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DESIGN AND DEVELOPMENT OF AIR QUALITY INDEX DISPLAY DASHBOARD MONITORING USING ESP32

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ABSTRACT:

The non-stop augmentation of pollutants is a hassle that needs to be addressed straightaway. Pollution affects our fitness in addition to reasons fundamental environmental modifications like Global warming and climate variations. Air pollutants are one in all the largest demanding situations that the sector is going through these days because it has were given negative consequences on human fitness like lung cancer, breathing, and coronary heart diseases. There is a want to continuously measure, analyze, and screen the air first-rate on a real-time foundation to take suitable measures every time needed. We have proposed a version that makes use of the idea of the Internet of Things to permit the person to recognize approximately the awareness of dangerous gases gift around him and for this reason, permit the person to recognize the first-rate of air. The parameters which might be monitored right here are MQ135, Carbon monoxide (CO), Carbon dioxide (CO2), temperature, and humidity. The values of those parameters are in addition displayed on an IoT platform, ThingSpeak, with inside the shape of a graph in addition to a number. If the awareness of Carbon dioxide exceeds a positive threshold, the buzzer receives triggered.

Keywords: ESP32 Board, LCD Display, Adafruit IO, MQ135, MQ7, and DHT11 Sensors**.**

I. INTRODUCTION:

Air is one of the most important elements in human life [1]. In today's world, air pollution is increasing at an alarming rate, leading to climate change, which hurts everyone. It is polluted by toxic gases emitted by industrial enterprises and vehicle emissions, resulting in an increase in the concentration of harmful gases and fine dust in the atmosphere [2]. Various toxic gases emitted by industrial plants and vehicles are dangerous to terrestrial and marine life. Health problems such as stroke, heart disease, lung cancer, and respiratory diseases are all caused by poor air quality. Poor air quality poses a major risk to children, asthmatics, pregnant women, and the elderly [5]. These pollutants will also corrode our infrastructure and historic sites. People need to know how their activities affect air quality. CS reports that millions of people worldwide die prematurely due to air pollution every year [3]. Studies have shown that fine dust can significantly increase air pollution. Therefore, air quality has become a major issue of global concern, which is why

the air quality index needs to be continuously monitored to ensure that our environment is healthy and livable. A platform to check the surrounding air quality. The air quality monitoring system can help us determine the quality of the air we breathe. The Internet of Things is common in all walks of life, and Dongfang Document also plays an important role in our air quality monitoring system. This document focuses on the design and implementation of an IoT-based air quality index monitoring system that we hope to develop using ESP 32 microcontrollers. PPM, temperature and humidity are also displayed on the IoT platform ThingSpeak through various sensors. The platform dashboard will be open to everyone so that everyone can monitor the air quality at the installation site [2]. So we can easily track it with our computer or mobile phone. The motivation behind our project is to protect the environment by preventing industrial plants and vehicles from emitting harmful gases. We know the air quality in real-time so that we can take necessary measures immediately when necessary.

II. Related Work:

We reviewed and checked several existing systems designed to solve this problem. With our proposed system, we are trying to reduce overall costs by using better alternatives that can provide us with near-accurate readings. Kumar, S. et al. [4] suggested a system in which the Raspberry Pi plays an important role in node management. The sensors they use in the system measure particulate matter, temperature, humidity, pressure, CO, and CO2. An additional ADC must be connected to the converter pin (ADC) on the board. Here, they are connected to an Arduino UNO that provides a high-efficiency ADC. Since you are using Raspberry Pi 2 Model B, it does not have a built-in Wi-Fi adapter. A WLAN adapter is used. They also used the MQTT protocol to show the results on the IBM Watson IoT platform. Raspberry Pi 3B has a built-in WLAN adapter, which leads to the use of SS circuits. This is implemented in their system by Gupta, Harsh, and others [5]. Another way to measure air quality is to use Arduino UNO as the main device, which is a suggestion made by Kennedy Okokpuji et al. [1] in their article. Since Arduino does not have a built-in WLAN module, an external WLAN module must be connected. The module is Node MCU ESP8266. Node MCU ESP8266 is a development board specially developed for IoT applications, so it can also be used as the main controller in the system. This is discussed in the article by A. Kumar et al. [6] Display. There is only one ADC pin on the ESP8266 board, so if more pins are needed, an additional ADC chip must be inserted. Another method is to use an ESP32 microcontroller. ESP32 has two processor cores, making it faster than other cores, a built-in Wi-Fi module, and many ADC pins. Asia Newman F et al. [7] introduced this in their work. They send sensor values to the cloud through the Blink platform. Compared with other sensors, particle sensors are quite expensive. Jayaratne R et al. [8] mentioned six inexpensive PM2.5 sensors in their paper and evaluated their suitability for various applications. ...

III. PROPOSED SYSTEM DESIGN:

a. **Project Overview:** The proposed shape is an air pleasant tracking machine primarily based totally on the Internet of Things. The sensors that we've used are assisting in sensing the presence and attention of few dangerous gases, dirt debris gift with inside the air at that very time and additionally to test temperature and humidity at that specific time. These sensors are linked to the controller in step with their output kind this is an analog or virtual output. The controller might not most effectively acquire information from numerous sensors however through an in-constructed Wi-Fi module, it's also accountable to ship the recorded information to an IoT platform. IoT platform will save real-time sensor information and additionally plot graphs, charts, and numeric values. Thus, we might be capable of the screen the air pleasant on the place wherein the machine might be set up on a real-time basis.

b. **Block Diagram:**

Block Diagram Of Air Quality Index Display Dashboard Monitoring Using Esp32

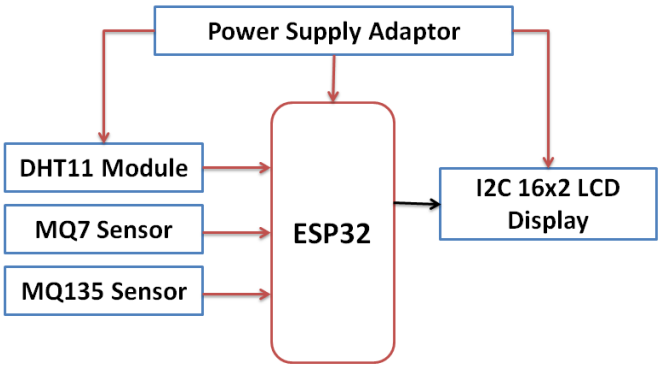

Fig 1: System Architecture

Fig-1 demonstrates the block structure of our air nice tracking gadget. ESP32 is serving as the principle controlling unit in our gadget. Different environmental parameters like Carbon Dioxide, Carbon Monoxide, particulate remember, Temperature, and Humidity are being sensed through the sensors. The sensors are linked to ESP32. ESP32 gathers information sensed through the sensors and constantly transmits it to the cloud over the internet. The sensor we've used for detecting particulate remember is, GP2Y1010AU0F. It is a dirt sensor module, this means that it can discover cigarette smoke, residence dirt gift around us. Dust may not appear dangerous however in reality, it's far small debris of 2.5um and 10um in diameter and that debris can without problems penetrate the lungs which can motive diverse fitness problems. The dimension of the debris of diameter 2.5um and 10um is known as 2.5PM and 10PM respectively. This sensor can feel as much as 2.5PM. It offers an analog output. Other analog sensors utilized in our gadget are MQ7 (Gas sensor) and MQ135 (air nice sensor) and they're used for measuring Carbon Monoxide and Carbon Dioxide respectively. DHT11 is the sensor this is used for measuring temperature and humidity sensor and it offers virtual output. This sensor information is constantly despatched to an IoT platform for tracking air nice on a real-time basis. The IoT platform we've used is ThingSpeak. The sensor information is displayed inside the shape of graphs and numeric values on ThingSpeak. A buzzer is likewise linked to ESP32 that might begin ringing whilst the awareness of Carbon Dioxide inside the air exceeds a selected fee i.e., the restriction above which it's far dangerous to our fitness. Buzzer offers virtual output.

IV. HARDWARE DESCRIPTION:

a. ESP32 Microcontroller: The microcontroller we have used in this project is ESP32. ESP32 microcontroller has a powerful chip with a dual processing core. This makes it faster than the other controllers discussed above. It is a low-cost, low-power microcontroller and it has an in-built Wi-Fi module, on-chip Bluetooth Low Energy (BLE), good deep sleep modes.

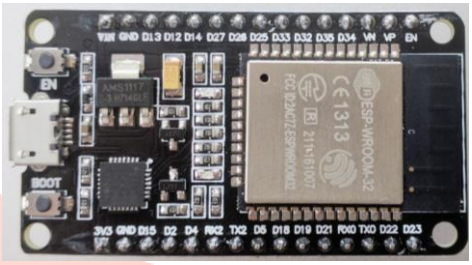

Fig 2: ESP32 Board

It supports 18 channels for 12-bit ADC and 2 channels for 8-bit DAC. All the incoming data from the sensors is processed by ESP32. ESP32 is a low-cost System on Chip (SoC) Microcontroller from Espressif Systems, the developers of the famous ESP8266 SoC. It is a successor to ESP8266 SoC and comes in both single-core and dual-core variations of the Tensilica's 32-bit Xtensa LX6 Microprocessor with integrated Wi-Fi and Bluetooth.

b. I2C LCD Display: I2C Module has an inbuilt PCF8574 I2C chip that converts I2C serial data to parallel data for the LCD.

Fig 3: I2C LCD Display

These modules are currently supplied with a default I2C address of either 0x27 or 0x3F. To determine which version you have checked the black I2C adaptor board on the underside of the module. If there 3 sets of pads labeled A0, A1, & A2 then the default address will be 0x3F. If there are no pads the default address will be 0x27. The module has a contrast adjustment pot on the underside of the display. This may require adjusting for the screen to display text correctly.

c. MQ135 Air Quality Sensor: The **MQ-135 Gas sensor** can detect gases like Ammonia (NH3), sulfur (S), Benzene (C6H6), CO2, and other harmful gases and smoke. Similar to other MQ series gas sensors, this sensor also has a digital and analog output pin.

Fig 4: MQ135 Air Quality Sensor

When the level of these gases goes beyond a threshold limit in the air the digital pin goes high. This threshold value can be set by using the onboard potentiometer. The analog output pin outputs an analog voltage which can be used to approximate the level of these gases in the atmosphere.

d. MQ7 Sensor: MQ-7 is a Carbon Monoxide (CO) sensor, suitable for sensing Carbon Monoxide concentrations (PPM) in the air. The MQ-7 sensor can measure CO concentrations ranging from 20 to 2000ppm. This sensor has high sensitivity and a fast response time. The sensor's output is an analog resistance. The drive circuit is very simple, just a voltage divider; all you need to do is power the heater coil with 5V DC or AC, add a load resistance and connect the output to an ADC or a simple OPAMP comparator.

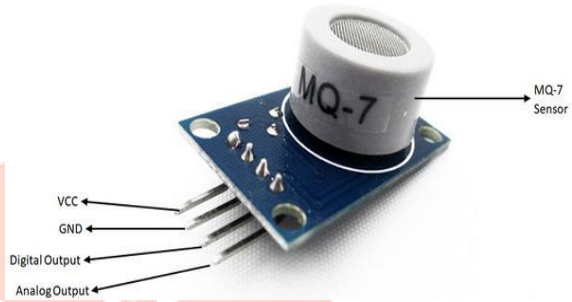

Fig 5: MQ7 CO2 Sensor

MQ7 is a Carbon Monoxide (CO) sensor, suitable for sensing Carbon Monoxide concentrations (PPM) in the air. MQ7 Gas sensor can measure CO concentrations ranging from 20 to 2000 ppm. This sensor has high sensitivity and a fast response time. The sensor's output is an analog resistance. This sensor comes in a package similar to the MQ3 alcohol sensor. MQ7 gas sensor has a high sensitivity to Carbon Monoxide. The sensor could be used to detect different gases that contain CO; it is with low cost and suitable for different applications. They are used in gas detecting equipment for carbon monoxide (CO) in family and industry or cars.

e. DHT11 Sensor: DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any microcontroller such as Arduino, Raspberry Pi, etc… to measure humidity and temperature instantaneously.

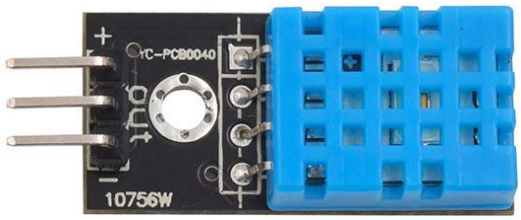

Fig 6: DHT11 Sensor

DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture-holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC measure, the process changed resistance values and change them into digital form.

f. **Power Supply:** The ESP32 Board operates between 2.2V to 3.6V. But we supply 5V from Micro-USB port. For 3.3V there is already an LDO voltage regulator to keep the voltage steady at 3.3V. ... The power required by ESP32 is 600mA, as ESP32 pulls as much as 250mA during RF transmissions.

Fig 7: 5V DC Power Supply Adaptor

V. SOFTWARE DESCRIPTION:

a. **Arduino Integrated Development Environment**: Arduino IDE is publicly accessible software where one can easily write codes and upload them to the board. It makes code compilation very easy. Being a cross-platform application, codes can be written in C and C++ language for Windows, macOS, and Linux.

b. **ThingSpeak**: ThingSpeak is an open-source IoT platform where one can combine, picture, and examine live streams of data in the cloud. Graphs, charts, numeric values of sensor data can be plotted on ThingSpeak. The sensor data is stored and resolved over HTTP which works based on a request and response system.

VI. METHODOLOGY:

Our IoT-primarily based air first-rate tracking device is quite accurate, clean to use, and pretty affordable. GP2Y1010AU0F is a PM sensor linked to pin 36 of ESP32. MQ135 and MQ7 are linked to analog pin 32 and 34 of ESP32 respectively. DHT11 is hooked up to virtual pin 2 of ESP32. The buzzer is hooked up to virtual pin 18 of ESP32. GP2Y1010AU0F has a hole component at its center. So, on every occasion the exceptional debris are with inside the hole detecting area, best then they may be sensed, and accordingly, suitable values may be obtained. The output turned into calculated the usage of the Dust density traits curve and is measured in mg/m3. Before beginning to paintings with MQ135 and MQ7, they want to be preheated after which calibrated. Preheating approach they want to take delivery of a 5V electricity to deliver for twenty-four hours at the least when you consider that the paintings at the heating principle. Since they deliver output in voltage stages, with the assist in their respective sensitivity traits curve they want to be transformed to PPM. We have used MQ135 for measuring CO2 attention. CO2 stages inside the air are 250- four hundred PPM: Normal. From four hundred to one thousand PPM: Typical with suitable air exchange. More than one thousand PPM: Poor air. As we additionally know, the ordinary variety of CO2 in our surroundings needs to be around 390-450 PPM. As quickly as CO2 attention is going above one thousand PPM, the buzzer could begin ringing. We have used MQ7 for measuring CO attention. CO stages inside the air and its ability fitness issues are 0-nine ppm: ordinary CO stages inside the air, no risk. 10-29 ppm: persistent issues over long-time period exposure. 100+ ppm CO: extreme symptoms, severe headaches, mind damage, coma, and/or death, specifically at

stages 300-four hundred+ ppm. The stay statistics of the air in the vicinity in which the device could be mounted may be visible at the dashboard of ThingSpeak from everywhere inside the global and to attain this, the tool needs to be linked to the internet.

VII. EXPERIMENTAL SETUP:

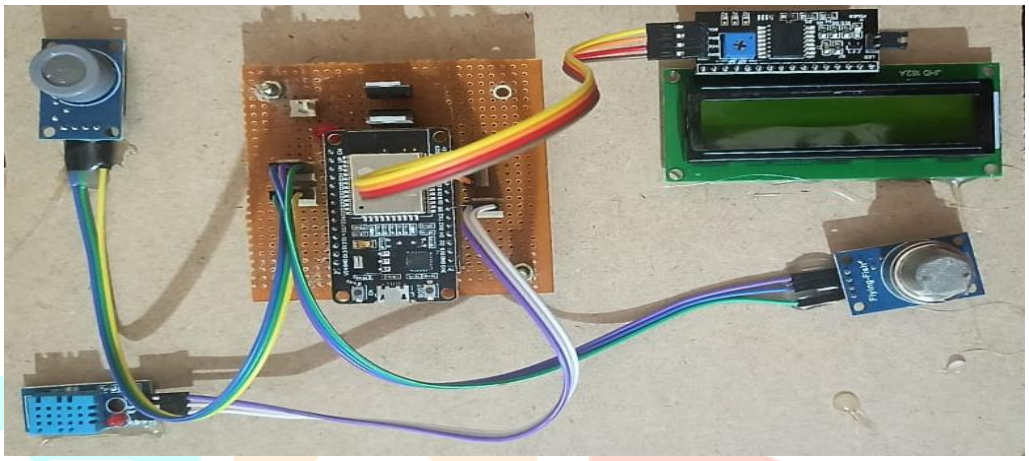

Fig 8.. Experiment Kit

VIII. RESULTS:

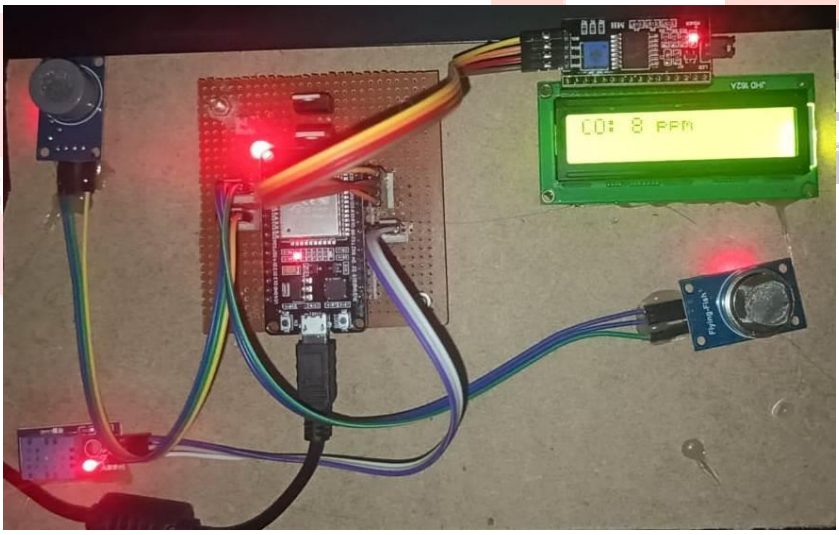

Fig 9: CO2 output

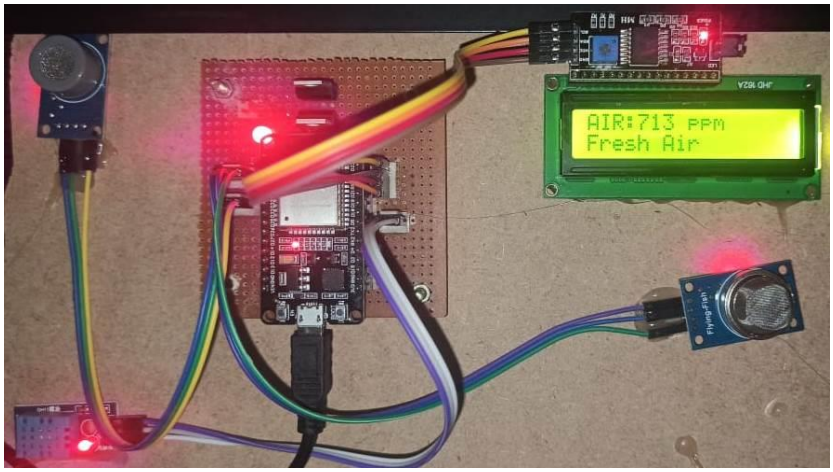

Fig 9: Air Quality Output

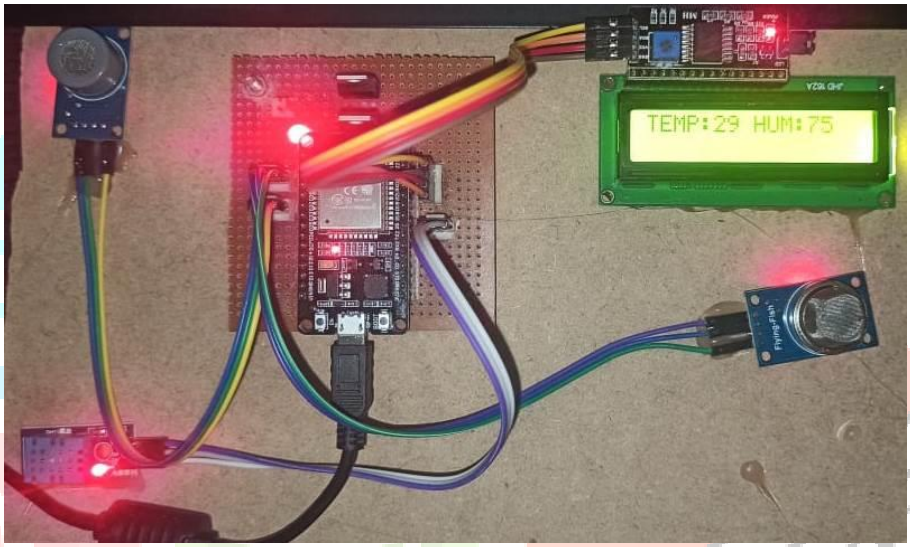

Fig 10: DHT11 Sensor Output

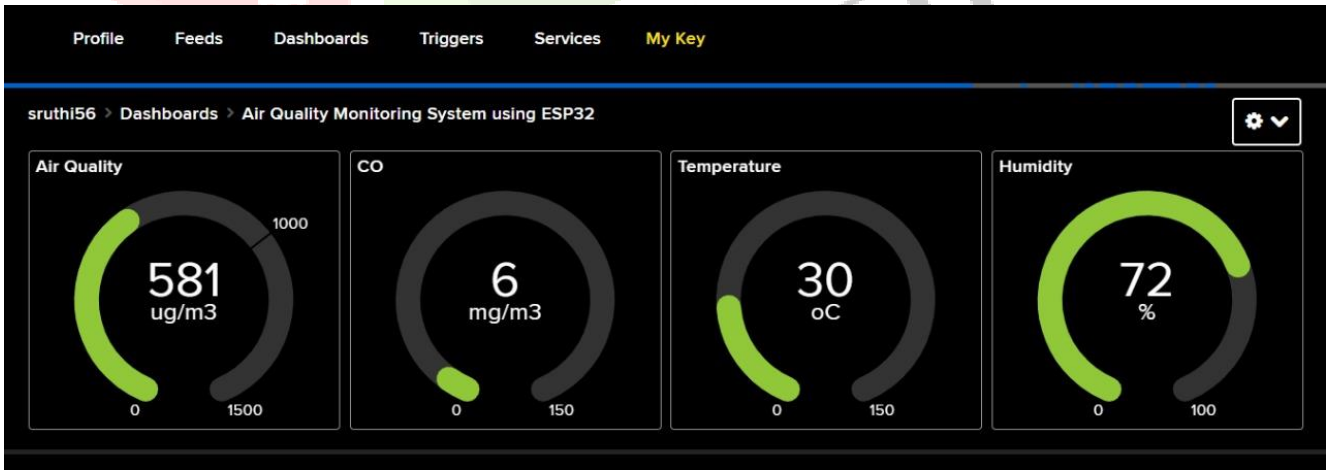

Fig 11: Adafruit IO Dashboard Display

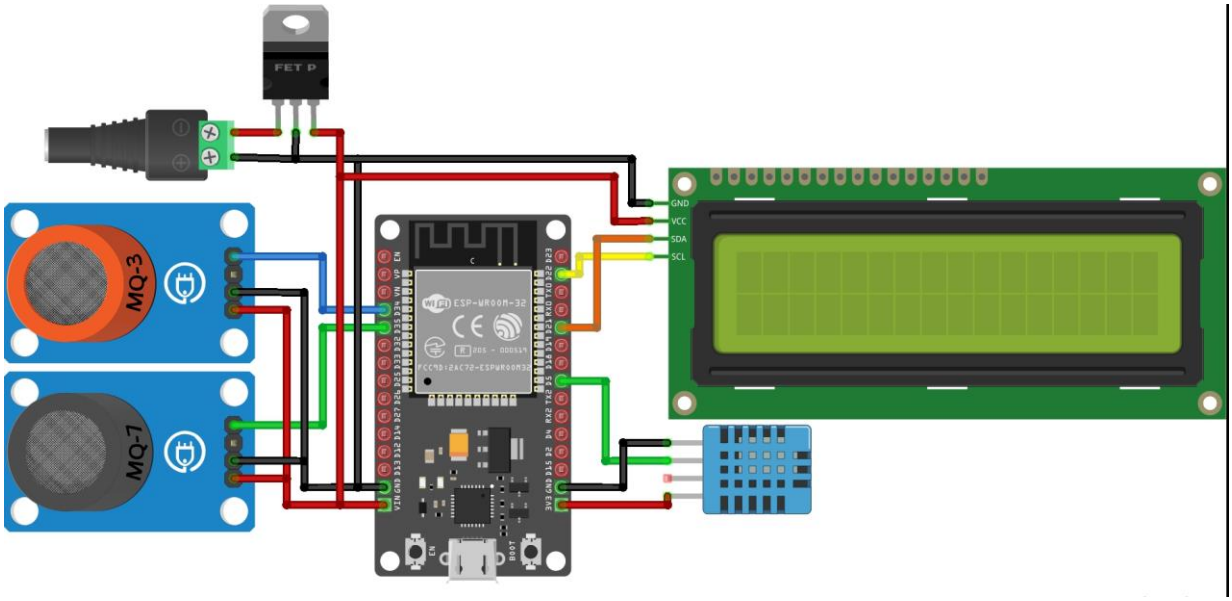

Fig 12: Schematic Diagram

IX. CONCLUSION:

This paper proposes a gadget this is price-efficient, low electricity eating and fairly correct gadget for tracking air first-class on a real-time foundation on a small scale with the assist of committed sensors and indicators humans while its stage is going past a positive restrict and shows the statistics in a manner anybody can understand. Leveraging the idea of IoT, the air across the hooked-up gadget may be monitored via way of means of anybody and from everywhere the usage of a telecall smartphone or a computer. The non-stop updating of statistics permits the customers to take well-timed movements right away on every occasion needed. This facilitates in curtailing air pollutants inside the surroundings around us that's a huge concern. Apart from being low in price and electricity consumption, it covers much less area and maybe hooked up everywhere. This affords first-rate performance and flexibility.

FUTURE SCOPE:

Such kind of gadget may be utilized in ways, one is as a stand-by myself tool as proven above or it could be established in vehicles. By putting it in vehicles, it can make drivers knowledgeable and aware of riding styles they comply with and the way it's far impacting the encircling and growing pollutants. By adopting higher riding conduct will in flip result in a discount in pollutants. It goes to gain them in addition to others through decreasing pollutants so all and sundry can breathe purifier air. In the future, extra sensors also can be introduced to this for this reason extending the gadget. Further, we also can regulate the gadget by including a characteristic of sending SMS to the person whilst the amount of any fuel line inside the surroundings exceeds a positive value. Such structures also can be carried out on a massive scale and assist in creating a clever city.

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