A MAJOR PROJECT ON

"Solar Air Dust Purifier"

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF

DIPLOMA IN AUTOMOBILE ENGINEERING

SUBMITTED TO:

GALGOTIAS UNIVERSITY, UNIVERSITY POLYTECHNIC

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CERTIFICATE

This is to certify that the project report entitled "SOLAR AIR DUST PURIFIER"

Was successfully completed by student of sixth semester Diploma in Automobile Engineering.

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In partial fulfilment of the requirements for the award of the Diploma in Automobile engineering and submitted to the Department of Automobile Engineering of Galgotias University, University of Polytechnic, work carried out during a period for the academic year 2021-22 as per curriculum.

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Session (2021-2022)

<u>DECLARATION</u>

We are ASHISH DIXT, PRIYANSHU MAURYA, RISHABH GUPTA, YASH VIKRAM SINGH CHAUHAN, SAMEER ABBAS understudy of Diploma In Automobile Engineering, Galgotias University, Greater Noida. Thus, Our Exploration work has been consolidated in a paper titled "SOLAR AIR DUST PURIFIER", exposed to the work of the branch at Galgotias University Greater Noida under the immediate direction and supervision of Professor, ER.ANIL KUMAR (Project Mentor) in Galgotias University. The work is unique and no piece of this work has been submitted to any other confirmation or degree. All the given data correspond to the best information.

<u>ACKNOWLEDGEMENT</u>

ABSTRACT

The utility model relates to a solar energy air purifier, comprising a small flower box, wherein a box body of the small flower box has a lower surface provided with a plurality of air inlets, a circumference of the upper surface provided with a plurality of sets of air outlets, an inner part provided with a negative ion generator and a back surface provided with a solar panel which can supply power for the negative ion generator by a control switch arranged on the box body surface the control switch is used to control the make and break of the negative ion generator. The solar energy air purifier is characterized in that (1) the self-sufficiency of energy consumption is realized (2) the air purification is realized by negative ions and a small amount of active oxygen.

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<u>MOTIVATION</u>

Pollution has rocked the world with skyrocketing pollution levels. Though the long term solution to the pollution problem lies in finding and minimizing pollution sources, we need to bring the current pollution levels under control by the time. The best way of controlling pollution is by using air purifiers. But regular indoor air purifiers are small low power devices that don't posses enough purifying capability needed for outdoor spaces. Along with this there is also an issue of power supply in outdoor machines.

So here we design a heavy duty outdoor air purifier that is made for outdoor purification along and powered by solar panels so it is energy independent. Our solar air purifier consists of a heavy duty suction fan that pulls air from the bottom of the purifier through a layer of HEPA and Carbon filters for elimination of PM 10 PM 2.5 pollutants as well as gases.

The purifier uses 2 layer purification, the first one being HEPA layer and second and active carbon filter. The combination of these 2 filters leads to dual filtration using a centrifugal air force to suck large amount of air and purify it of dustparticles.

Now this suction fan is used to suck out air using high power centrifugal force and blowing out fresh air from the top. The system also includes an air quality sensor and display to display the current air quality. We now use a solar panel

for the power supply. The panel is used to supply electricity to battery which in turn powers the motor to run the suction fan.

The machine is mounted with 4 castor wheels and a handle for easy movement. This makes the air purifier portable so it can be easily moved to school play areas, parks, residential areas, public places for efficient and instant pollution control.

INTRODUCTION

As we know that air pollution level in cities is very high. Most of pollution comes as by-product from vehicle and construction of buildings, these are in form of particulate matter which are like methane, carbon dioxide, dust particulate etc. These create a lot of health problems like respiratory illness, decreased lung functions, development of diseases like asthma etc. Larger dust particles are major particulate among these and if its air quality value are down to minimum then air has very improved quality in which all type of living things can breathe easily. Although there are many types of air purifier that are available in market but none of them are sufficient enough to deliver its working efficiency in public places like bus stand, near hospitals, traffic signals etc. Many institutes are also not able to afford these because of high cost and installation cost. Government organizations have very low budget for air purifier like extra expenditure. So, it is advisable to develop such air purifier which can cost less and are highly efficient. So, we are making solar powered air purifier, which runs on solar energy without use of filters and also works for longer duration than others. It uses component like solar panel, fan, converter, pump, etc.

OVERVIEW OF PROJECT

- This project provides a combination of process of sensing several gas levels in the air and also the ambient temperature and humidity, thus sensing the quality of the air.

- The levels of the gases and the temperature is displayed in a LCD display panel , which continuously shows the real time output values of the gas sensors , temperature and humidity sensor.

OBJECTIVE:

- To measure and display temperature and humidity level of the environment.
- To combine advanced detection technologies to produce an air quality sensing system with advanced capabilities to provide low cost comprehensive monitoring.
- To display the sensed data in user friendly format in LCD display panel.

<u>LITERATURE REVIEW</u>

[1] National Air Quality Index

Awareness of daily levels of air pollution is important to the citizens, especially for those who suffer from illnesses caused by exposure to air pollution. Further, success of a nation to improve air quality depends on the support of its citizens who are well-informed about local and national air pollution problems and about the progress of mitigation efforts. Thus, a simple yet effective communication of air quality is important. The concept of an air quality index (AQI) that transforms weighted values of individual air pollution related parameters (e.g. SO2, CO, visibility, etc.) into a single number or set of numbers is widely used for air quality communication and decision making in many countries.

[2] Identification and Characterization of Particulate Matter Concentrations at Construction Jobsites

The identification and characterization of particulate matter (PM) concentrations from construction site activities pose major challenges due to the diverse characteristics related to different aspects, such as concentration, particle size and particle composition. Moreover, the characterization of particulate matter is influenced by meteorological conditions, including temperature, humidity, rainfall and wind speed. This paper is part of a broader investigation that aims to develop a methodology for assessing the environmental impacts caused by the PM emissions that arise from construction activities. The objective of this paper is to identify and characterize the PM emissions on a construction site with different aerodynamic diameters (PM2.5, PM10, total suspended particulates (TSP)), based on an exploratory study. Initially, a protocol was developed to standardize the construction site selection criteria, laboratory procedures, field sample collection and laboratory analysis.

[3] Atomization concept and theory

Atomization refers to the process of breaking up bulk liquids into droplets. Common home atomizers you may be familiar with include shower heads, perfume sprays, garden hoses, and deodorant or hair sprays. A spray is a collection of moving droplets that usually are the result of atomization; they are moving in a controlled fashion. Naturally occurring sprays are rain and ocean sprays. A droplet is a small particle of liquid having a more or less spherical shape. Droplets are also known as particles. The reason particles are round is due to the liquid's surface tension. Recall that surface tension is the property of a liquid that causes droplets and soap bubbles to pull together in a spherical form and resist spreading out. This property causes sheets or thin ligaments of liquid to be unstable; that is, they break up into droplets, or atomize.

[4] Understanding drop size

In order to accurately assess and understand drop size data, all of the key variables such as nozzle type, pressure, capacity, liquid properties and spray angle have to be taken into consideration. The drop size testing method should also be fully understood. The measurement techniques, type of drop size analyser and data analysis and reporting methods all have a strong influence on the results.

BLOCK DIAGRAM
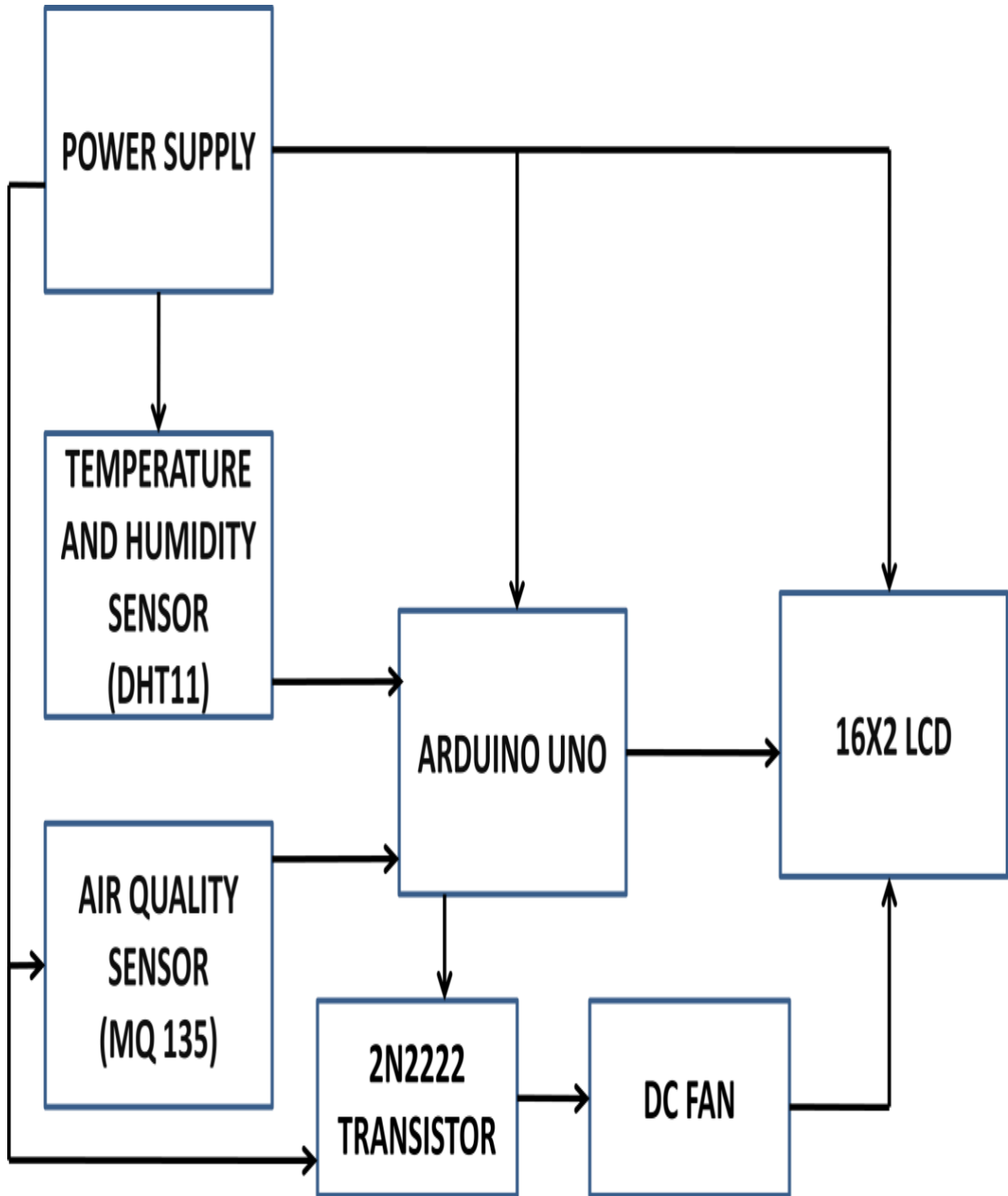
Fig 1(a): Block Diagram of Air Quality Monitoring and Sensing
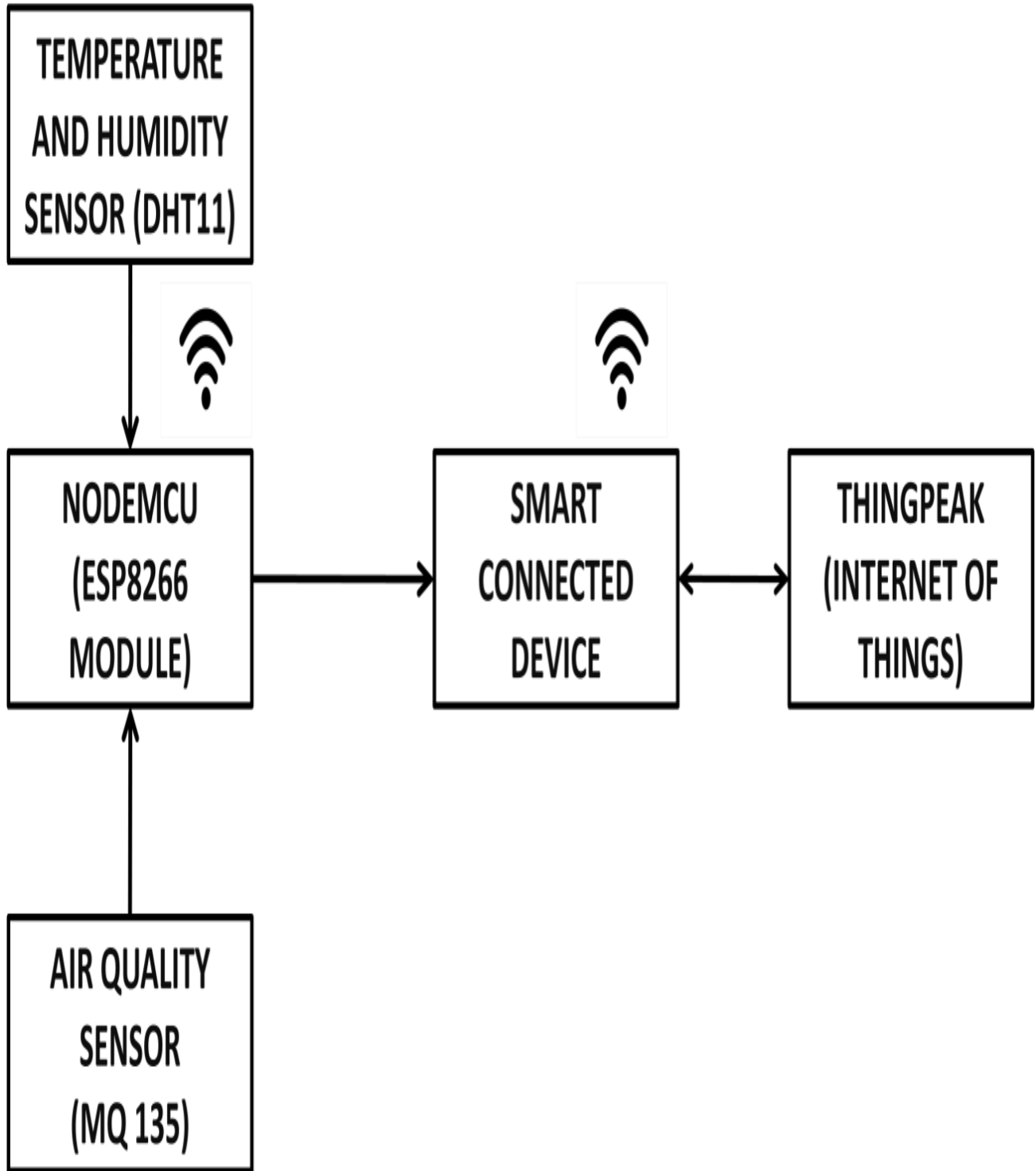
Fig 1(b): Block Diagram of sending the data to THINGSPEAK using NodeMCU

HARDWARE REQUIREMENTS:

➢ For Different Parameter Sensing:-

- Temperature and Humidity sensor (DHT11)

- Air Quality sensor (MQ 135)

- 2n2222 Transistor

- DC Fan

- Potentiometer

- 16x2 LCD Panel

- NodeMCU

- Arduino Uno

➢ For Power Supply:-

- Step down transformer (12-0-12 V,1 A)

- Diodes

- Voltage Regulator (7805)

- Capacitors (0.01 micro Farad, 470 micro Farad)

- Wires

SOFTWARE REQUIREMENTS:

- Arduino (Version 1.8.2)

- THINGSPEAK website

COMPONENT DESCRIPTION

1. Temperature and humidity sensor (DHT11):-

DHT11 digital temperature and humidity sensor is a composite Sensor contains a calibrated digital signal output of the temperature and humidity. Application of a dedicated digital modules collection technology and the temperature and humidity sensing technology, to ensure that the product has high reliability and excellent long-term stability. The sensor includes a resistive sense of wet components and NTC temperature measurement devices, and connected with a high-performance 8-bit microcontroller.
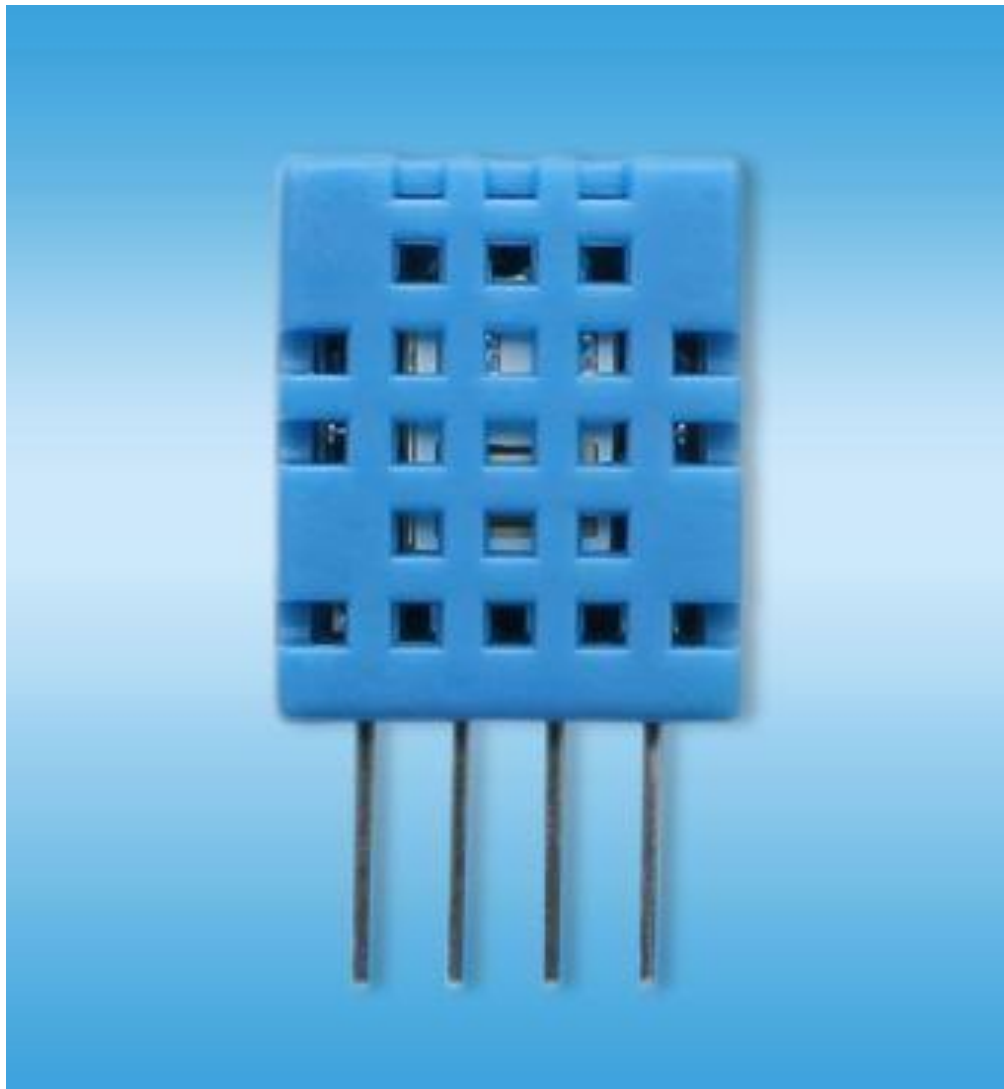
Fig 2: DHT11 Sensor

Pin Description:

- 1, the VDD power supply 3.5～5.5V DC

- 2 DATA serial data, a single bus
- 3, NC, empty pin
- 4, GND, used to connect the module to system ground

2. Air Quality Sensor (MQ135):-

Air quality click is suitable for detecting ammonia (NH3), nitrogen oxides (NOx) benzene, smoke, CO2 and other harmful or poisonous gases that impact air quality. The MQ-135 sensor unit has a sensor layer made of tin dioxide (SnO2), an inorganic compound which has lower conductivity in clean air than when polluting gases are present. To calibrate Air quality, use the on-board potentiometer to adjust the load resistance on the sensor circuit.

Fig. 3: MQ135 Sensor

Pin Description:

- 1, the VDD power supply 5V DC
- 2,GND , used to connect the module to system ground
- 3, DIGITAL OUT, You can also use this sensor to get digital output from this pin, by setting a threshold value using the potentiometer
- 4, ANALOG OUT, This pin outputs 0-5V analog voltage based on the intensity of the gas.

3. 2N2222 Transistor:-

The 2N2222 is a common NPN bipolar junction transistor(BJT) used for general purpose low power amplifying or switching applications. It is designed for low to medium current, low power, medium voltage, and can operate at moderately high speeds. It was originally made in the TO18metal can as shown in the picture. The 2N2222 is considered a very common transistor and is used as an exemplar of an NPN transistor. It is frequently used as a small-signal transistor and it remains a small general purpose transistor of enduring popularity.
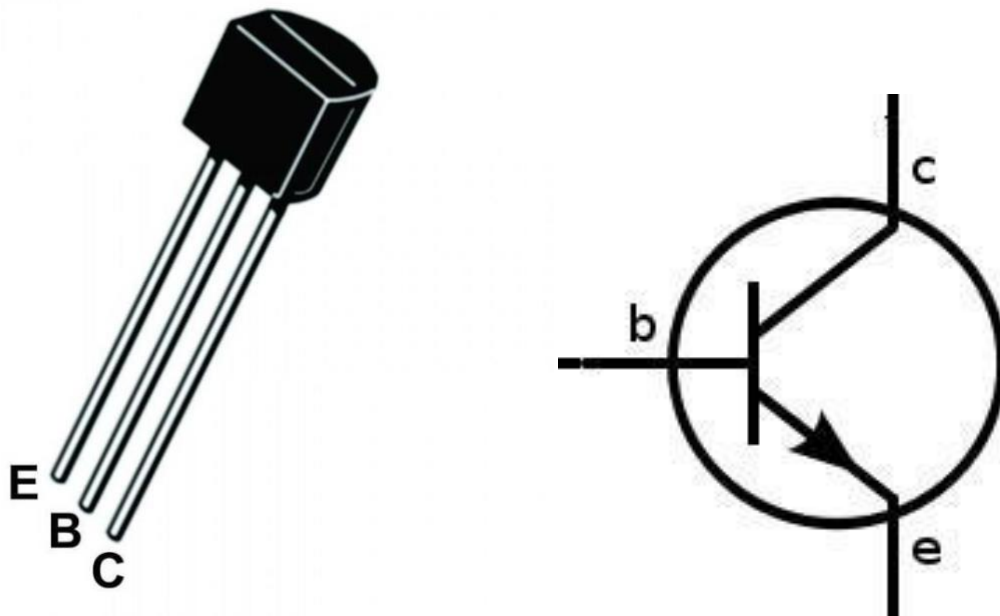
Fig. 4: 2N2222 Transistor

4. DC Fan:-

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor.
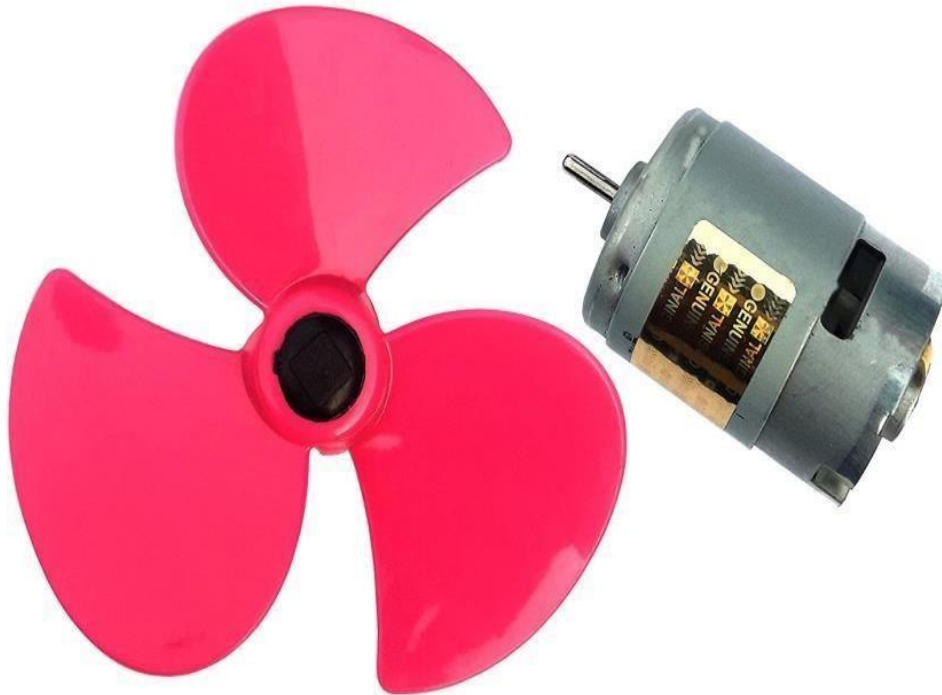
Fig 5: DC Motor with Fan

5. Potentiometer:-

A potentiometer is a three-terminal resistor with a sliding or rotating 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. The measuring instrument called a potentiometer is essentially a voltage divider used for measuring electric potential(voltage); the component is an implementation of the same principle, hence its name.

Fig 6: Potentiometer

6. 16X2 LCD Panel:-

A liquid-crystal display (LCD) is a flat-display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome.[1]LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and seven-segment displays.
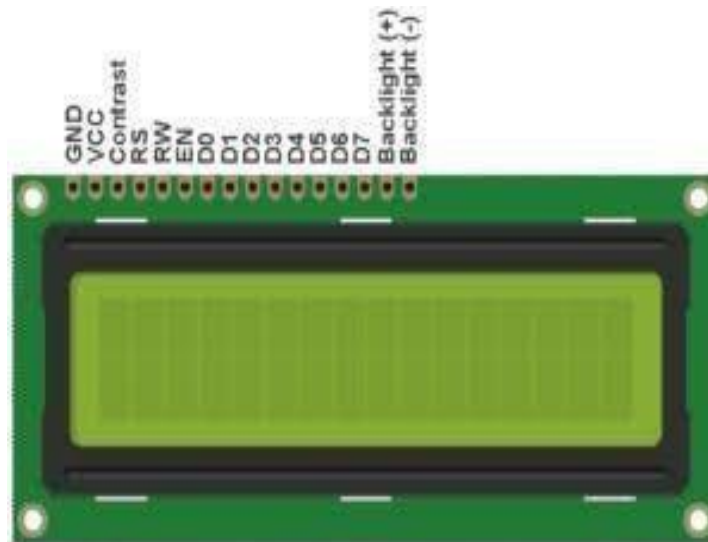
Fig 7: 16x2 LCD Display

Pin Description:

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	VEE
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight V_{CC} (5V)	Led+
16	Backlight Ground (0V)	Led-

Table 1: Pin Description of 16x2 LCD Panel

7. Arduino Uno:-

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures singlemicrocontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output(I/O) pins that

may be interfaced to various expansion boards (*shields*) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus(USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler tool chains, the Arduino project provides an integrated development environment(IDE) based on the Processing language project.
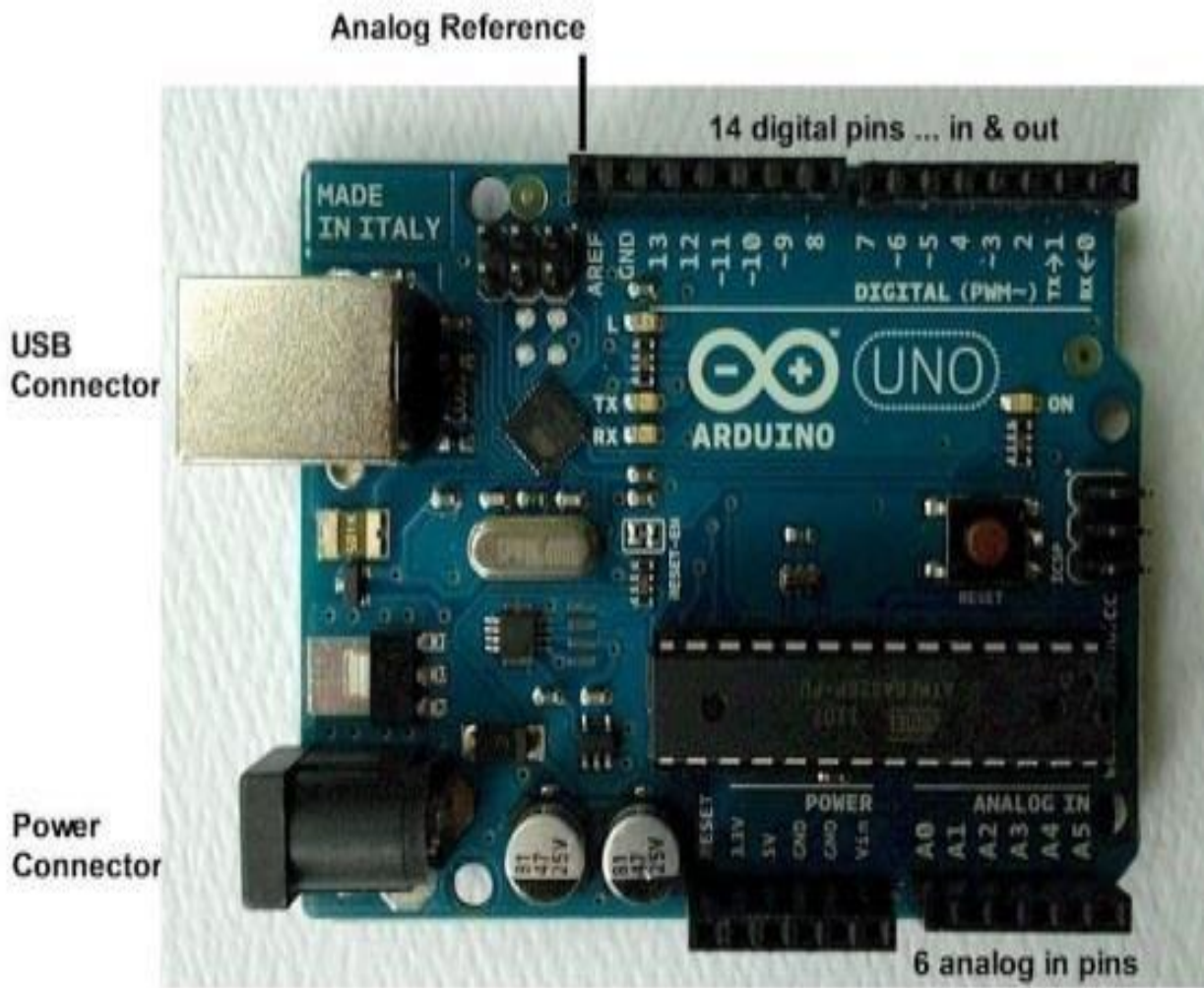
Fig 8: Arduino UNO

Pin Description:

Pin Category	Pin Name	Details

Power	Vin, 3.3V, 5V, GND	Vin: Input voltage to Arduino when using an external power source. 5V: Regulated power supply used to power microcontroller and other components on the board. 3.3V: 3.3V supply generated by on-board voltage regulator. Maximum current draw is 50mA. GND: ground pins.
Reset	Reset	Resets the microcontroller.
Analog Pins	A0 – A5	Used to provide analog input in the range of 0-5V
Input/Output Pins	Digital Pins 0 - 13	Can be used as input or output pins.
Serial	0(Rx), 1(Tx)	Used to receive and transmit TTL serial data.
External Interrupts	2, 3	To trigger an interrupt.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
SPI	10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK)	Used for SPI communication.
Inbuilt LED	13	To turn on the inbuilt LED.
TWI	A4 (SDA), A5 (SCA)	Used for TWI communication.
AREF	AREF	To provide reference voltage for input voltage.

Table 2: Pin Description of Arduino Uno

Technical Specification:

Microcontroller	ATmega328P– 8 bit AVR family microcontroller
Operating Voltage	5V

Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

Table 3: Technical Specification of Arduino Uno

8. Node MCU:-

Node MCU is an open source IoT platform. It includes firmware which runs on the ESP8266WiFiSoCfrom Espressif Systems, and hardware which is based on the ESP-12 module. The term "Node MCU" by default refers to the firmware rather than the development kits. The firmware uses the Luascripting language. It is based on the eLua project, and built on the EspressifNonOS SDK for ESP8266.
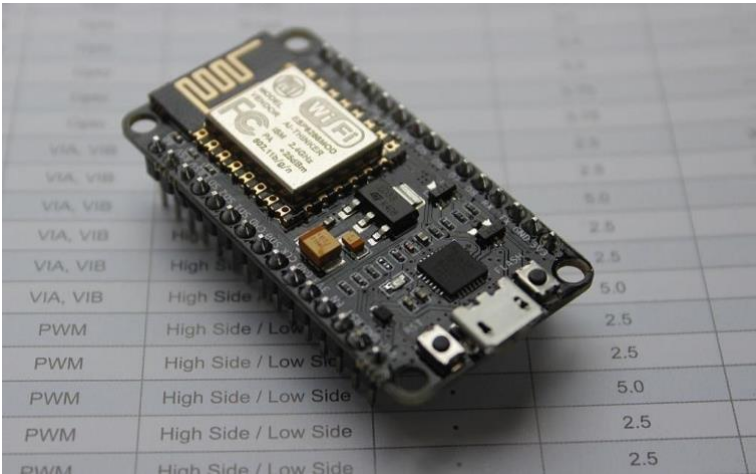
Fig 9: NodeMCU

COST ESTIMATION STRUCTURE:

Sl. No.	Name of Components	Cost (Rs.)
1.	Arduino Uno	400
2.	DTH11	150
3.	Bread board	60
4.	Jumper Wires	3/piece
5.	12-0-12 Transformer	130
6.	7805	20
7.	Capacitor	5/piece
8.	Resistances	3/piece
9.	16x2 LCD	140
10.	MQ 135	150
11.	NodeMCU	400
12.	DC Fan	20
13.	Potentiometer	10/piece
14.	2N222 Transistor	5/piece

Table 4: Cost of different Components

WORK PLAN:

Sl No.	Duration	Work done/will be done
1.	August'17- September'17	Selection of Project topic and study of the project topic.
2.	October '17	Study of previous work done related to our topic and preparing a literature review.
3.	November'17	Purchase of required components and making of a 5V power supply, and sensing of temperature and humidity using DTH11 sensor.
4.	December'17- May'18	Sensing of air quality using MQ135 and displaying the values on an LCD panel and sending the data to Thing Speak Platform using NodeMCU. And controlling the speed of Fan based on temperature sensed by DHT11.

Table 5: Work Plan

WORK DONE:

Connections:

- DTH11's voltage, ground is connected to +5V and 0V and signal can be connected to any Digital Pin 8 of Arduino Uno.

- MQ135's voltage and ground are connected to +5V and 0V and analog output pin is connected to analog Pin A0 of Arduino Uno.

- LCD RS pin to digital pin 12, Enable pin to digital pin 11,D4 pin to digital pin 5, D5 pin to digital pin 4, D6 pin to digital pin 3, D7 pin to digital pin 2, R/W pin to ground, VSS pin to ground, VCC pin to 5V, 10K resistor ends to +5V and ground and wiper to LCD VO pin.
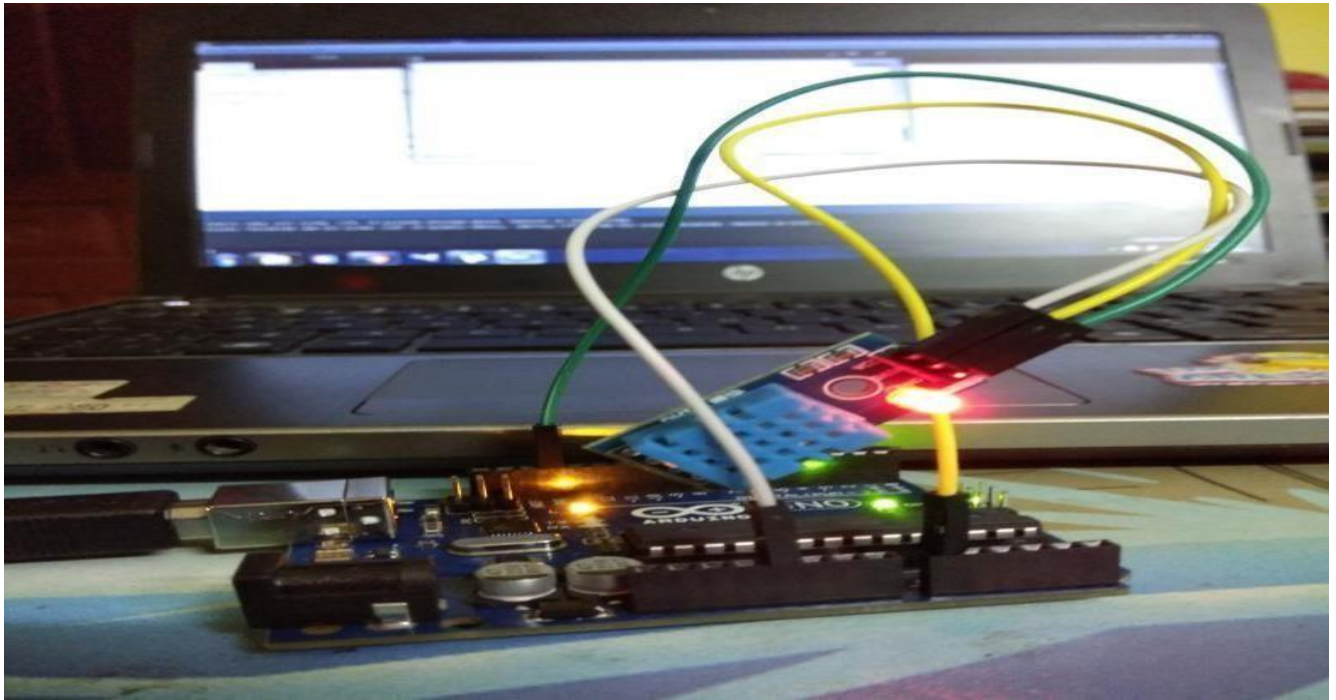
Fig 10: Connection of DTH11 with Arduino Uno
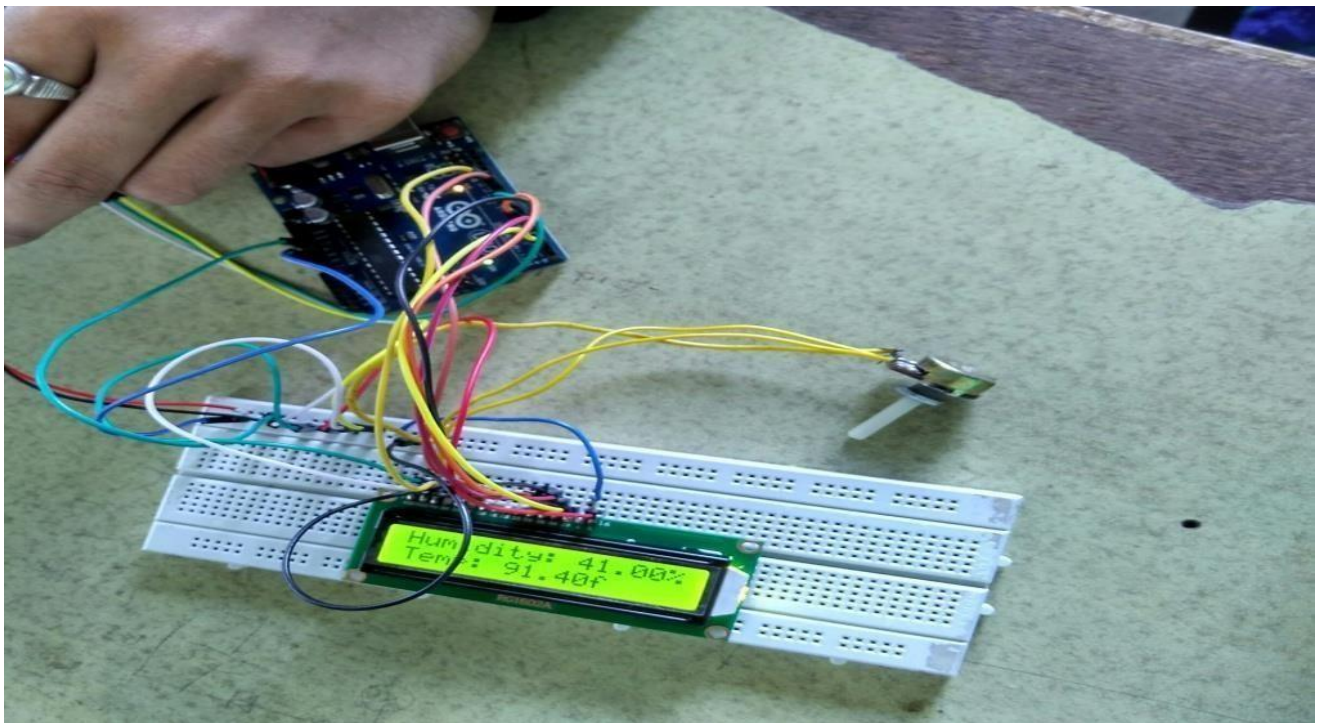
Fig 11: Connection of LCD with Arduino

- The data pins of DHT11 are connected to Digital pin of NodeMCU and that of MQ135 is connected to Analog Pin.
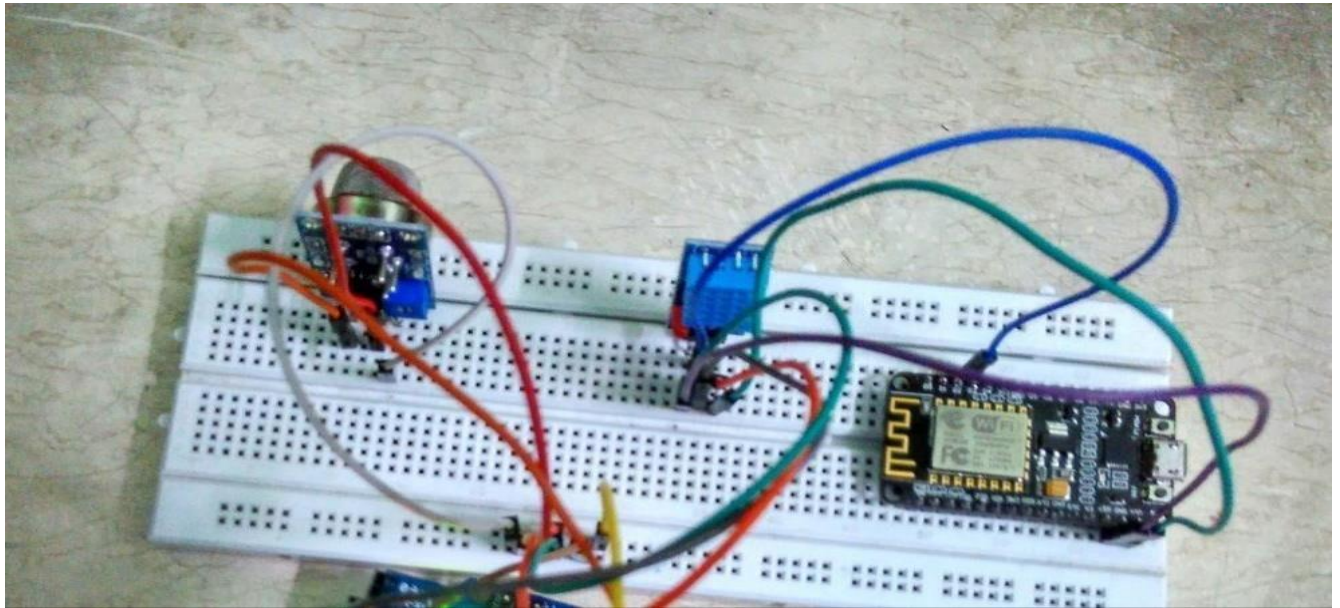
Fig 12: Connection of DHT11 and MQ135 with NodeMCU

- The base of 2N2222 transistor is connected to a pwm pin of Arduino Uno and the emitter and collecter of transisitor is connected to the DC Fan and supplied with 9V battery (in Forward Bias). The other connections are kept the same.
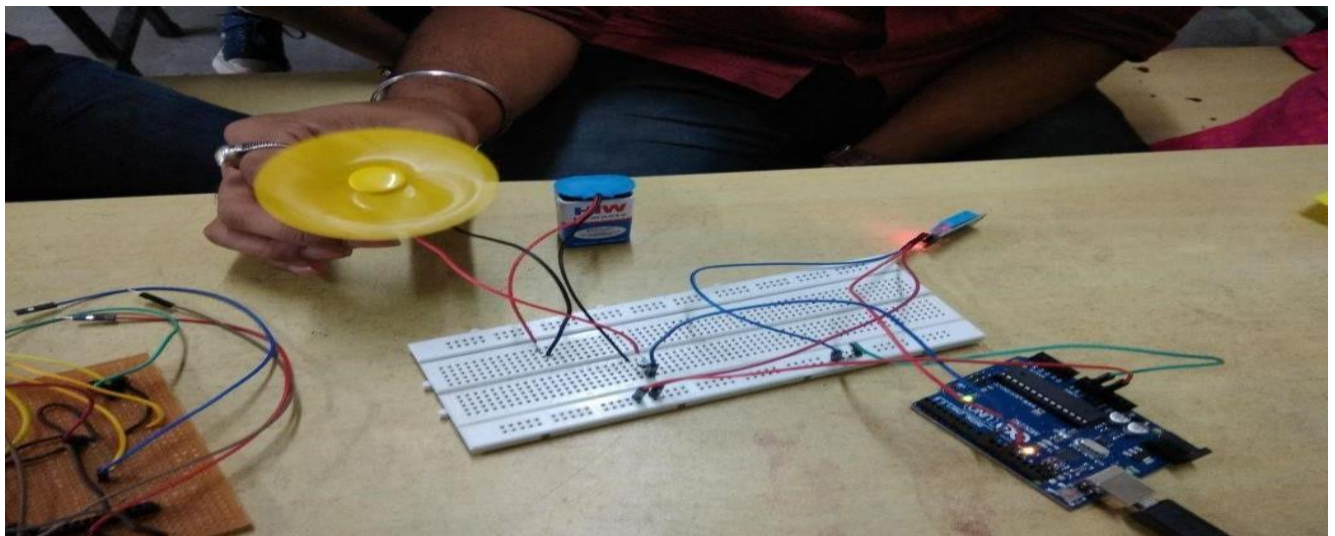
Fig 13: Connection of DHT11 with DC Fan

Flowchart for Displaying the Temperature, Humidity and Air Quality on LCD:

START

Include DHT, LiquidCrystal Library and define the pins on arduino to which DHT11 and MQ135 data pins are connected.

float temp=0,float hum=0, int airquality=0

Start accepting data from dht and sending data to 16x2 LCD.

The "temp" and "hum" value are read from the digital pin of arduino to which DHT11 is connected, and "airquality" value is read from analog pin of arduino to which MQ135 is connected.

The cursor of the LCD is set to line 0 and column 0, and in that line the temperature and humidity is displayed. The display is scrolled to the left to show the entire thing.

Then,the cursor is set to line 1 and column 0, and in this line humidity is displayed.

There is a delay of 100 microseconds and then the values are read from sensor again.

END

Flowchart for Controlling the Speed of Fan Based on Temperature:
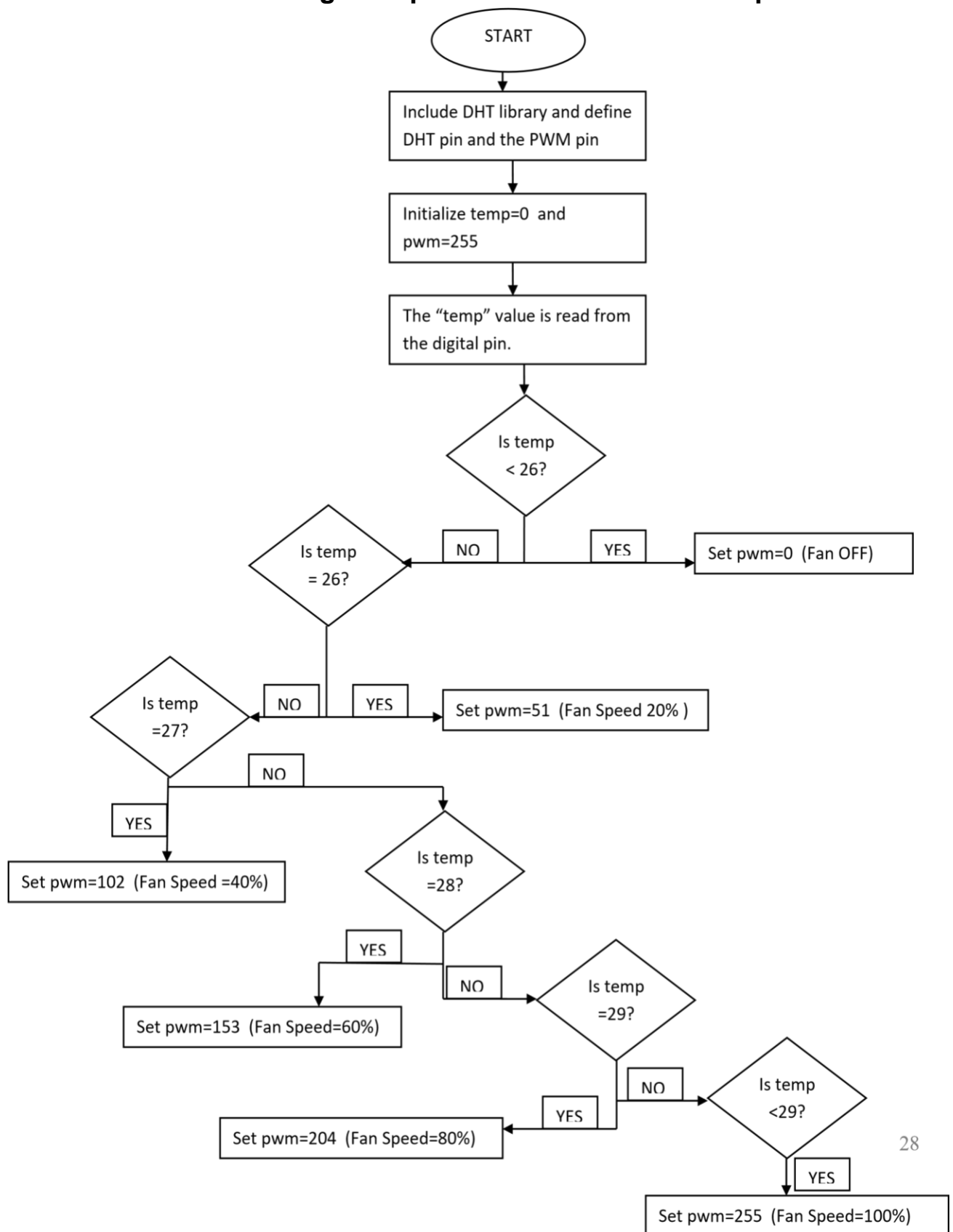
Flowchart for Sending the Temperature, Humidity and Air Quality on THINGSPEAK:

```
                          ┌─────────┐
                          │  START  │
                          └─────────┘
                               │
                               ▼
        ┌──────────────────────────────────────────────┐
        │  Include ThingSpeak,DTH11 and write the      │
        │  write API key from ThingSpeak               │
        └──────────────────────────────────────────────┘
                               │
                               ▼
        ┌──────────────────────────────────────────────┐
        │  Const char ssid="wifi id" ,const char       │
        │  pass="wifi password", const char            │
        │  server="api.thingspeak.server"              │
        └──────────────────────────────────────────────┘
                               │
                               ▼
        ┌──────────────────────────────────────────────┐
        │  Include DHT, LiquidCrystal Library and define│
        │  the pins on arduino to which DHT11 and       │
        │  MQ135 data pins are connected.               │
        └──────────────────────────────────────────────┘
                               │
                               ▼
        ┌──────────────────────────────────────────────┐
        │  float temp=0,float hum=0, int airquality=0   │
        └──────────────────────────────────────────────┘
                               │
                               ▼
        ┌──────────────────────────────────────────────┐
        │  Start accepting data from dht and sending    │
        │  data to ThingSpeak                           │
        └──────────────────────────────────────────────┘
                               │
                               ▼
        ┌──────────────────────────────────────────────┐
        │  The "temp" and "hum" value are read from the │
        │  digital pin of arduino to which DHT11  is    │
        │  connected, and "airquatiy" value is read from│
        │  analog pin of arduino to which MQ135 is      │
        │  connected and displayed on the serial monitor│
        └──────────────────────────────────────────────┘
                               │
                               ▼
        ┌──────────────────────────────────────────────┐
        │  If the client is connected to server then the│
        │  data from the sensors is updated to the      │
        │  channel in ThingSpeak                        │
        └──────────────────────────────────────────────┘
                               │
                               ▼
        ┌──────────────────────────────────────────────┐
        │  There is a delay of 30 seconds after which the│
        │  values are again read from the sensors.      │
        └──────────────────────────────────────────────┘
                               │
                               ▼
                          ┌─────────┐
                          │   END   │
                          └─────────┘
```
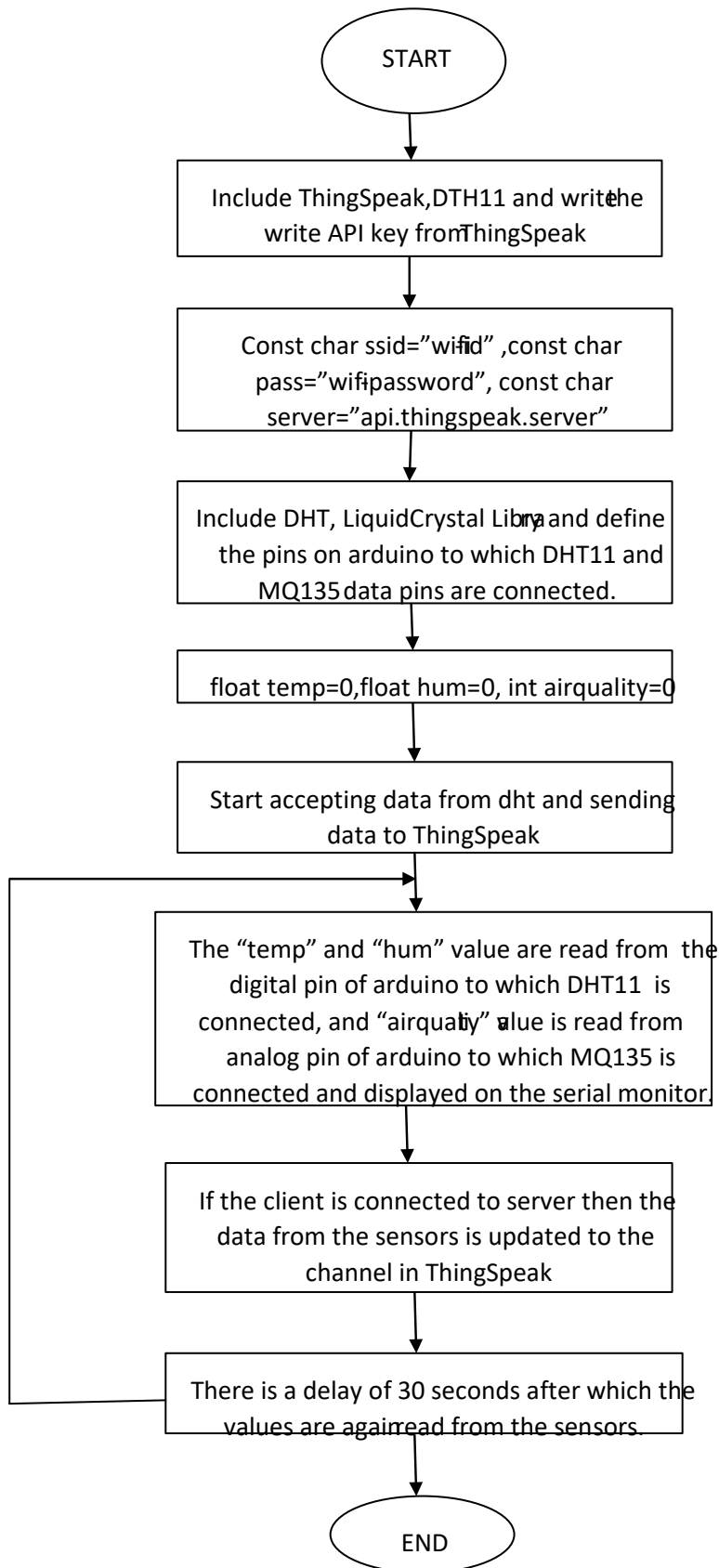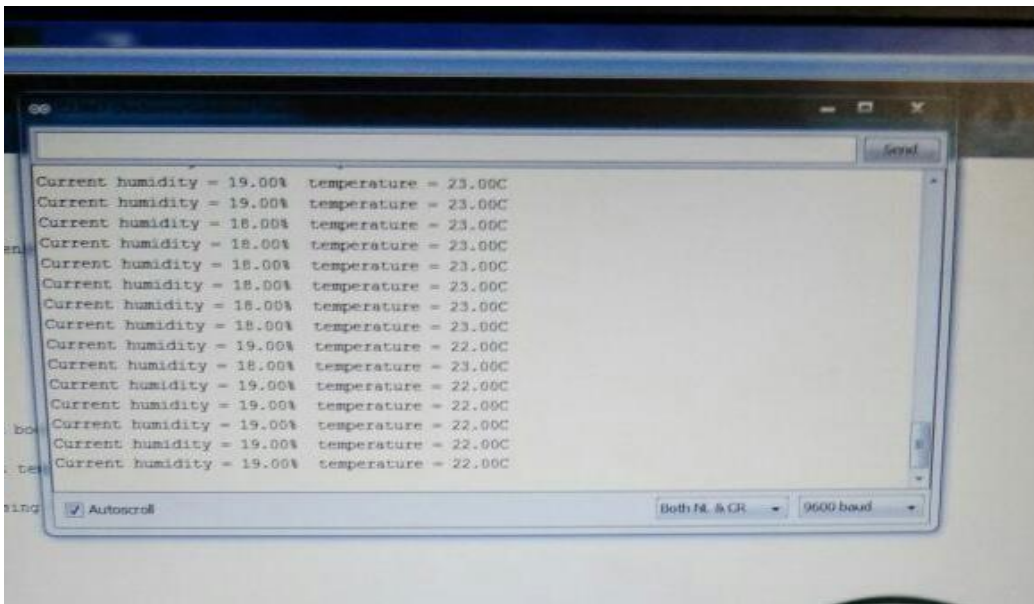
Output:

Fig 14:

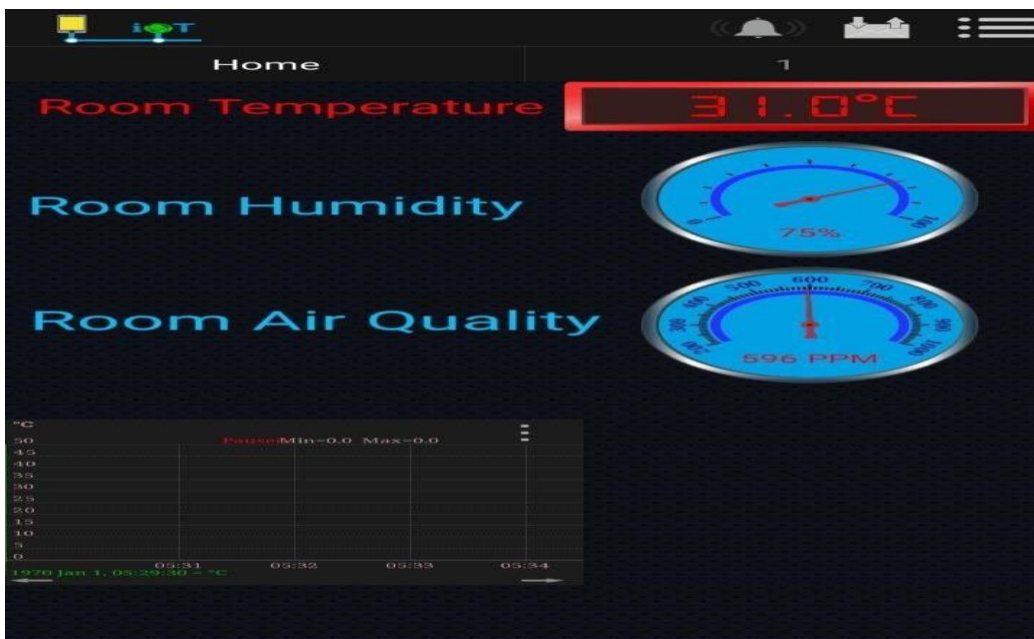**Output of DHT11 sensor (on Serial Monitor)**

Fig 15:

Output of DHT11 and MQ135 in THINGSPEAK app
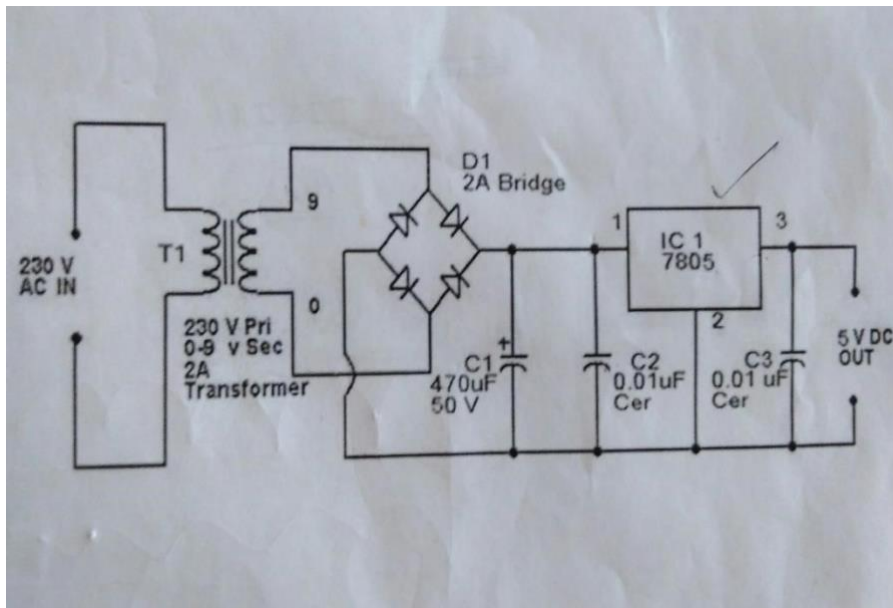
Construction of Power Supply:

Fig 16: Circuit Diagram of 5V Regulated Power Supply

Fig 17: Connections of 5V Regulated Power Supply

WORKING

There is a chamber in which air is sucked in by the fan, while the air is entering it passed through strainer. Simultaneously water is pumped from reservoir to the atomizer, which converts water into small water droplets and these droplets are suspended into the chamber along with air. These water droplets have adhesive property due to which the particulate matter and dust particles get absorbed on them. This way air is cleaned and is flown out from chamber by exhaust fan. The water with dust and particulate matter is collected in evaporation tank, where water under goes natural evaporation process, leaving behind the dust and particulate matter these are periodically cleaned and water is used again in air cleaning process.

Different components of projects:

1. **Chamber-** The chamber is the main part of the air purifier. The polluted air from the environment is sucked into the chamber using a fan. It is designed in rectangular crosssection. In the chamber the rack arrangement is close fitted containing the atomizers and the baffle arrangement. It is designed to provide adequate space for atomization by atomizers and efficient adhering of particles with water droplets. The outlet side of the chamber is elevated from the base to reduce the air flow speed and amount of moisture in the clean air. A clearance is provided at the bottom in the chamber for easy flow of water containing particulate matter.

2. **Atomizer-** The atomizer is used to convert water into very fine droplets. There are two atomizers in the air purification system. The atomizers used in this system are solid cone type. High pressure water is pumped at inlet of the atomizer. In the atomizer, the pressure head of water is converted into kinetic head by the Bernoulli's principle, this result in high velocity and low pressure of water at the outlet. When this high velocity water

through the atomizer outlet comes in contact with the air, the air friction acts and the kinetic head of the water is converted into surface energy. Thus, very fine droplets are obtained.

3. **Pump-** A pump is installed in the device. This water is pumped at high pressure and supplied through the pipes into the atomizers. This is a booster pump which provides reliable inlet pressure. This pump is capable of continuous duty.

4. **Fan-** A 750 RPM fan is installed at the vent of the device. This fan has two implications that are to suck polluted air from the inlet environment into the chamber and also to flow away the clean air into the outlet environment.

5. **Solar Panel-** There is an installation of a 100-watt solar panel. This panel is used to produce electricity from radiation of sunrays. The panel consists of a grid of inter connected photovoltaic cells.

6. **Electrical Converter-** There is a 500-watt capacity converter installed in device which is used to convert DC voltage of solar panel power source into AC voltage which is used charge the battery in the system.

7. **Battery-** A battery with a high capacity and a low power rating is installed which delivers a low amount of electricity (enough to run a fan and pump) for a long time.

Some Accessories-

- **Pump-** A total of 1.56 metre length pipe is used in the device. These are used to connect and flow water from pump to nozzle.

- **Strainer-** A Strainer is installed in the chamber which prevents residue moisture from entering the fan. It is made of fine fabric.

- **Rack-** Rack is a structure made by bolting the iron angle bar. It installs the baffles and the nozzles. It can be extracted from and inserted into the chamber.

- **Baffles-** Baffles are installed on the rack by nut and bolt. The main purpose of baffles is to increase the air flow path, providing adequate time for efficient absorption of dust particles with water droplets.
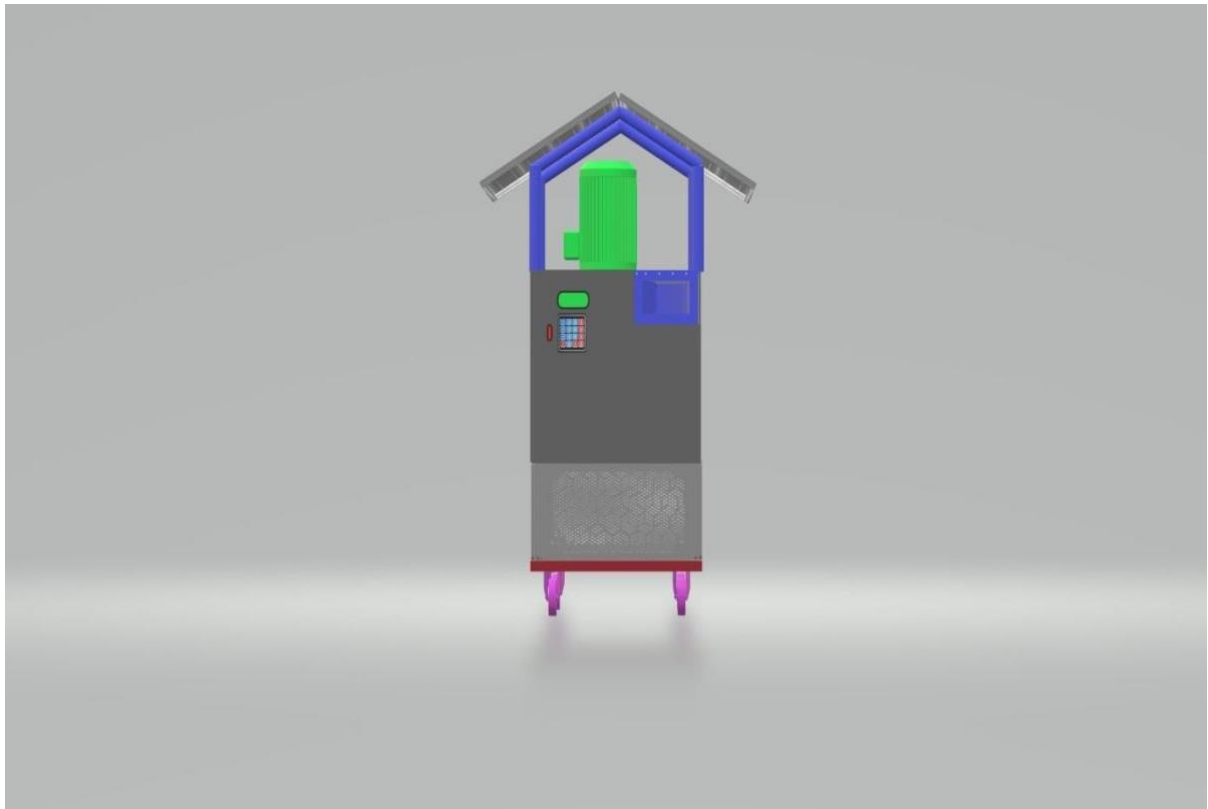
Side View
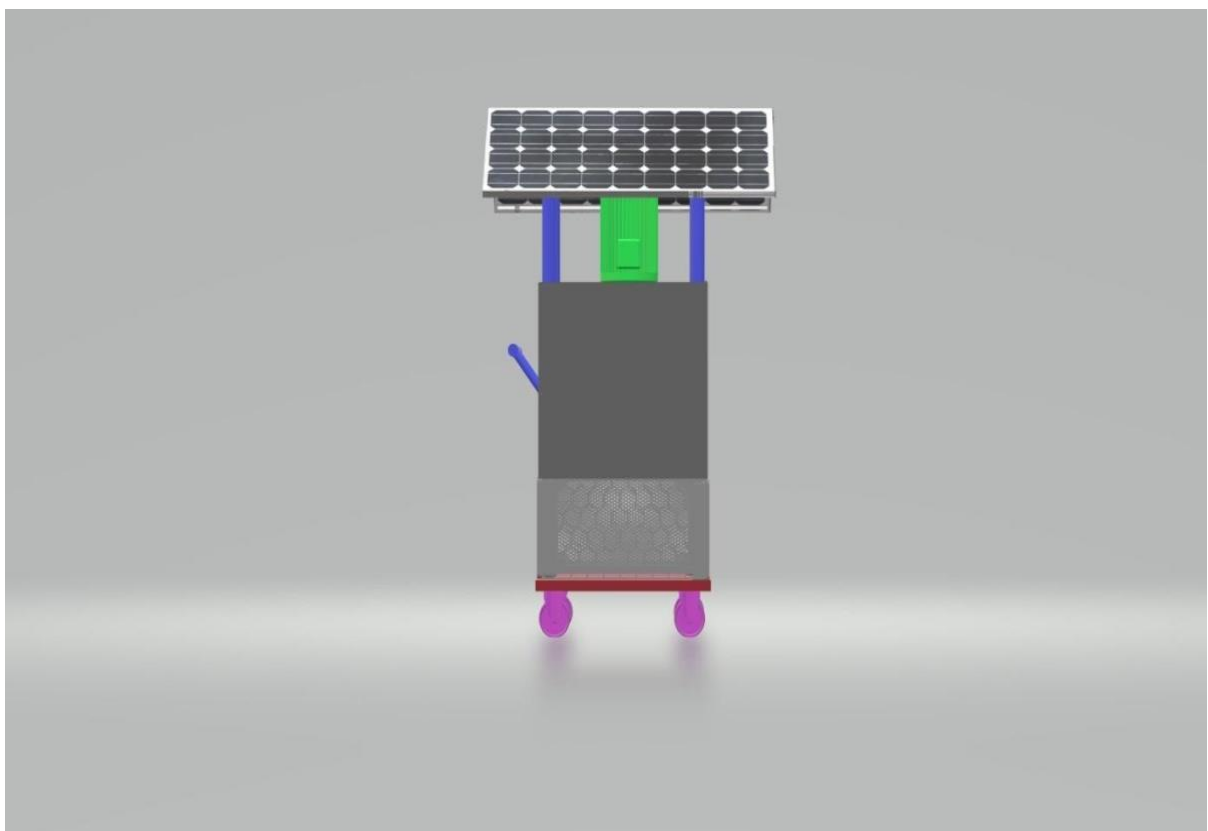
Front View

Advantages:

- Heavy Duty Purifiers ⬜ Automatic Operation
- Fast Purification
- Easy to Clean Removable Filters
- No External Power Supply Needed

Disadvantages:

- Needs Battery Maintenance
- Needs Sunlight for Power

Applications:

- Parks & Playgrounds
- Corridors and Open Places
- Open Restaurants and Terraces
- Schools & Colleges
- Residential Societies
- Railway, Metro Stations and Airports

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