IOT-Based Air Purifier with Quality Monitoring

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Abstract

The aim of this project is to develop an intelligent air purifier with quality monitoring capabilities to reduce indoor air pollution and mitigate health risks. With indoor air quality becoming a growing concern, especially in densely populated areas like India where a significant portion of the population is engaged in agriculture, there is a pressing need for innovative solutions. The "Design and Fabrication of Smart Air Purifier with Quality Monitoring" system is designed to address this need by minimizing indoor air pollution while enhancing monitoring accuracy and efficiency. The proposed system features a multipurpose autonomous air purifier equipped with quality monitoring sensors, controlled via an ESP module. Field tests demonstrate the system's successful operation, with the air purifier effectively removing pollutants while monitoring air quality parameters in real-time.

Keywords: Smart Air Purifier, Quality Monitoring, ESP-Module, Indoor Air Pollution

Introduction

Introducing the next evolution in air purification technology: the air purifier with built-in quality monitoring. This innovative device revolutionizes the way we approach indoor air quality by combining advanced filtration with real-time monitoring capabilities. Gone are the days of guessing about the cleanliness of your indoor environment now, you can have immediate access to comprehensive air quality data at your fingertips.Imagine a device that not only removes harmful pollutants such as dust, pollen, and volatile organic compounds from the air but also continuously monitors the levels of these contaminants, providing you with up-to-the-minute insights. With sensors detecting a range of pollutants, from fine particulate matter to allergens, you can trust that your air purifier is working diligently to keep your indoor environment clean and healthy.

Brief Review of Project

The Project Air Purifier with Quality Monitor offers a comprehensive solution for improving indoor air quality. Its primary function, air purification, is complemented by a quality monitor that provides real-time feedback on air conditions.

1. **Air Purification:** The purifier effectively filters out pollutants, allergens, and other harmful particles from the air, ensuring a cleaner and healthier indoor environment.
2. **Quality Monitor:** The built-in quality monitor continuously assesses air quality parameters such as particulate matter (PM2.5), volatile organic compounds (VOCs), and humidity levels. This feature allows users to track air quality trends and make informed decisions to maintain a healthy atmosphere.
3. **Smart Functionality:** Some models may include smart features like Wi-Fi connectivity and mobile app

integration, enabling remote monitoring and control of the purifier from anywhere.

4. **User-Friendly Design:** The purifier is designed with user convenience in mind, featuring intuitive controls and easy maintenance procedures.

5. **Energy Efficiency:** Energy-efficient operation helps to minimize power consumption, making it cost-effective and environmentally friendly.

Literature Review

1. Sujuan Liu : worked on "A low-power real-time air quality monitoring system using LPWAN based on LoRa" "This paper introduces a low-power real-time air quality monitoring system leveraging LoRa Wireless Communication technology. It integrates multiple air pollution sensors, a single-chip microcontroller, and a LoRa modem to enable long-range communication up to 2 km. With a low TX power of approximately 110mA and the inclusion of a solar PV-battery component, the system ensures extended device operation. A user-friendly GUI enhances ease of use, making it a cost-effective, high-coverage solution for air quality monitoring."

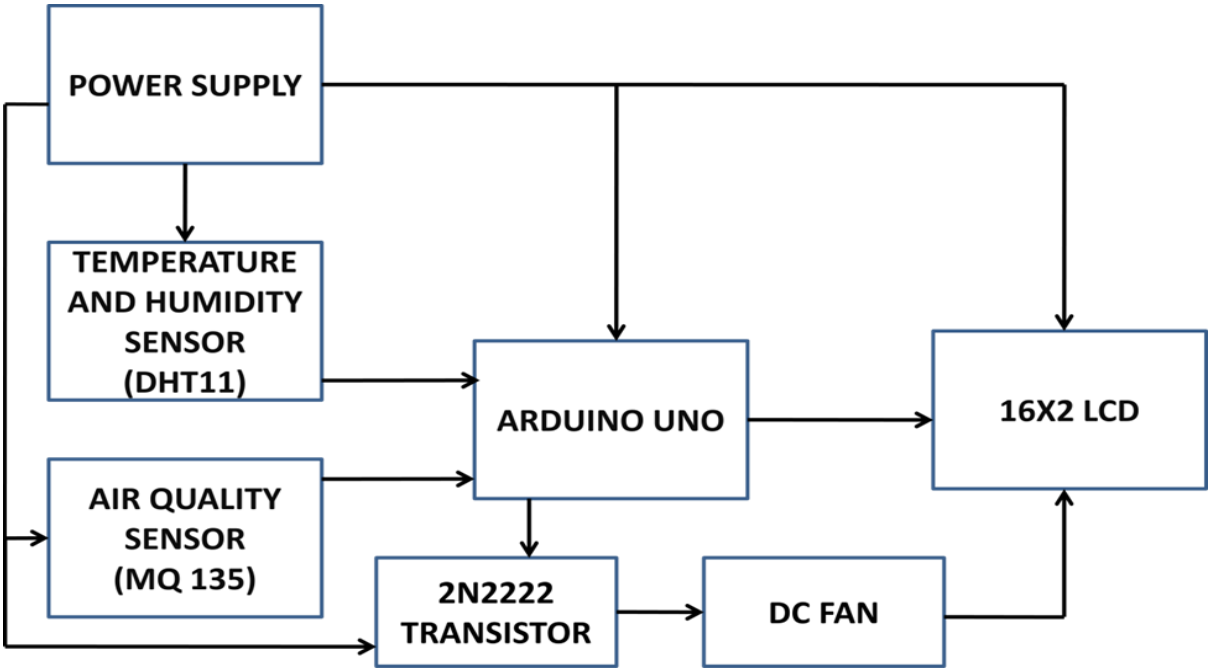
2. M.F.M Firdhous : worked on "IoT enabled proactive indoor air quality monitoring system for sustainable health management" This paper proposes an IoT-based indoor air quality monitoring system focused on tracking ozone concentrations near a photocopy machine. It utilizes a semiconductor sensor for ozone monitoring, transmitting data every five minutes via Bluetooth to a gateway node, which then communicates with a processing node over WiFi. The system is calibrated using standard methods and can issue warnings when pollution levels exceed preset thresholds.

3. R du Plessis : worked on " wireless system for indoor air quality monitoring " This paper describes the development of a wireless monitoring system which can be deployed in a building. The system measures carbon dioxide, carbon monoxide and temperature. The system developed in this paper can serve as the monitoring component of a HVAC control system and function as an indoor air quality monitor independently.

4. Shreya Jain : worked on "Polluino: An efficient cloud-based management of IoT devices for air quality monitoring " This paper describesThe Internet of Things paradigm originates from the proliferation of intelligent devices that can sense, compute and communicate data streams in a ubiquitous information and communication network. The great amounts of data coming from these devices introduce some challenges related to the storage and processing capabilities of the information. This strengthens the novel paradigm known as Big Data. In such a complex scenario, the Cloud computing is an efficient solution for the managing of sensor data. This paper presents Polluino, a system for monitoring the air pollution via Arduino. Moreover, a Cloud-based platform that manages data coming from air quality sensors is developed.

5. Yonggao Yang: worked on "A smart sensor system for air quality monitoring and massive data collection" This paper Reviewing the Air pollution has been a global challenge for environment protection. Effectively collecting and scientifically visualizing the air quality data can better help us monitor the environment and address related issues. This article presents a smart sensor system for air quality monitoring which consists of three units: the smart sensor unit, the smartphone, and a server.

DESIGN & COMPONENT SELECTION



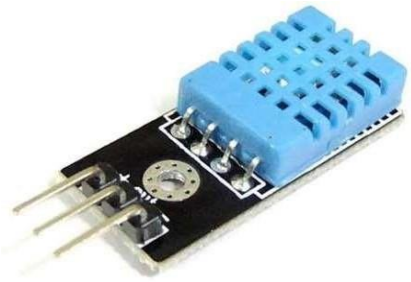
BLOCK DIAGRAM

Components used:

1. Temperature and Humidity sensor (DHT11)
2. Air Quality sensor (MQ 135)
3. 2n2222 Transistor
4. DC Fan
5. Potentiometer
6. 16x2 LCD Panel
7. NodeMCU
8. Arduino Uno
9. pre filter
10. Hepa filter
11. carbon filter

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 an NTC temperature measurement devices, and connected with a high-performance 8-bit microcontroller.

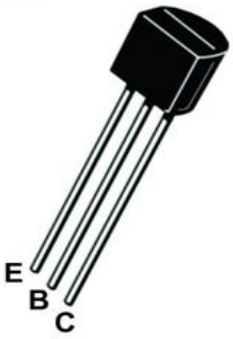


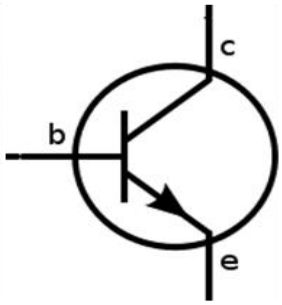
AIR QUALITY SENSOR (MQ135):

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.

2n2222 TRANSISTOR:

The program ensures students attain core competency in designing and fabricating mechanical systems relevant to air purifiers, including thermal and hydraulic machines, and materials selection. Through sustainable computer-aided solutions, they develop efficient air purification systems while upholding professional standards and ethical values. This approach integrates principles of mechanical engineering with environmental consciousness, ensuring graduates can contribute effectively to the field of air purification while maintaining integrity and social responsibility.





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.

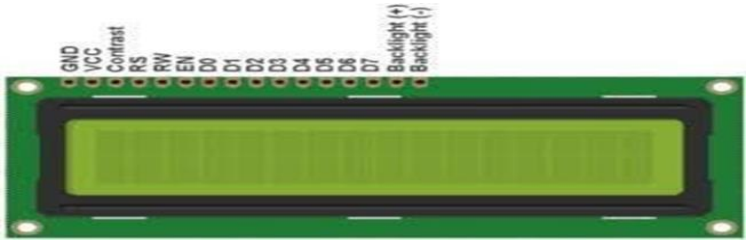
POTENTIOMETER:

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.

16x2 LCD Panel:

A liquid-crystal display (LCD) is a flat-panel 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.

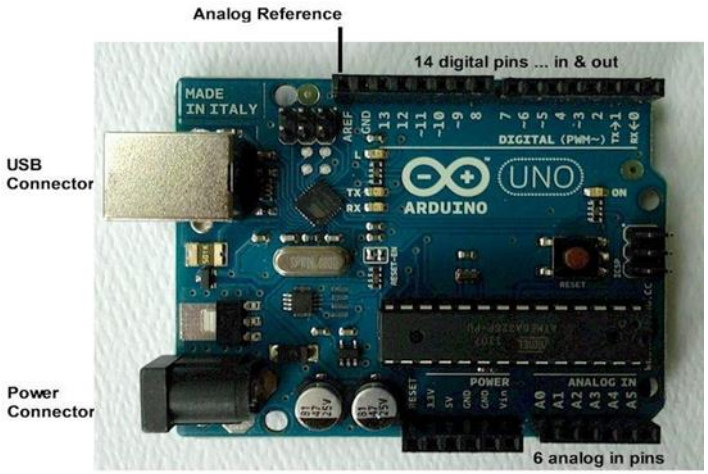


NODE MCU:

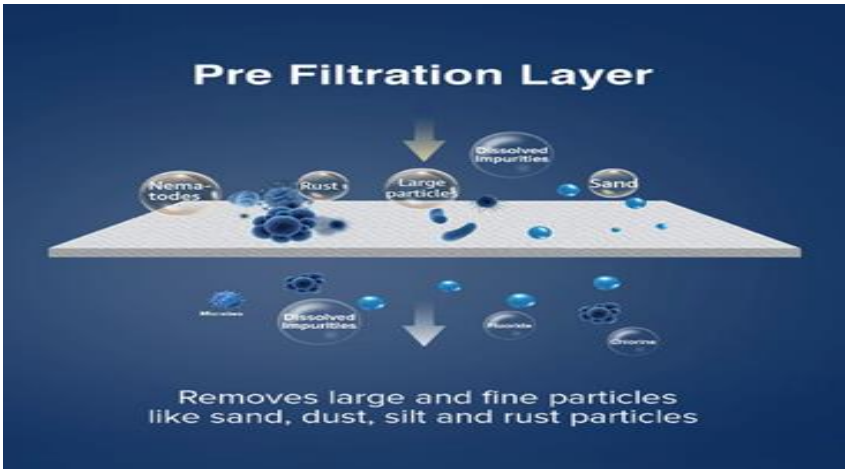
NodeMCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi- Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the development kits. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non- OS SDK for ESP8266.

ARDUINO UNO:

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



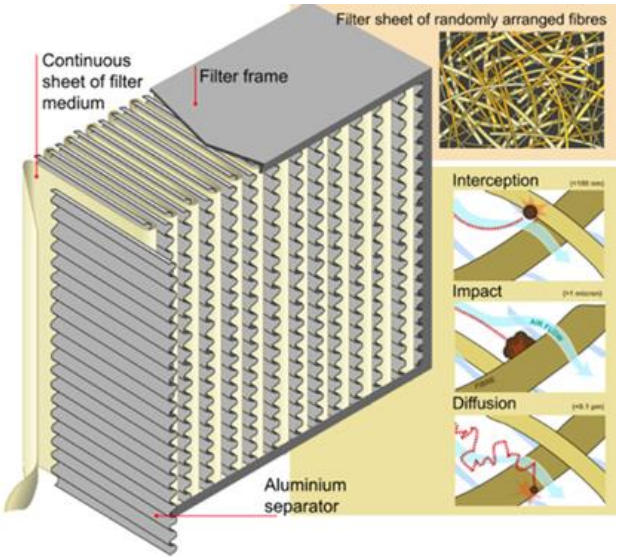
PER FILTER:



Pre-filters play a crucial role in air purifiers, acting as the first line of defense against airborne contaminants. By capturing larger particles such as dust, hair, and pet dander, they significantly enhance indoor air quality by reducing the presence of visible pollutants. Moreover, pre-filters contribute to the longevity of the main filter by preventing larger particles from clogging it, thus extending its lifespan and reducing the frequency of filter replacements. This not only saves time and effort but also reduces maintenance costs in the long run. Additionally, pre-filters enhance the overall efficiency of the air purifier by allowing the main filter to focus on capturing smaller, more harmful particles like allergens, bacteria, and viruses. Their washable or replaceable nature makes pre-filters easy to clean and maintain, ensuring optimal performance of the air purification system. Overall, pre-filters are essential components that not only improve air quality but also contribute to the efficient operation and longevity of air purifiers.

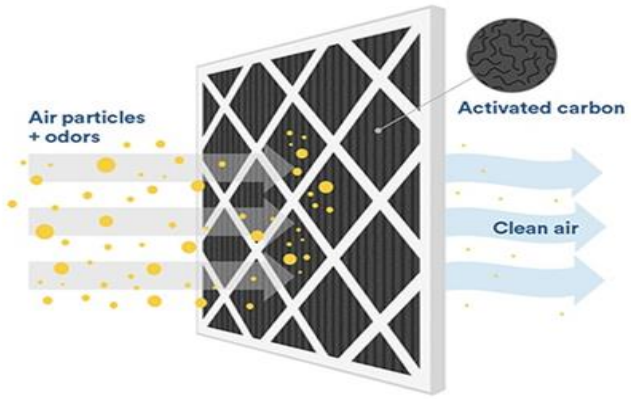
Hepa Filter:

HEPA stands for High Efficiency Particulate Air. HEPA filters are a type of mechanical air filter that can trap a large amount of very small particles that other vacuum cleaners would simply recirculate back into the air of your home. They're commonly used in air purifiers and vacuum cleaners, as well as in some medical settings, to remove allergens, dust, pet dander, and other airborne particles. HEPA filters are designed to meet certain standards of efficiency, typically removing at least 99.97% of particles that are 0.3 microns in diameter or larger.



carbon filter:

carbon filter is made of activated carbon also called as activated charcoal , carbon air filters can help to trap odors.



Activated carbon air filters work by adsorbing organic chemicals from the air. However, over time, these filters can become saturated with pollutants, filling up the adsorption sites. When this happens, the filter loses its effectiveness in trapping pollutants, and chemicals with a higher affinity for the adsorption sites may displace others. Factors like temperature and humidity influence this process. As a result, when a carbon air filter is saturated, it may emit a strange odor, indicating the need for replacement.

- Improved Indoor Air Quality
- Removes Unpleasant Odours
- Helps to Remove Smoke and Chemical Fumes
- Long-lasting

Program code:

```
#include <Wire.h>

#include <LiquidCrystal_I2C.h>

#define BLYNK_TEMPLATE_ID "TMPLKWxj0Fk5"

#define BLYNK_DEVICE_NAME "Automation"

#define BLYNK_AUTH_TOKEN "z5bzztTdvDz-NIKNc9p1v8m8XRk1lLA8"

#define BLYNK_PRINT Serial//

#include <ESP8266WiFi.h>

#include <BlynkSimpleEsp8266.h>

char auth[] = BLYNK_AUTH_TOKEN;
```

```
char ssid[] = "robo";
char pass[] = "1234567890";
// Attach virtual serial terminal to Virtual Pin V1
WidgetTerminal terminal(V1);
LiquidCrystal_I2C lcd(0x27, 16, 2);
 const int gasb=A0,gasa=D5;
const int BUZZ=D8;
void setup() {
 Serial.begin(115200);
delay(200);
lcd.begin();
lcd.backlight();
lcd.clear();
lcd.setCursor(1,0);
lcd.print("Connecting to");
  lcd.setCursor(3,1);
  lcd.print("Blynk IoT");
  Blynk.begin(auth, ssid, pass);
  lcd.clear();
  lcd.setCursor(3,0);
  lcd.print("Welcome to");
  delay(2500);
  lcd.clear();
  lcd.setCursor(5,0);
  lcd.print("Smart");
```

```
  lcd.setCursor(3,1);
  lcd.print("Air Purifier");
  delay(4000);
  pinMode(BUZZ,OUTPUT);
  pinMode(gasa,INPUT);
}
 void loop() {
  Blynk.run();
  int gasbv=analogRead(gasb);
  int gasav=digitalRead(gasa);
//
//  Serial.print(gasbv);
//  Serial.print("    ");
//  Serial.println(gasav);
  if(!gasav){
    Serial.println("Status:High Pollution Alert!");
    terminal.println("Status:High Pollution Alert!") ;
    Blynk.logEvent("emergeny_alert","High Pollution Alert!");
    lcd.clear();
    lcd.setCursor(2,0);
    lcd.print("High Pollution");
    lcd.setCursor(5,1);
    lcd.print("Alert!");
    digitalWrite(BUZZ,HIGH);
  }else if(gasav&&gasbv>600){
```

```
    Serial.println("Status: Service Air Filter");
    terminal.println("Status: Service Air Filter") ;
    lcd.clear();
    lcd.setCursor(2,0);
    lcd.print("Change the");
    lcd.setCursor(5,1);
    lcd.print("Filter");
  }else{
    lcd.clear();
    lcd.setCursor(0,1);
    lcd.print("Good Air Quality");
    Serial.println("Status: Good Air Quality");
    terminal.println("Status: Good Air Quality") ;
    digitalWrite(BUZZ,LOW);
  }
 delay(2000);
}
```

Fabrication :

Outer Cover/Frame: Holds the filter in place.
Filter Pad: Removes particles from the air.
Mesh Screen: Provides additional support and prevents the filter pad from collapsing.
Finger Guard: Protects fingers from accidents involving the fan's moving blades.
Assembling the finger guard to the purifier.

Testing the display board and checking the outlet air tube on the air purifier.Display board shows the air quality index on how much it purifies.we checked the how
much of air has released from outlet.

Assembling the Arduino board to the purifier
which is used to perform user tasks to get output on the required index.we use code to run the air purifier on quality index.its sends to display board to shows the air quality index.

Finally we assembled the air purifier with required components.
we tested the air purifier in gajuwaka until the output matches to gajuwaka air quality index.

Conclusion:

In conclusion, investing in an air purifier with quality monitoring capabilities offers significant benefits for both health and peace of mind. By continuously monitoring the air quality in your indoor environment, these devices can effectively remove pollutants and allergens, ensuring cleaner and healthier air for you and your loved ones to breathe.

Air purifiers with quality monitoring are becoming increasingly important in our daily lives due to the rising levels of air pollution. They not only help in purifying the air but also provide real-time data about the air quality. Here are some key conclusions based on recent studies and developments:

- Effectiveness: Air purifiers with quality monitoring have been found to be effective in filtering out pollutants. For instance, a study on an IoT-enabled air pollution monitoring and air purifier system found that the designed filter effectively filters all the particles above 0.3 µm1.
- Performance: The performance and efficiency of both air quality monitoring and air purifier systems have been tested and found satisfactory. In one case, an air purifier was able to produce 96 percent of clean air and could run up to 14 hours a day by a solar-powered system2.
- Technological Advancements: The integration of IoT technology with air purifiers has led to the development of smart systems that can monitor and control air quality more efficiently1.
- Health Benefits: These devices can significantly reduce the risk of health issues caused by indoor pollutants, which can trigger neurological problems, respiratory infections, or symptoms in asthma sufferers

Finally, air purifiers with quality monitoring are a promising solution to tackle air pollution and improve indoor air quality. They offer a combination of purification and real-time monitoring, making them an essential tool for maintaining a healthy living environment. However, it's important to note that while these devices can help improve air quality, they are not a substitute for reducing sources of pollution and improving ventilation.

Future Scope:

1. Enhanced sensor technology for greater accuracy and sensitivity.
2. Integration of artificial intelligence for predictive analysis and automatic adjustment of settings..
3. Cloud-based analytics for data aggregation and enhanced understanding of pollution patterns.
4. Health monitoring features including allergen and pathogen detection.
5. Focus on sustainability with renewable energy usage and energy-efficient methods..
6. Integration with smart home ecosystems for seamless operation.
7. Development of portable and wearable air quality monitoring devices.
8. Incorporation of real-time feedback mechanisms for user interaction.
9. Expansion of global networks for comprehensive air quality monitoring.
10. Adoption of eco-friendly materials and manufacturing processes.

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