Project submitted in partial fulfillment for the Degree of B. Tech in Applied Electronics & Instrumentation Engineering under West Bengal University of Technology

AUTONOMOUS TEMPERATURE MONITORING ROBOT FOR HAZARDOUS ENVIRONMENT

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CERTIFICATE OF APPROVAL

The project report titled "Autonomous Temperature Monitoring Robot for Hazardous Environment" prepared by **Ananda Ghosh**, Roll No:11705514003, **Eleena Ghosh**, Roll No:11705514015, **Subham Karmakar**, Roll No:11705514032,is hereby approved and certified as a creditable study in technological subjects performed in a way sufficient for its acceptance for partial fulfilment of the degree for which it is submitted.

It is to be understood that by this approval, the undersigned do not, necessarily endorse or approve any statement made, opinion expressed or conclusion drawn therein, but approve the project only for the purpose for which it is submitted.

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RECOMMENDATION

I hereby recommend that the project report titled "**Autonomous Temperature Monitoring Robot for Hazardous Environment**" prepared by **Ananda Ghosh**, Roll No:11705514003, **Eleena Ghosh**, Roll No:11705514015, **Subham Karmakar**, Roll No:11705514032, be accepted in partial fulfillment of the requirement for the Degree in, Bachelor of Technology from Applied Electronics &Instrumentation Engineering, RCC Institute of Information Technology, Kolkata under MaulanaAbulKalam Azad University of Technology, West Bengal (Formerly known as West Bengal University of Technology)

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Dr. Srijan Bhattacharya

Table of content:

List of Figures **Page No.**

List of Tables Page No.

ABSTRACT

In today's world robotics is a fast growing and an interesting field. Now a days communication is part of advancement of technology, so we decided to work on this field, and design something which will make human life simpler on day today aspect.

This project is a basic stage of any automatic robot. This robot has suffiecient intelligence to cover the maximum area of provided space. The robotic vehicle has an intelligence built in it such that it directs itself whenever an obstacle comes in its path. This robotic vehicle is built, using a micro-controller of AT mega 8 family. An ultrasonic sensor is used to detect any obstacle ahead of it and sends a command to the microcontroller. Depending on the input signal received, the micro-controller redirects the robot to move in an alternate direction by actuating the motors which are interfaced to it through a motor driver.

Furthermore, it is also capable of detecting the temperature and humidity of the surrounding area. With the help of ESP8266 it also transmits the data collected to a remote computer.

1. INTRODUCTION

From its initiation in the 1950s, modern robots have come a long way and rooted itself as an immutable aid in the advancement of humankind. In the course of time, robots took many forms, based on its application, and its size varied from a giant 51 feet to microscopic level. In the course of technological developments of robots, one aspect remained instrumental to their function, and that is mobility.

Robotics is the branch of technology that deals with the design, construction, operation, and application of robots. A machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer is defined as a robot. Obstacle avoidance is a primary requirement of any autonomous mobile robot.Obstacle avoidance Robot is design to allow robot to navigate in unknown environment by avoiding collisions.[1]Obstacle avoiding robot senses obstacles in the path,avoid it and resumes its running. There are some very famous methods for robot navigation like wall-following, edge detection, line following.Obstacle avoidance in robots can bring more flexibility in maneuvering in varying environments and would be much more efficient as continuous human monitoring is not required. This project developed an obstacle avoiding robot which can move without any collision by sensing obstacles on its course with the help of ultrasonic distance sensors and the temperature and humidity with DHT11.

[2]To date, there have been a number of successful attempts in designing obstacle avoiding robots. These works differ by selection of sensors, path mapping process and the algorithms applied to set the operational parameters. There have been numerous projects in this arena using laser scanner, infrared sensor, GPS and multiple sensors to accomplish obstacle detection and avoidance. Researchers are persistently trying to find more precise ways to develop autonomous robot or vehicle movement technology.

2. PROPOSED SYSTEM

The project proposes a autonomous robotic vehicle, In which no remote is used for controlling the robotic actions. It intelligently detects obstacles present on its path through the sensors,avoid it and take decision on the basis of internal code that we set for it. The detail information is givenin the following subtopics which will help you to understand the whole system and its design.

3. DESCRIPTION

3.1. BASIC DESIGN OF ROBOT

This robot was built an Arduinodevelopment board on which microcontroller is placed.Arduino board is connected with DC Motor throughMotor driver board(pin 2, pin 3, pin 4, pin 5).The movement of robot will be stop whenever there is an obstacle is present on its path which can be detected by ultrasonic sensors. Ultrasonic sensors give time in length to the microcontroller asa input for further actions. The temperature detecting sensor is connected with the arduino as well.

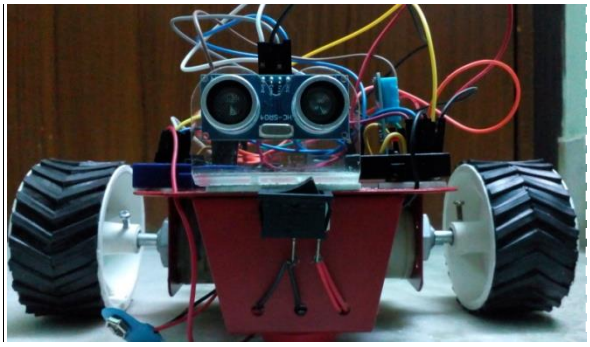

Fig 1. Front view of an obstacle avoiding robot

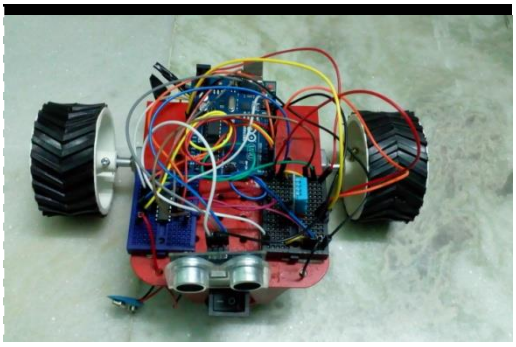

Fig 2. Top view of an obstacle avoiding bot

3.2. SENSOR FOR OBSTACLE AVOIDANCE

Varieties of sensors are available which can be used forthe detection of obstacles. Some of the very popular sensors are: Infrared sensors (IR),Ultrasonic sensors, Cameras, which can be used as a part of Computer Vision, Sonar. It can measure the distancein its field of view of about thousands to hundredspoint. In the design of robot, we are usingultrasonic sensors for obstacle

detection and avoidance. The ultrasonic sensors continuously emit the frequency signals, when obstacle is detected these signals are reflected back which then considered as input to the sensor.

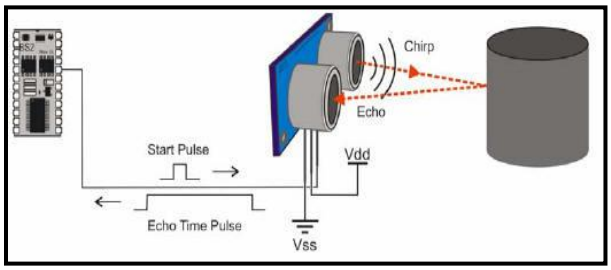

Fig 3. Schematic Diagram

The ultrasonic sensor consists of a multi vibrator,which is fixed at its base. The multi vibrator is combination of a resonator and vibrator. The ultrasonic waves generated by the vibration are delivers to the resonator. Ultrasonic sensor consists of two parts: the emitter which produces a 40kHz sound wave and detector which detects 40 kHz sound wave and sends electrical signal back to the microcontroller. In our project, we are using HC-SR04 ultrasonic sensors which consist of 4 pins VCC, Trigger, Echo and GND.

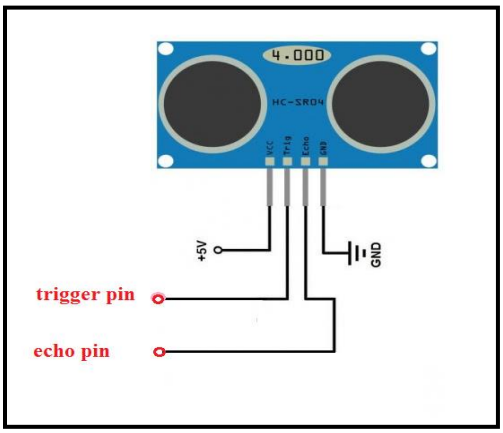

Fig 4. HC-SRO4 Sensor Diagram

Features:

Power Supply: +5V DC

Working Current: 15mA

Effectual Angle: <15degree

Ranging Distance: 2cm – 400cm

Resolution: 0.3cm

Measuring Angle: 30 degree

3.3. TEMPERATURE AND HUMIDITY SENSOR (DHT 11)

The DHT sensors are made of two parts, a capacitive humidity sensor and a thermistor. There is also a very basic chip inside that does some analog to digital conversion and spits out a digital signal with the temperature and humidity. The digital signal is fairly easy to read using any microcontroller.

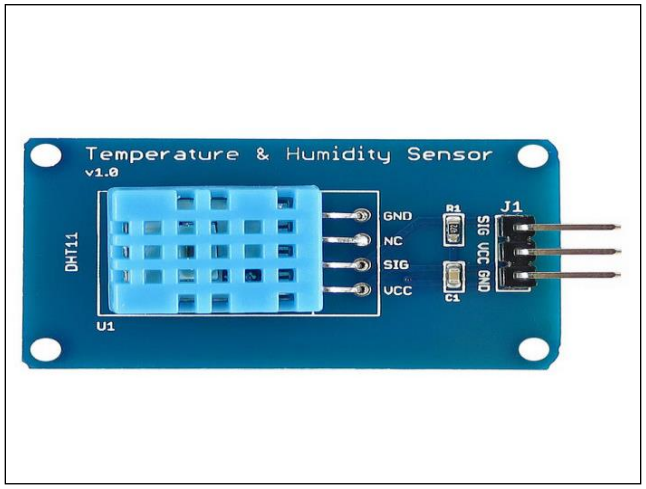

Fig 5. Temperature and Humidity measuring sensor

- Ultra low cost
- 3 to 5V power and I/O
- 2.5mA max current use during conversion (while requesting data)
- Good for 20-80% humidity readings with 5% accuracy
- Good for 0-50°C temperature readings ±2°C accuracy
- No more than 1 Hz sampling rate (once every second)
- Body size 15.5mm x 12mm x 5.5mm
- 4 pins with 0.1" spacing

3.4. ARDUINO UNO R3

The Arduino Uno R3 is a microcontroller board based on a removable, dual-inline-package (DIP) ATmega328 AVR microcontroller. It has 20 digital input/output pins (of which 6 can be used as PWM outputs and 6 can be used as analog inputs). Programs can be loaded on to it from the easy-to-use Arduino computer program. The Arduino has an extensive support community,

which makes it a very easy way to get started working with embedded electronics. The R3 is the third, and latest, revision of the Arduino Uno.

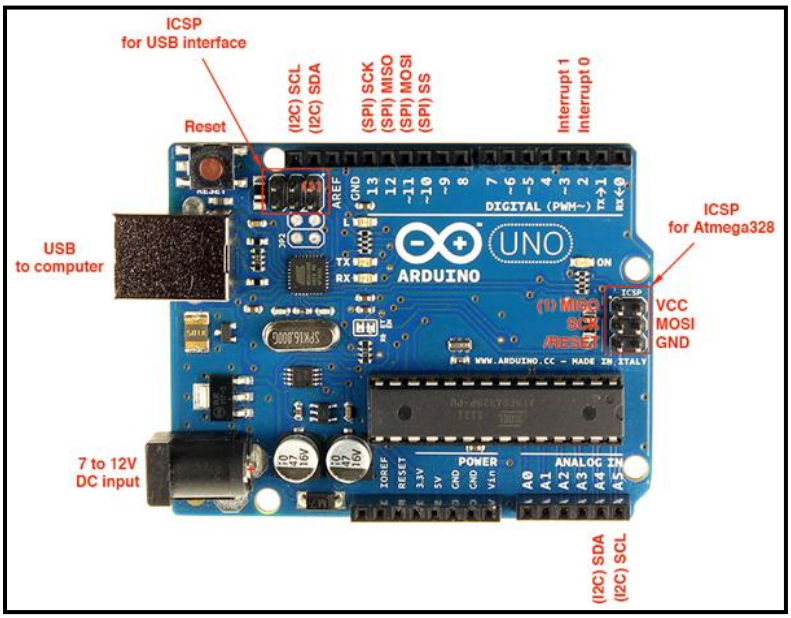

Fig 6. Arduino Uno R3

SPECIFICATIONS:

- Microcontroller: ATmega328P
- Operating Voltage : 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limit): 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- PWM Digital I/O Pins: 6
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB (ATmega328P) of which 0.5 KB used by bootloader
- SRAM: 2 KB (ATmega328P)
- EEPROM: 1 KB (ATmega328P)
- Clock Speed: 16 MHz

3.5. MOTOR DRIVER L293D

L293D is a dual H-Bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.

L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.

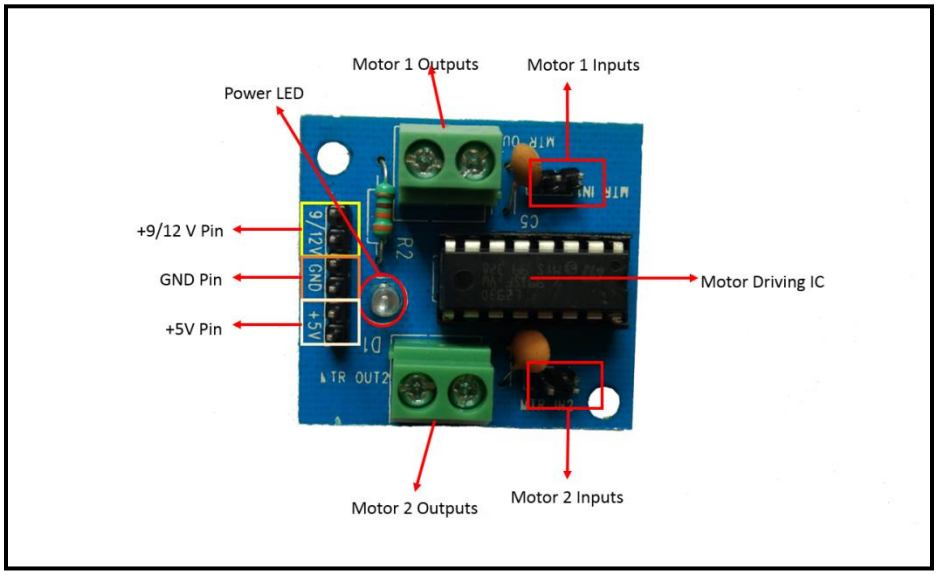

Fig 7. Motor driver L293D

SPECIFICATIONS:

- Supply Voltage Range 4.5V to 36V
- 600-mA Output current capability per driver
- Separate Input-logic supply
- It can drive small DC-geared motors, bipolar stepper motor.
- Pulsed Current 1.2-A Per Driver
- Thermal Shutdown

- Internal ESD Protection

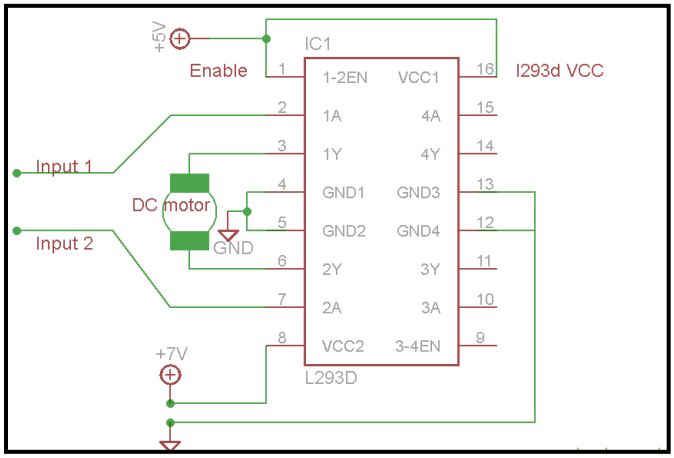

Fig 8. Pin Diagram of l293D

Geared DC motors were coupled with rear wheels of car. It was used to drive car. Interfacing of DC motor done through H-Bridge IC (L293D).

Specification:

- 12V DC.
- 300RPM.

3.6. NODE MCU ESP 8266

The MCU ESP8266 is low cost Wireless Fidelity (wi-fi) module with MCU (microcontroller unit) capability.This small module allows microcontrollers to connect to a Wi-Fi network. It is manufactured by Espressif system which is a Chinese manufacturer.

In our project we have used this wi-fi module to wirelessly communicate with the robot.

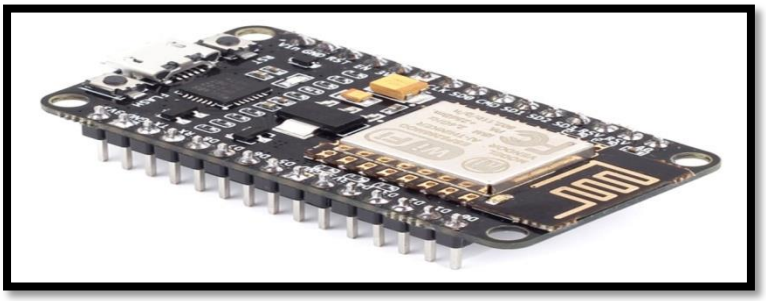

Fig 9. Node MCU ESP 8266

3.7. MISCELLANEOUS

- 9V Adapter
- 2 Wheels
- 3 Breadboards
- Sensor Brackett
- Jumper Wires

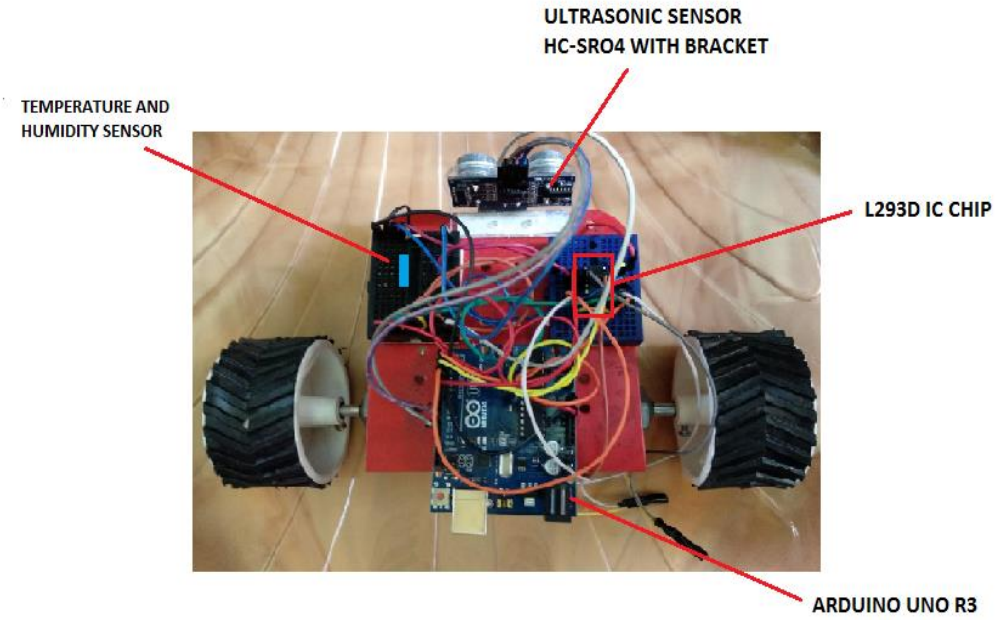

Fig 10. The robot with its different parts.

4. BLOCK DIAGRAM:

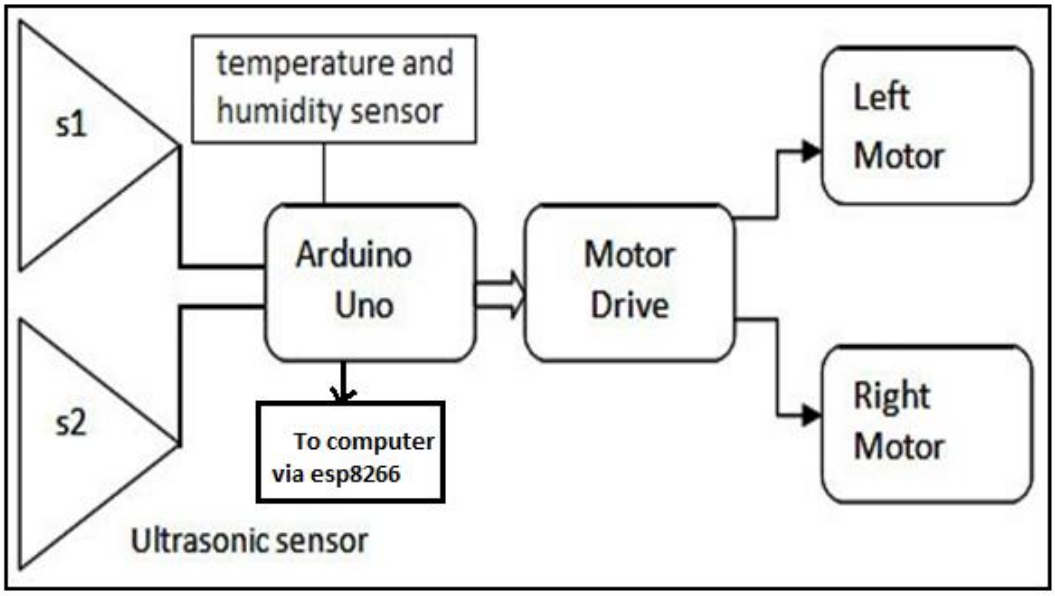

Fig 11. Block Diagram of an Obstacle Avoiding Robot.

5. CIRCUIT DIAGRAM:

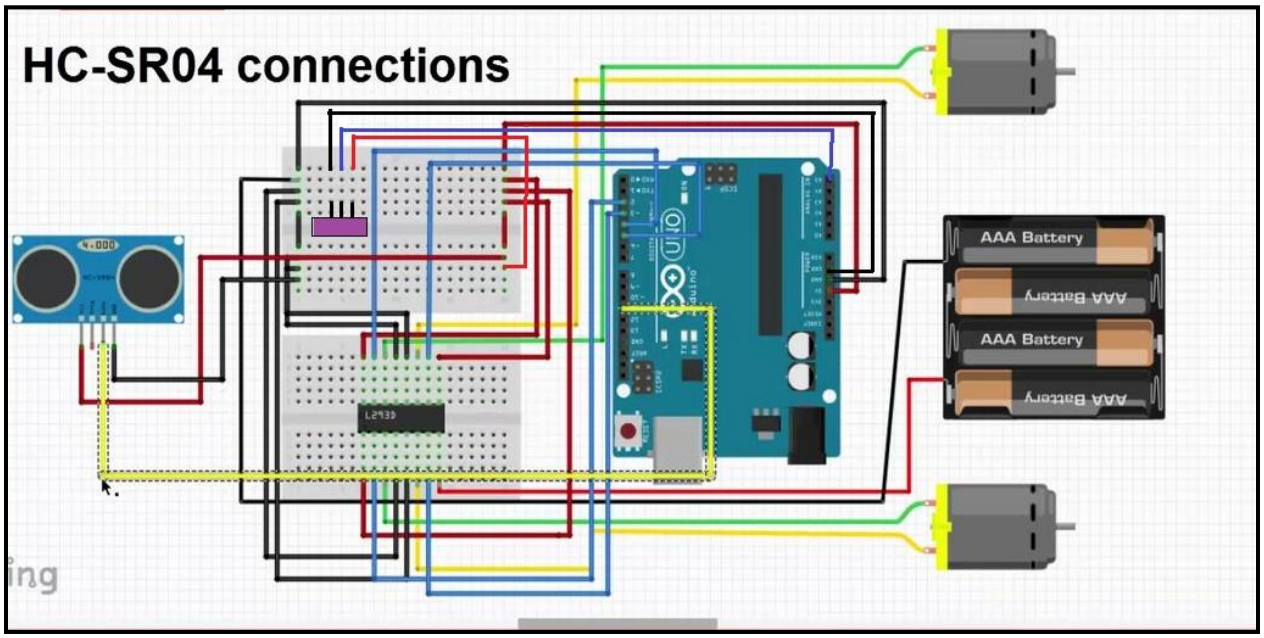

Fig 12. Circuit Diagram

6. FLOW CHART

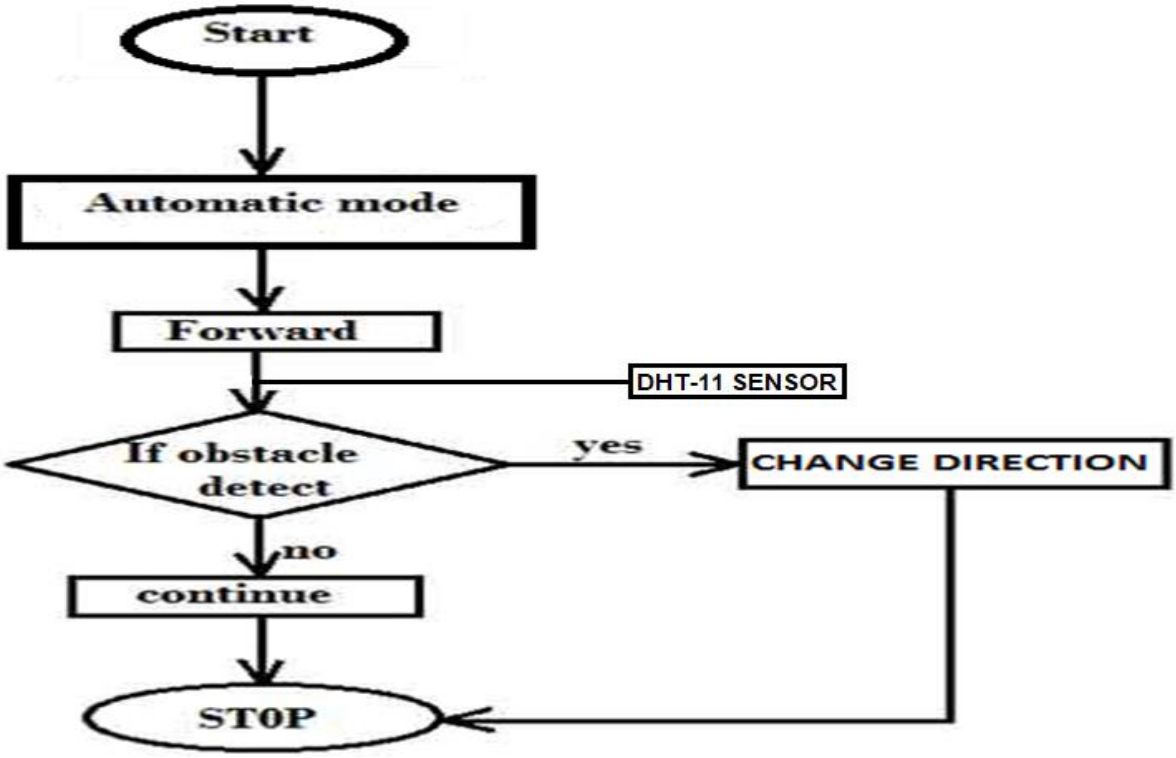

Fig. 13. Flow chart of the program

7. CODING.

```
#include "DHT.h"
#define DHTPIN 8     // what pin we're connected to
#define DHTTYPE DHT11   // DHT 11
DHT dht(DHTPIN, DHTTYPE);
constint trig = 12;
constint echo = 11;
constintleftForward = 2;
constintleftBackward = 3;
constintrightForward = 4;
constintrightBackward = 5;
```

```
int duration = 0;
int distance = 0;
void setup()
{
pinMode(trig , OUTPUT);
pinMode(echo , INPUT);
pinMode(leftForward , OUTPUT);
pinMode(leftBackward , OUTPUT);
pinMode(rightForward , OUTPUT);
pinMode(rightBackward , OUTPUT);
Serial.begin(9600);
dht.begin();
}
void loop()
{
digitalWrite(trig , HIGH);
delayMicroseconds(1000);
digitalWrite(trig , LOW);


duration = pulseIn(echo , HIGH);
distance = (duration/2) / 28.5 ;
Serial.println("duration=");
Serial.println(duration);
delay(1000);
Serial.println("distance=");
Serial.println(distance);
float h = dht.readHumidity();
float t = dht.readTemperature();
  // check if returns are valid, if they are NaN (not a number) then something went wrong!
if (isnan(t) || isnan(h)) {
```

```
Serial.println("Failed to read from DHT");
  } else {
Serial.print("Humidity: ");
Serial.print(h);
Serial.print(" %\t");
Serial.print("Temperature: ");
Serial.print(t);
Serial.println(" *C");
delay(3000);
  }
if ( distance < 50 )
  {
digitalWrite(leftForward , LOW);
digitalWrite(leftBackward , HIGH);
digitalWrite(rightForward , HIGH);
digitalWrite(rightBackward , LOW);
delay(1000);

  }
else
  {
digitalWrite(leftForward , HIGH);
digitalWrite(leftBackward , LOW);
digitalWrite(rightForward , HIGH);
digitalWrite(rightBackward , LOW);
  }
}
```

8. RESULT

In this project, an Obstacle Avoiding Robot is designed. It is an Arduino based robot that uses ultrasonic range finder sensors to avoid collisions. In addition to that it can also measure the temperature and humidity of the surrounding area and feed the result back to a remote computer. The robot has been based assembled based on the circuit diagram and programming done based on the flow chart.

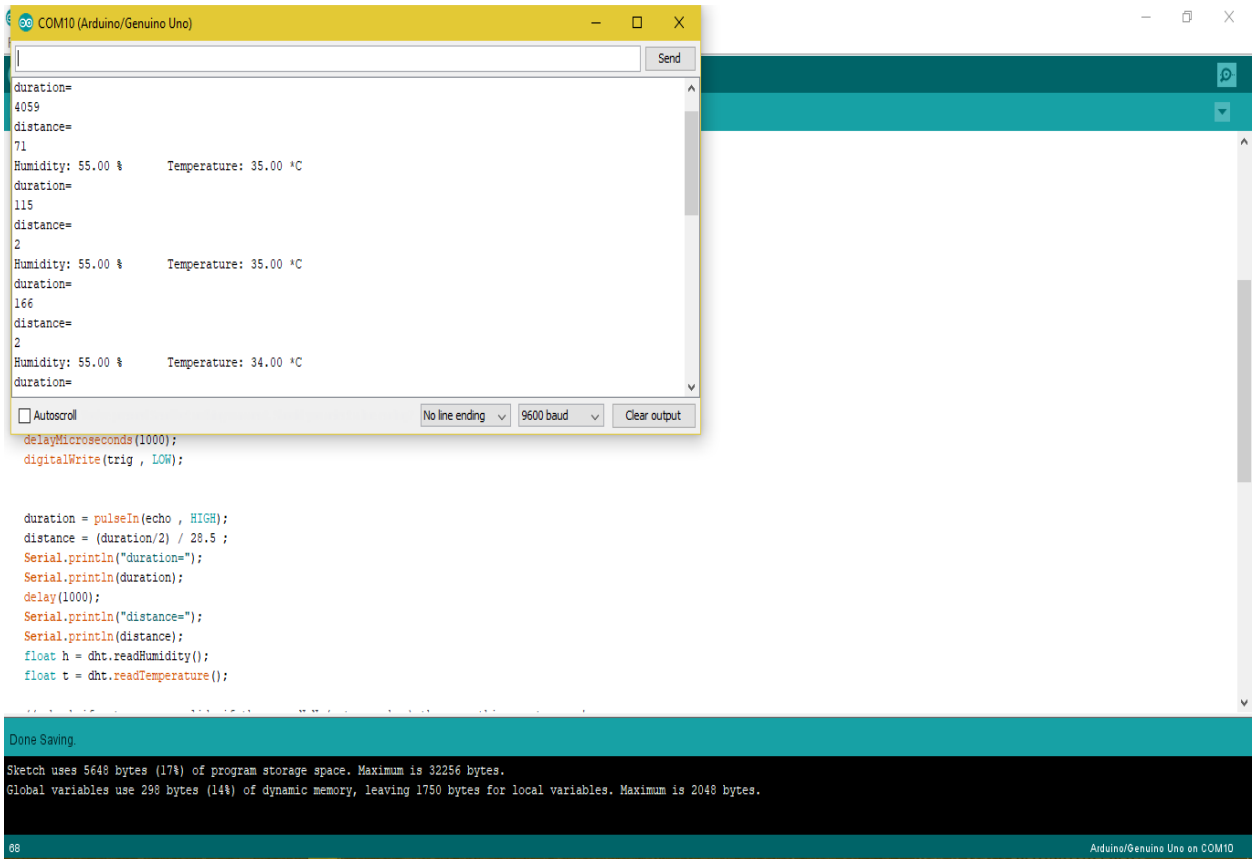

Fig 14. Parameters sensed by the bot as shown in the serial monitor.

Fig 15. The robot before detecting an obstacle

Fig 16. The robot after detecting an obstacle changes direction.

9. CONCLUSION

An autonomous temperature monitoring robot for hazardous environment is an intelligent robot, which can automatically sense the temperature and overcome obstacles on its path. It contains of a Microcontroller to process the data, and Ultrasonic sensors to detect the obstacles on its path.

Obstacle avoidance is one of the most important aspects of mobile robotics. Without it .robot movement would be very restrictive and fragile. This project also presents a dynamic steering algorithm which ensures that the robot does n'thave to stop in front of an obstacle which allows robot to navigate smoothly in an unknown environment, avoiding collisions.

It has a vast field of application. They can be used as services robots. Equally they have great importance in scientific exploration and emergency rescue, there may be places that are dangerous for humans or even impossible for humans to reach directly, then we should use robots to help us. In those challenging environments, the robots need to gather information about their surroundings to avoid obstacles. Nowadays, even in ordinary environments, people require that robots to detect and avoid obstacles.

10. REFERENCES

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11. PRICE ESTIMATION

SLNo.	ITEM	QTY	PRICE (INR)
1.	9V 1A Adapter	1 Pc.	120
2.	Arduino UNO R3	1Pc.	400
3.	HC-SR04	1 Pc.	100
4.	L293D	1Pc.	110
5.	Wheel	2Pc.	70
6.	Breadboard	3Pc.	180
7.	9V Battery	1PC.	20
8.	Sensor Brackett	1PC.	70
9.	Wire	10Pc.	50
10.	Big Breadboard	1Pc.	60
11.	Veroboard	1Pc.	50
12.	Base	1Pc.	5
13.	DHT11	1Pc.	100
14.	L293D Chip	1Pc.	30
15.	Node mcu	1Pc.	400
16.	Jumper Wire	10Pc.	50
18.	Rechargeable battery and charger	1Pc	400
	TOTAL		2245

.

Table no 1

12. DATASHEETS

12.1. Ultrasonic ranging module : HC-SR04

Specifications: power supply:5V DC quiescent current :<2mA effectual angle: <15° ranging distance: 2cm – 400cm.

A short ultrasonic pulse is trransmitted at the time 0, reflected by an object. The senor receives this signal and converts it to an electric signal. The next pulse can be transmitted when the echo is faded away. This time period is called cycle period. The recommend cycle period should be no less than 50ms. If a 10μs width trigger pulse is sent to the signal pin, the Ultrasonic module will output eight 40kHz ultrasonic signal and detect the echo back. The measured distance is proportional to the echo pulse width and can be calculated by the formula above. If no obstacle is detected, the output pin will give a 38ms high level signal.

12.2. ARDUINO UNO R3

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip.

Summary :

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V

Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

- Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The power pins are as follows:

- VIN. The input voltage to the Arduino board when it's 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 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it.
- 3V3. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND. Ground pins.

• Memory

The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

• Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode(),digitalWrite(), and digitalRead()functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt()function for details.
- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite()function.
- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.
- LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

12.3. MOTOR DRIVER L293D

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
VS	Supply Voltage	36	V
VSS	Logic Supply Voltage	36	V
V_i	Input Voltage	7	V
Ven	Enable Voltage	7	V
Io	Peak Output Current (100 µs non repetitive)	1.2	A
Ptot	Total Power Dissipation at T_{pins} = 90 °C	4	W

Tstg, Tj	Storage and Junction Temperature	– 40 to 150	°C

Table no 2

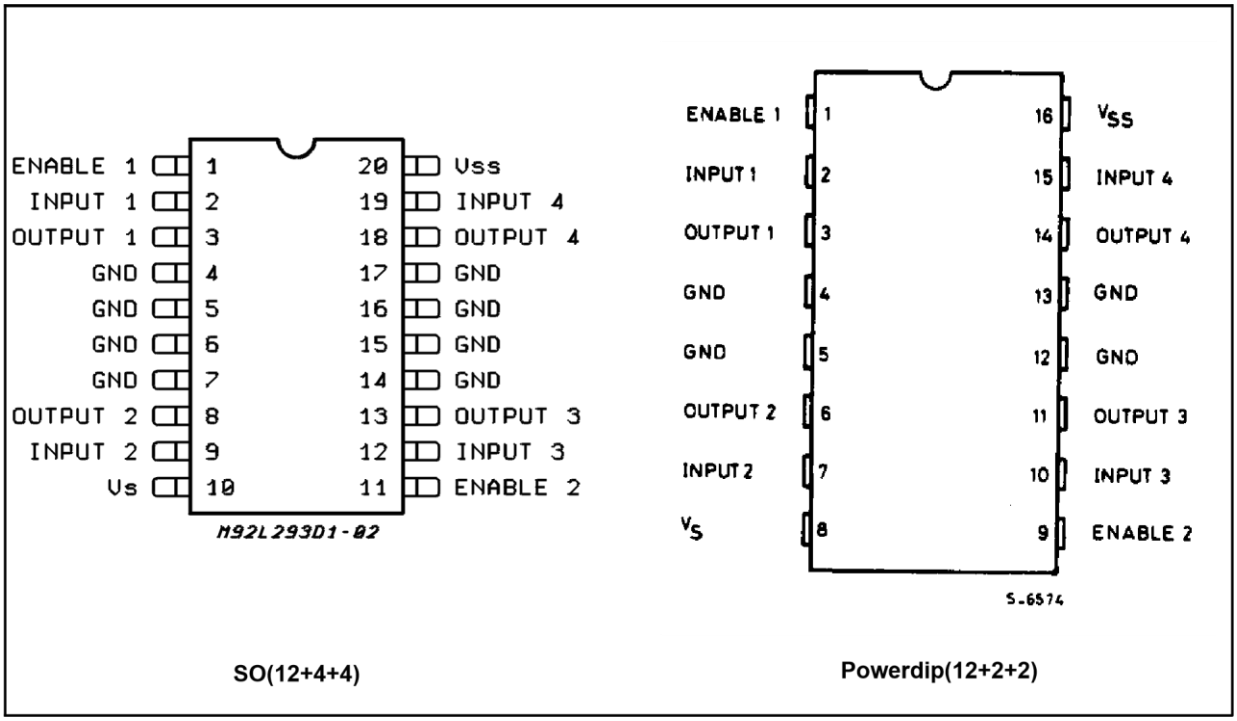

Fig 17. Pin configuration

12.4. NODEMCU ESP-8266

Espressif's ESP8266EX delivers highly integrated Wi-Fi SoC solution to meet users' continuous demands for efficient power usage, compact design and reliable performance in the Internet of Things industry.

With the complete and self-contained Wi-Fi networking capabilities, ESP8266EX can perform either as a standalone application or as the slave to a host MCU. When

ESP8266EX hosts the application, it promptly boots up from the flash. The integrated highspeed cache helps to increase the system performance and optimize the system memory.

- Wi-Fi Protocols
- 802.11 b/g/n/e/i support.
- Wi-Fi Direct (P2P) support.

- P2P Discovery, P2P GO (Group Owner) mode, GC(Group Client) mode and P2P Power Management.
- Infrastructure BSS Station mode / P2P mode / SoftAP mode support.
- Hardware accelerators for CCMP (CBC-MAC, counter mode), TKIP (MIC, RC4), WAPI (SMS4), WEP (RC4), CRC.
- WPA/WPA2 PSK, and WPS driver.
- Additional 802.11i security features such as pre-authentication, and TSN.
- Open Interface for various upper layer authentication schemes over EAP such as TLS, PEAP, LEAP, SIM, AKA, or customer specific.
- 802.11n support (2.4 GHz).
- Supports MIMO 1×1 and 2×1, STBC, A-MPDU and A-MSDU frame aggregation and 0.4 μs guard interval.
- WMM power low U-APSD.
- Multiple queue management to fully utilize traffic prioritization defined by 802.11e standard.
- UMA compliant and certified.
- 802.1h/RFC1042 frame encapsulation.
- Scattered DMA for optimal CPU off load on Zero Copy data transfer operations.
- Antenna diversity and selection (software managed hardware).
- Clock/power gating combined with 802.11-compliant power management dynamically adapted to current connection condition providing minimal power consumption.
- Adaptive rate fallback algorithm sets the optimum transmission rate and Tx power based on actual SNR and packet loss information.
- Automatic retransmission and response on MAC to avoid packet discarding on slow host environment.
- Seamless roaming support.

- Configurable packet traffic arbitration (PTA) with dedicated slave processor based design provides flexible and exact timing Bluetooth co-existence support for a wide range of Bluetooth Chip vendors.

Dual and single antenna Bluetooth co-existence support with optional simultaneous receive (Wi-Fi/Bluetooth) capability.

Specifications:

Categories	Items	Parameters
Wi-Fi	Standards	FCC/CE/TELEC/SRRC
	Protocols	802.11 b/g/n/e/i
	Frequency Range	2.4G ～ 2.5G (2400M ～ 2483.5M)
	Tx Power	802.11 b: +20 dBm
		802.11 g: +17 dBm
		802.11 n: +14 dBm
	Rx Sensitivity	802.11 b: -91 dbm (11 Mbps)
		802.11 g: -75 dbm (54 Mbps)
		802.11 n: -72 dbm (MCS7)
	Antenna	PCB Trace, External, IPEX Connector, Ceramic Chip
Hardware	CPU	Tensilica L106 32-bit micro controller
	Peripheral Interface	UART/SDIO/SPI/I2C/I2S/IR Remote Control GPIO/ADC/PWM/LED Light & Button
	Operating Voltage	2.5V ~ 3.6V
	Operating Current	Average value: 80 mA
	Operating Temperature Range	-40°C ~ 125°C
	Storage Temperature Range	-40°C ~ 125°C
	Package Size	QFN32-pin (5 mm x 5 mm)
	External Interface	-

Software	Wi-Fi Mode	Station/SoftAP/SoftAP+Station
	Security	WPA/WPA2
	Encryption	WEP/TKIP/AES
	Firmware Upgrade	UART Download / OTA (via network)
	Software Development	Supports Cloud Server Development / Firmware and SDK for fast on-chip programming
	Network Protocols	IPv4, TCP/UDP/HTTP/FTP
	User Configuration	AT Instruction Set, Cloud Server, Android/iOS App

Table 3.

12.5. DHT 11

- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA (measuring) 60uA (standby)
- Output: Serial data
- Temperature Range: 0°C to 50°C
- Humidity Range: 20% to 90%
- Resolution: Temperature and Humidity both are 16-bit
- Accuracy: ±1°C and ±1%
- The **DHT11** is a commonly used **Temperature and humidity sensor.** The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor is also factory calibrated and hence easy to interface with other microcontrollers.

- The sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracy of ±1°C and ±1%. So if you are looking to measure in this range then this sensor might be the right choice for you.