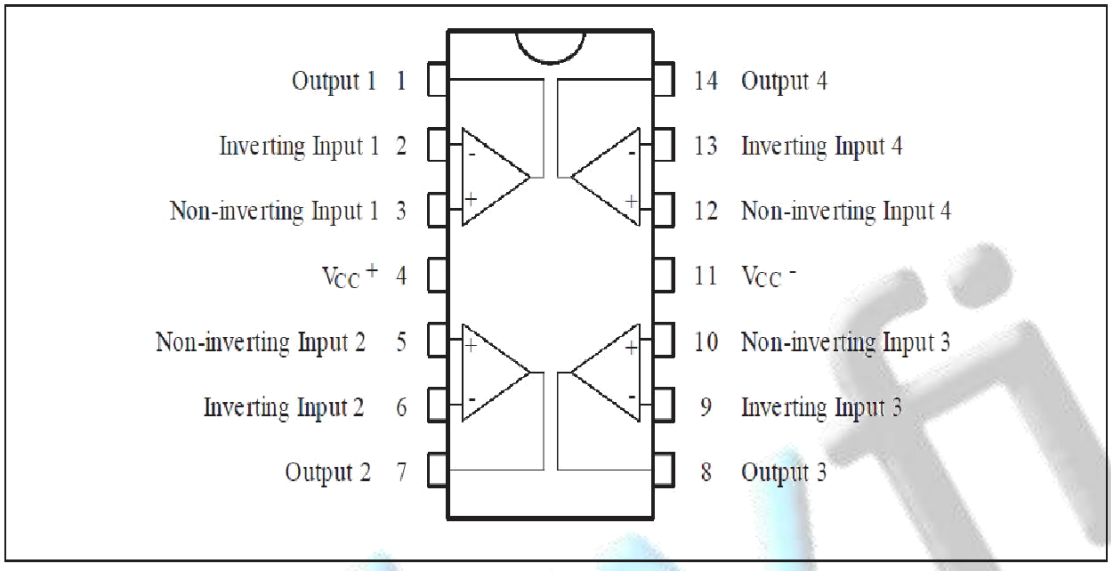
NOTE:

From the above observation it is very clear that when sensor Input is connected to the Inverting Input terminal then output changes inversely i.e. for inputs lower than the reference value, higher outputs are obtained and vice versa. When sensor input is connected to Non-Inverting input terminal then output would be same i.e. for inputs lower than reference value, lower outputs are obtained and vice versa. Hence the corresponding names for the input terminals.

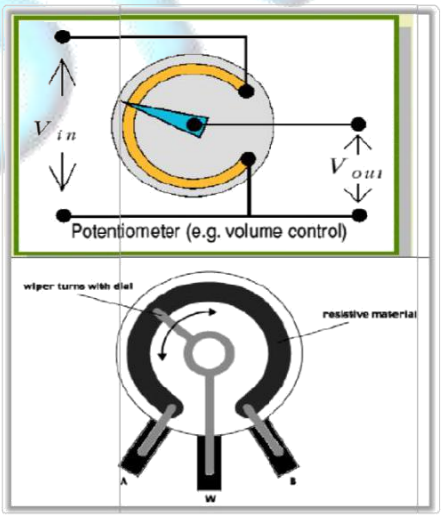
We can set the reference voltage by using the potentiometer, and for comparator circuitry operation LM324 IC is used which has got four Op-Amps in it.

LM324:

PIN CONNECTIONS (top view)

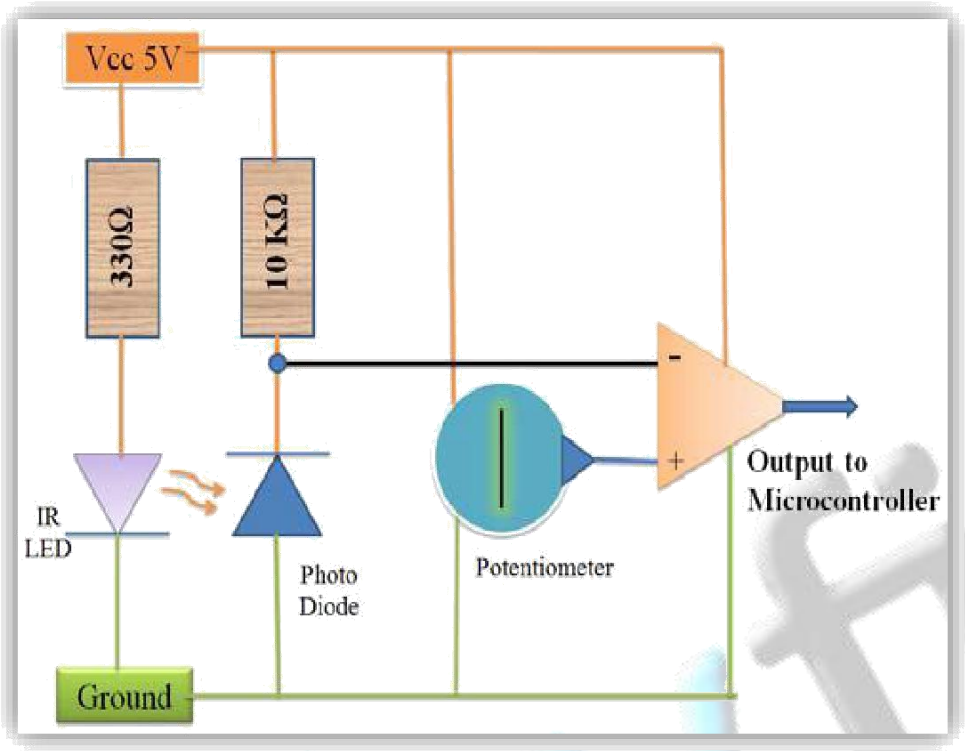


POTENTIOMETERS (VARIABLE RESISTOR):



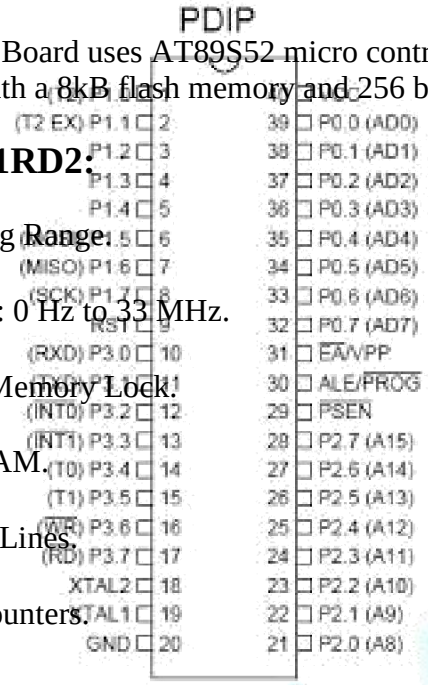
A potentiometer is a three-terminal resistor with a sliding contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat Potentiometers are used for setting up the reference voltage (V_{ref}).

OVERVIEW OF SENSOR CONNECTION:



After digitalizing the sensors' data, it is sent to micro controller for further processing and execution.

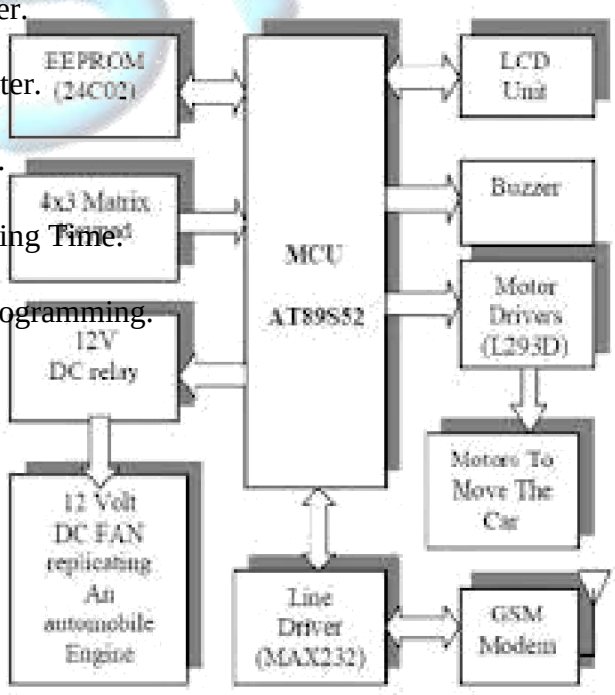
MICRO CONTROLLER:



The Skyfi Labs Development Board uses AT89S52 micro controller which comes under 8051 family. It is equipped with a 8kB flash memory and 256 bytes of data RAM.

FEATURES OF P89V51RD2:

- 4.0V to 5.5V Operating Range.
- Fully Static Operation: 0 Hz to 33 MHz.
- Three-level Program Memory Lock.
- 256 x 8-bit Internal RAM.
- 32 Programmable I/O Lines.
- Three 16-bit Timer/Counters.
- Eight Interrupt Sources.
- Full Duplex UART Serial Channel.
- Low-power Idle and Power-down Modes.
- Interrupt Recovery from Power-down Mode.
- Watchdog Timer.
- Dual Data Pointer.
- Power-off Flag.
- Fast Programming Time.
- Flexible ISP Programming.



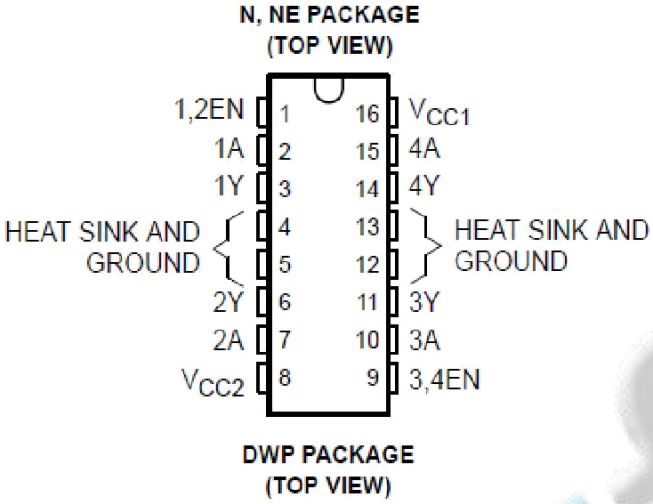
PIN DIAGRAM OF AT89S52:

In Skyfi Labs' development board, thePort1 Lower has been used for input (connected to comparator) and Port2 Lower for output (connected to motor driver).

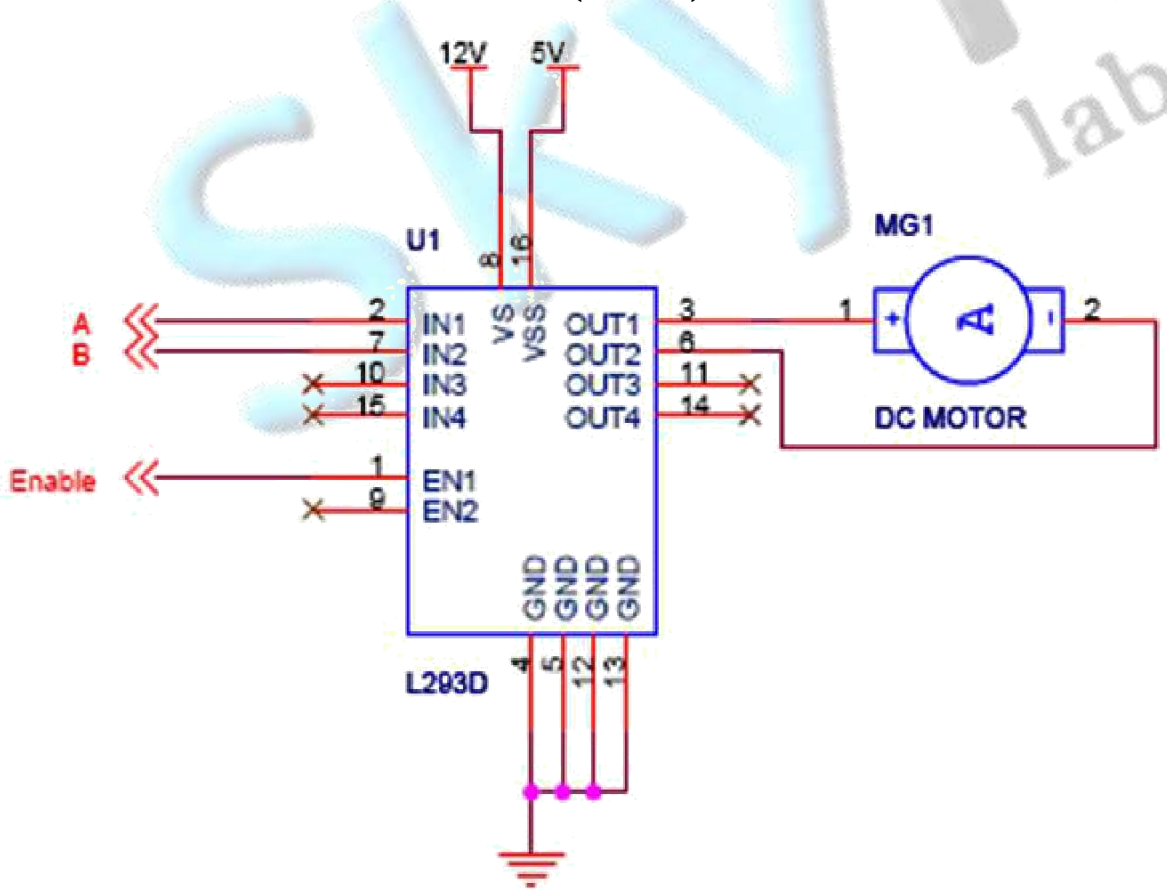
BLOCK DIAGRAM:

MOTOR DRIVER:

- The L293 and L293D are quadruple high-current half-H drivers.
- The L293 is designed to provide bidirectional drive currents of up to 1A at voltages from 4.5V to 3.6V



OPERATION OF MOTOR DRIVER (L293D):



TRUTH TABLE:

A	B	DESCRIPTION
0	**0**	Motor stops or Breaks
0	**1**	Motor Runs Anti-Clockwise
1	**0**	Motor runs Clockwise
1	**1**	Motor stops or breaks

For the above table, the Enable has to be set 1. Motor power is mentioned as 12V, but the power supply can be connected according to the rating of the motors used.

NOTE:

- The above operation of a Motor Driver demonstrates its working with only one DC motor connected to it. Note that in our robot the PCB is used to drive two motors and the settings need to be done accordingly.

DC MOTORS:

D.C Motors are the easiest to control. One D.C Motor requires two signals for its operation. To change its direction one just needs to reverse the polarity of power supply across it.

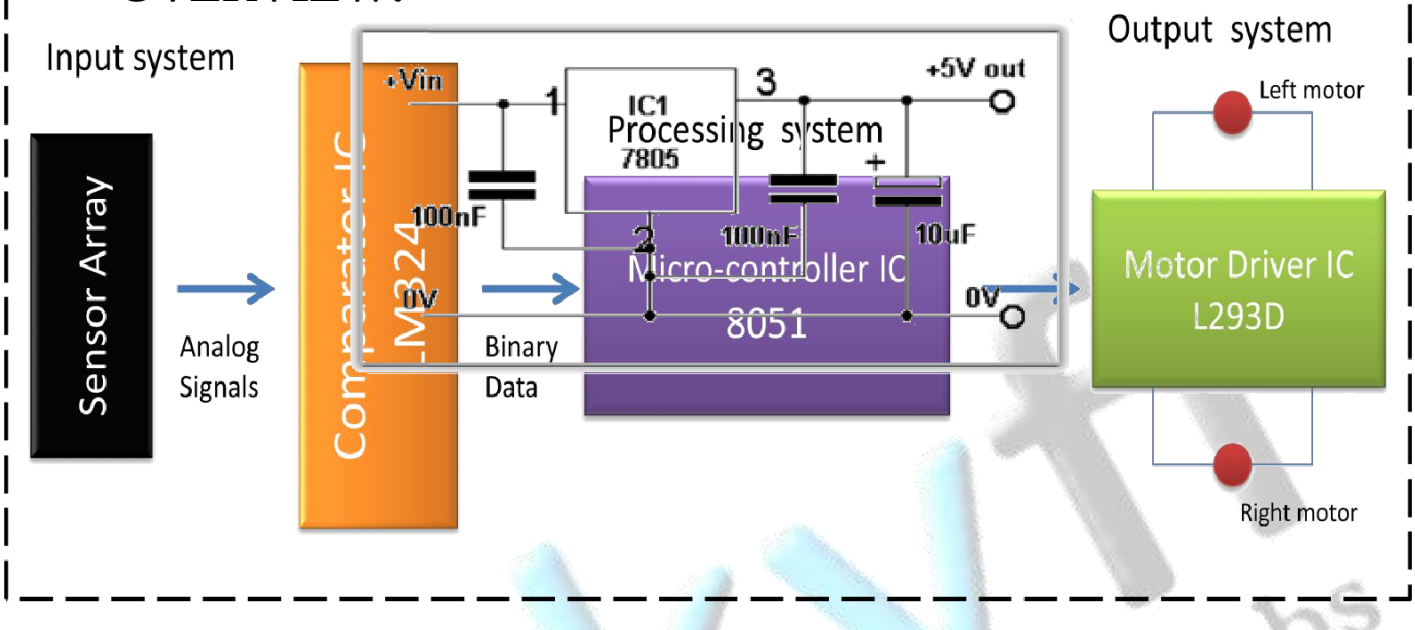
Figure of DC Motor

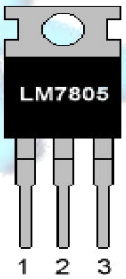
Speed of motor depends upon its RPM rating and we can vary the speed of motor by changing the voltage across the motor terminals. Gears are used to increase the torque of D.C Motor on the expense of its speed.

SPECIFICATIONS OF THE MOTORS USED IN WORKSHOP:

60 RPM-12V DC Geared Motor.

OVERVIEW:





VOLTAGE REGULATOR:

7805 is a **Voltage Regulator** Integrated Circuit. It is a member of 78xx series of fixed linear voltage regulator ICs.

BLOCK DIAGRAM:

The **Voltage Regulator IC** maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage to which it is designed to provide. 7805 provides +5V regulated power supply.

PIN DIAGRAM OF 7805:

PIN CONFIGURATION OF 7805:

Pin No	NAME	FUNCTION
1	Input	Input Voltage; (5V-18V)
2	Ground	Ground (0V)
3	Output	Output Voltage; (4.8V-5.2V)