SHRI RAMDEOBABA COLLEGE OF ENGINEERING AND MANAGEMENT, NAGPUR.

Introduction to IoT

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"IoT based Dust Detection and Management"

Submitted By
Section A

Chirag Hitesh Pabari (Roll No: 101,Sec-A)
Ganesh Narayan Moroliya (Roll No: 102, Sec-A)
Hemant Bhojraj Paunikar (Roll No: 103, Sec-A)

Department of Electronics and Communication Engineering

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1. Introduction

Environmental pollution has emerged as a critical global issue in recent times, particularly with regard to air quality in urban regions. Of the various pollutants, particulate matter (PM) stands out as a significant contributor to air pollution, posing substantial health risks to individuals. Monitoring PM levels has thus become imperative to uphold air quality standards. This project introduces an innovative solution—a dust detection system leveraging IoT technology—to address this concern specifically in indoor environments.

This project revolves around an IoT-based dust detection system designed to not only detect but also manage dust levels indoors. The system employs a dust detection sensor seamlessly integrated with a Node MCU ESP8266 microcontroller. This setup enables real-time monitoring of dust concentrations. When the dust levels surpass predefined thresholds, the system autonomously triggers the activation of an exhaust fan. The primary objective is to alleviate dust accumulation promptly, ensuring a healthier indoor environment for occupants.

By combining advancements in sensor technology with IoT capabilities, this system offers a proactive approach to indoor air quality management. It acts as a preemptive measure against potential health hazards associated with elevated dust levels. Furthermore, the integration of smart functionalities facilitates swift and efficient response mechanisms, contributing to overall environmental well-being.

In essence, this project presents a user-friendly and efficient solution to tackle indoor air pollution, particularly concerning particulate matter. Its implementation holds promise for enhancing the quality of life in urban areas by fostering cleaner and healthier indoor environments.

2.Objectives

1. Develop an IoT-based dust detection system capable of accurately measuring and monitoring dust levels in indoor environments in real-time.

2. Implement a proactive approach to indoor air quality management by integrating the dust detection system with an exhaust fan, which activates automatically when dust levels exceed predefined thresholds.

3. Establish a user-friendly and efficient solution to mitigate the adverse effects of indoor air pollution, particularly concerning particulate matter, thereby promoting healthier indoor environments for occupants.

3.Components Used

Dust Detection Sensor: This sensor is responsible for measuring the concentration of dust particles in the environment. It provides analog or digital output based on the detected dust levels.

NodeMCU ESP8266: The NodeMCU ESP8266 serves as the main control unit of the system. It collects data from the dust sensor and processes it to determine the dust levels. It also communicates with the Thingspeak platform to upload the data for visualization and further analysis.

Exhaust Fan: An exhaust fan is integrated into the system to expel dust particles from the environment when the dust levels exceed a certain threshold. The fan is controlled by the Node MCU ESP8266 based on the measured dust levels.

Thingspeak Platform: Thingspeak is used as a cloud-based IoT platform for collecting, visualizing, and analyzing the data transmitted by the NodeMCU ESP8266. It provides real-time monitoring of dust levels and enables remote management of the system.

4. Circuit Diagram

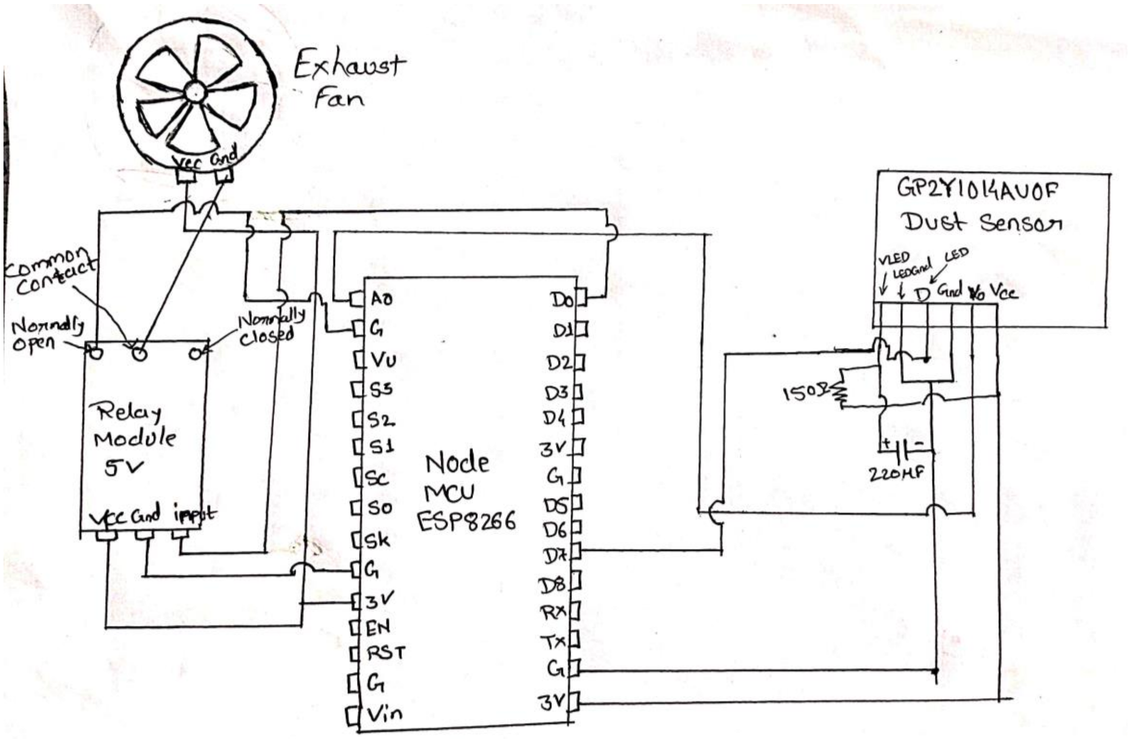

Fig No 1: Circuit diagram

5.Working

System Initialization:
The initialization process begins with establishing a connection between the NodeMCU ESP8266 and the Wi-Fi network. This enables the NodeMCU ESP8266 to communicate with external servers and platforms for data transmission and management. Additionally, during this phase, the dust sensor is configured to ensure proper communication with the NodeMCU ESP8266 and accurate measurement of dust concentration levels.

Data Acquisition:
Following initialization, the dust sensor starts continuously monitoring the surrounding environment for dust particles. It employs various detection techniques, such as light scattering, depending on the sensor type. The sensor collects data regarding the concentration of dust particles present in the air. This data is then transmitted to the NodeMCU ESP8266 at regular intervals for processing and analysis.

Threshold Check:
Upon receiving data from the dust sensor, the NodeMCU ESP8266 compares the measured dust levels with predefined thresholds. These thresholds are set based on air quality standards and desired indoor air quality levels. If the measured dust levels exceed the predefined thresholds, indicating poor air quality, the system proceeds to activate the exhaust fan for dust mitigation.

Exhaust Fan Activation:
When the dust levels exceed the predefined thresholds, signifying a decline in indoor air quality, the NodeMCU ESP8266 triggers the activation of the exhaust fan. The exhaust fan is strategically positioned to expel dust particles from the indoor environment, thereby improving air quality and creating a healthier living or working environment for occupants.

Data Transmission:
Simultaneously with fan activation, the NodeMCU ESP8266 initiates the transmission of collected data to the Thingspeak platform. This data includes information on dust levels, operational status, and any relevant parameters. By transmitting this data in real-time, the system enables remote monitoring and analysis of indoor air quality trends, facilitating informed decision-making and proactive maintenance strategies.

Continuous Monitoring:
Even after fan activation and data transmission, the system maintains continuous monitoring of dust levels in the indoor environment. By periodically re-evaluating dust concentrations, the system ensures prompt response to any fluctuations in air quality. This ongoing monitoring allows for dynamic adjustment of fan operation to maintain the desired indoor air quality standards over time.

Program:

```
#include <ESP8266WiFi.h>
#include <ThingSpeak.h>

WiFiClient client;

long myChannelNumber = 2493015;
const char myWriteAPIKey[] = "B7O0C45TY5HJPS4J";


// Define pins
const int measurePin = A0;  // Analog pin for dust sensor measurement
const int ledPower = 13;     // Digital pin for LED power control
const int ExhaustFan = 16;
const int AirFilter = 5;


// Variables to store measured values
float voMeasured = 0;
float dustVoltage = 0;
float dustDensity = 0;

//variables to update and send on thingspeak for exhaust fan and air filter condition
int a,b;

void setup() {
  Serial.begin(115200);   // Initialize serial communication
  WiFi.mode(WIFI_STA);
  WiFi.begin("vivo", "asdfghjkl");
  while(WiFi.status() != WL_CONNECTED)
  {
    delay(200);
    Serial.print("..");
  }
  Serial.println();
  Serial.println("NodeMCU is connected!");
  Serial.println(WiFi.localIP());

  pinMode(ledPower, OUTPUT);  // Set LED power pin as output
  pinMode(ExhaustFan, OUTPUT);
  pinMode(AirFilter, OUTPUT);


  ThingSpeak.begin(client);

}

void loop() {
```

```
  // Turn on LED power
  digitalWrite(ledPower, LOW);
  delayMicroseconds(280);

  // Read analog value from dust sensor
  voMeasured = analogRead(measurePin);

  // Wait before turning off LED
  delayMicroseconds(40);
  digitalWrite(ledPower, HIGH);
  delayMicroseconds(9680);

  // Calculate dust voltage based on measured analog value
  dustVoltage = voMeasured * (3.0 / 1024);

  // Convert dust voltage to dust density
  // Use calibration values obtained from sensor datasheet or experimentation
   dustDensity = 170 * dustVoltage - 0.1;  // Example calibration (adjust as needed)

   if(dustDensity > 200)
   {
    digitalWrite(ExhaustFan,HIGH);
    digitalWrite(AirFilter,HIGH);
    a = 5;
    b = 5;
    Serial.println("Exhaust Fan And Air Filter is ON.");
   }
   else{
    digitalWrite(ExhaustFan,LOW);
    digitalWrite(AirFilter,LOW);
    a = 0;
    b = 0;
   }

  // Display the result
  Serial.print("The current dust concentration is: ");
  Serial.print(dustDensity);
  Serial.println(" ug/m3");
  Serial.println(a);
  Serial.println(b);
  ThingSpeak.writeField(myChannelNumber, 1, dustDensity, myWriteAPIKey);
  ThingSpeak.writeField(myChannelNumber, 2, a, myWriteAPIKey);
  ThingSpeak.writeField(myChannelNumber, 3, b, myWriteAPIKey);

  delay(500);  // Delay before next measurement and sending
}
```

6. Result and Conclusion

The IoT-based dust detection system presented in this project offers an effective solution for monitoring and managing indoor air quality. By integrating dust sensors, microcontrollers, and cloud platforms, the system provides real-time monitoring of dust levels and automates the operation of the exhaust fan to maintain a healthy indoor environment. This system can be deployed in various settings, including homes, offices, and industrial facilities, to mitigate the adverse effects of air pollution on human health.

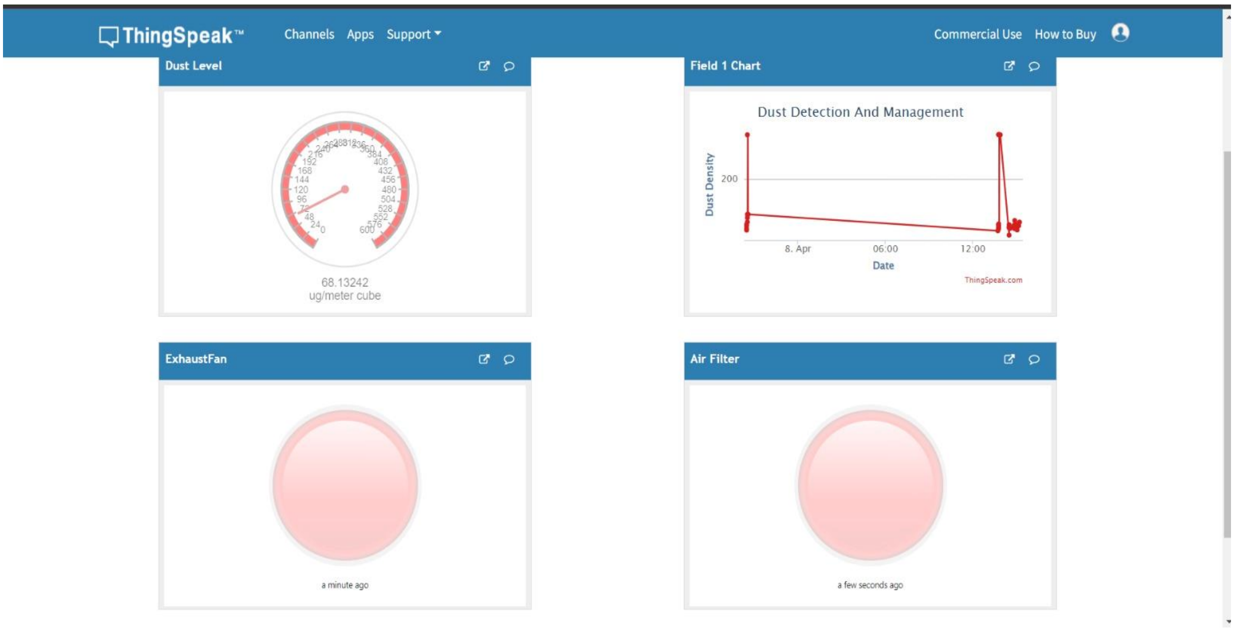

FIG NO 2: Before Execution

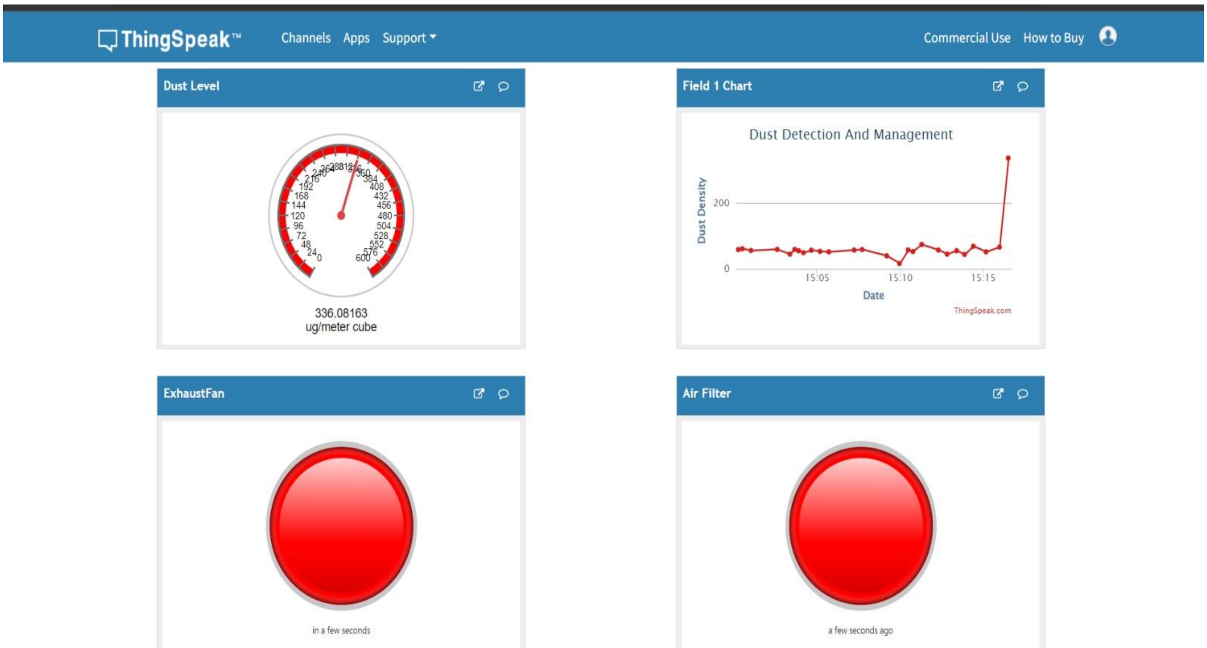

FIG NO 3: After Execution

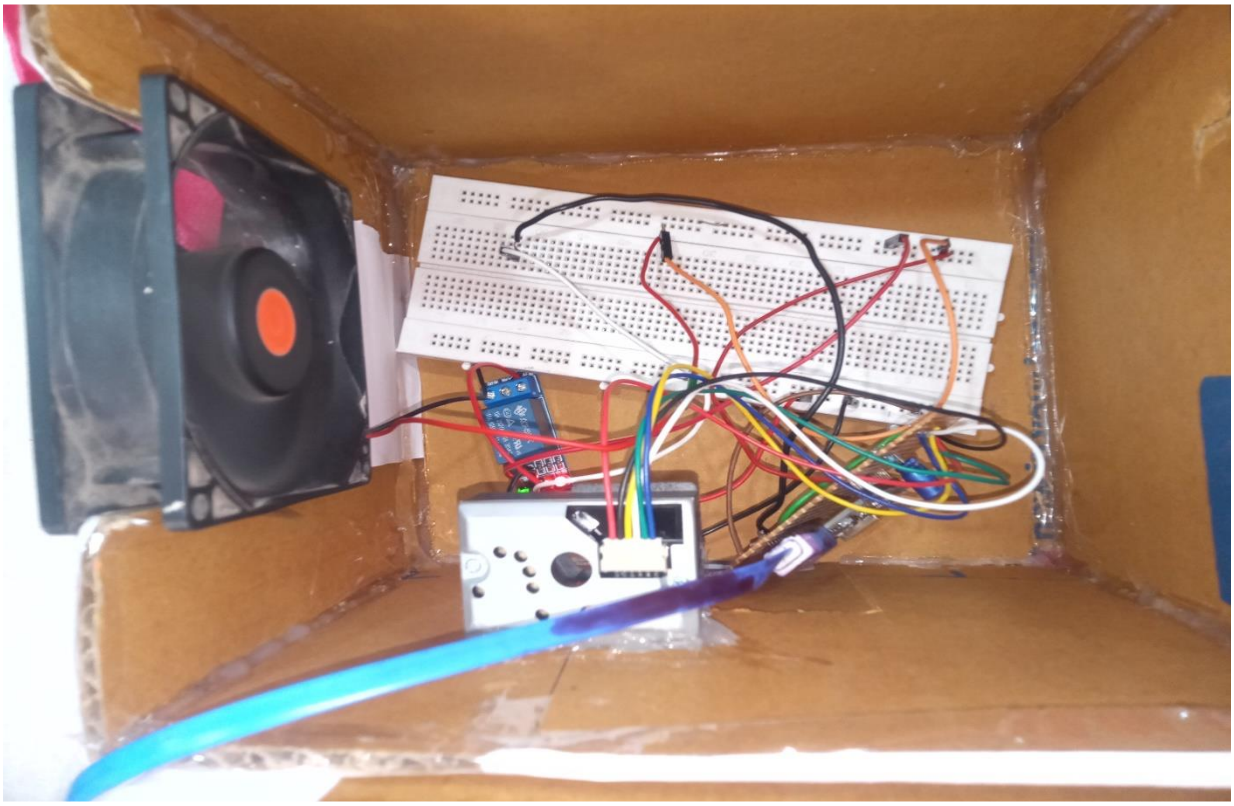

FIG NO 4: Internal Structure

FIG NO 5: Front view of model

7. Future Scope and Enhancements

Multi-Pollutant Monitoring: Enhance the system's capabilities by integrating gas sensors to monitor a wider range of pollutants beyond dust, including CO_2, VOCs, and NO_2. This expansion broadens the scope of the project, providing comprehensive indoor air quality monitoring and management.

Advanced Data Analytics: Implement advanced data analytics techniques to analyze the collected data more effectively. By employing machine learning algorithms, the system can identify patterns, trends, and correlations in air quality data, enabling proactive decision-making and predictive maintenance strategies.

Smart Control Strategies: Develop intelligent control strategies for the operation of the exhaust fan and other components based on real-time sensor data. By incorporating adaptive algorithms, the system can dynamically adjust fan speed and other parameters to optimize energy efficiency while maintaining desired air quality levels.

Integration with Smart Home Systems: Extend the system's functionality by integrating it with smart home automation platforms. This integration enables seamless interaction with other smart devices and allows users to control and monitor indoor air quality remotely using voice commands or mobile applications.

8. References

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