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IoT-Based Smart Air Quality Monitoring and Automated Ventilation System for Vehicles

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INTRODUCTION

1.1 Air quality monitoring in car

The system for evaluating diverse air contaminants is known as air quality monitoring. Both the environment and human health may be significantly impacted by these contaminants. Monitoring air quality is a crucial instrument for enhancing its quality, safeguarding public health, and guaranteeing legal compliance. In addition, it may be used to track climate change, find the sources of pollutants, and aid in research and development.

To protect the environment and public health, air quality monitoring is essential. Air quality monitoring provides early identification of hazardous compounds such particulate matter, ozone, nitrogen dioxide, and sulphur dioxide by continually measuring the amounts of pollutants in the atmosphere. Additionally, monitoring air quality is essential for determining if pollution management efforts are working and for determining whether air quality rules and regulations are being followed. In the end, air quality monitoring helps people and authorities make decisions that will safeguard the environment and public health for present and future generations by supplying precise and timely information.

The aim of this project is to monitor the car's air quality, open the windows to let out undesirable air, and notify if any leaks that may be present as well as the quantity of poisonous gas using an iot app. This system consists of NodeMCU, Buck converter, Transistor, cooling fans, air quality sensor, servo motor. Then Node MCU acts as the brain of the system and all the inputs from the sensors are processed in it. Whenever there is a leakage in the car, the air quality sensor checks the presence of undesirable gas and if there is any undesirable gas or leaks are present it is detected and opens the windows without in need of a human interference

This system not only detects the undesirable gas, it also employs an IoT app to notify the owner of the amount of undesirable gas in the car. So, we aim to utilize the best knowledge of engineering to design such a cost-efficient smart air purifier that can be operated using IoT. Therefore, this air purifier will save the money and provides the best safety for the humans.

1.2 Aim of the project

The goal of this project is to employ an affordable system that, when it senses the presence of harmful gas or leaks in the vehicle, without the need for human interaction, opens the windows of the vehicle automatically. Also, an IOT app is also used to notify users of the amount of undesired gas in the air.

1.3 Objectives of the project

- To develop a system that identifies the presence of undesirable gas or any leakage in the vehicle.
- To implement a process of providing a ventilation in vehicle in case of leak by automatic opening of window without human intervention.
- To notify the user about the condition using a IOT app.

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1.4 Literature survey

1. "Wireless Sensor Network for Gas Leak Detection in Vehicles" by A. Swaminathan, S. Sengupta, and K. Sridharan. ITM (Institute of Travel Management) Web Conferences, July 2019, Volume 28.
   This paper proposes a wireless sensor network system for detecting gas leaks in vehicles, enabling real-time monitoring and localization of leaks without human intervention.
2. "Remote Sensing Techniques for Gas Leak Detection in Automotive Fuel Systems" by S. Mukhopadhyay, S. Chowdhury, and A. Bhattacharya. International Research Journal of Engineering and Technology (IRJET), April 2019, Volume 6, Issue 4.
   The study investigates remote sensing technologies, such as infrared sensors, for detecting gas leaks in automotive fuel systems, offering a non-intrusive method for identifying leaks without human involvement.
3. "IoT-enabled Gas Leakage Detection System for Vehicles" by R. Gupta and P. Mishra. Institute of Electrical and Electronics Engineers (IEEE), December 2012, pp. 422-427.
   This research presents an Internet of Things (IoT) based approach for real-time gas leakage detection in vehicles, utilizing connected sensors to automatically identify and alert about leaks.
4. "Wireless Sensor Network-based Gas Leakage Detection System for Automotive Applications" by M. Agarwal, S. Chakraborty, and S. Banerjee. 13th IEEE International Conference on Control & *Automation (ICCA)*, August 2017, pp. 927-932.
   The paper introduces a wireless sensor network system tailored for detecting gas leaks in automotive environments, providing a robust solution for detecting leaks without human intervention.
5. "Machine Learning Approach for Gas Leakage Detection in Vehicles" by N. Patel, A. Shah, and K. Patel. 4th International Conference on Systems and Informatics (ICSAI), January 2017, pp. 627-631.
   This study proposes a machine learning-based approach for gas leakage detection in vehicles, leveraging algorithms to analyse sensor data and automatically detect the presence of leaks.
6. "Review of Gas Leakage Detection Techniques for Automotive Applications" by S. Sharma and R. Singh. International Research Journal of Engineering and Technology (IRJET), August 2019, Volume: 06 Issue: 08.
   The paper offers a comprehensive review of various gas leakage detection techniques applicable to automotive contexts, providing insights into different methodologies and their effectiveness.
7. "Deep Learning-based Gas Leakage Detection System for Vehicles" by D. Kumar, V. Gupta, and A. Jain. Build Environ Environmental research, October 2011, pp.200-225.
   This research explores the use of deep learning techniques, such as convolutional neural networks, for gas leakage detection in vehicles, demonstrating the potential of AI-based approaches for autonomous detection.
8. "Wireless Gas Leakage Detection System for Automotive Fuel Systems" by A. Mishra, S. Mohapatra, and B. Das. International Journal of Science Technology & Engineering (IJSTE), June 2018, Volume 4, Issue 12.
   The study presents a wireless gas leakage detection system specifically designed for automotive fuel systems, offering a reliable and automated solution for detecting and addressing leaks.
9. "Blockchain-enabled Smart Gas Leakage Detection System for Vehicles" by P. Sharma, R. Jain, and S. Gupta. International Research Journal of Engineering and Technology (IRJET), July 2020, Volume 07, Issue 07.
   This research proposes a smart gas leakage detection system for vehicles, integrating blockchain technology for secure data management and communication, ensuring reliable detection without human intervention.
10. "Fuzzy Logic-based Gas Leakage Detection System for Automobiles" by S. Singh, M. Sharma, and K. Verma. International Journal of Innovative Research in Computer Science and Technology (IJIRCST), May 2021, Volume 09, Issue 04.
    The paper presents a gas leakage detection system for automobiles based on fuzzy logic, offering a robust method for handling imprecise sensor data and autonomously detecting leaks.

1.5 ORGANIZATION OF THE REPORT

The dissertation contains seven chapters in total and is organized as under:

ß CHAPTER 1

This chapter includes the introductory part of the report depicting the basic concepts, need and objective of IoT based air quality monitoring in vehicle and narrates the detailed literature review.

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ß CHAPTER 2

This chapter describes the Importance and features of air quality monitoring and gives the problem faced by the existing methods used for air quality monitoring.

ß CHAPTER 3

This chapter deals with the proposed methodology that is used in IoT based air quality monitoring in vehicles along with the working of its block diagram and circuit diagram.

ß CHAPTER 4

This chapter deals with the complete hardware requirements used for IoT based air quality monitoring in vehicles.

ß CHAPTER 5

This chapter deals with the software requirements of this project.

ß CHAPTER 6

This chapter deals with the introduction of cloud concepts and facilitates the utilization of Blynk web server using cloud.

ß CHAPTER 7

This chapter contains the output photographs of this project.

ß CHAPTER 8

This chapter includes the conclusion, outcomes, novelty and future scope of the project.

CHAPTER 2

EXISTING METHOD

2.1 Existing system

The air quality monitoring identifies the undesirable gas present in the vehicle. As soon as the gas or leakage is detected the car automatically reaches the off condition. Moreover, in normal vehicles it tends to fire accidents. A sudden off condition in vehicles leads to road accidents.

2.2 Types of gas detection system

- Fixed Gas Detection Systems.
- Portable Gas Detectors.
- Real-Time Air Quality Monitoring Systems
- Remote Monitoring and Telemetry

2.2.1 Fixed gas detection systems:

Application:

Fixed gas detection systems consist of stationary gas sensors strategically placed throughout the environment to continuously monitor for specific gases, such as methane, carbon monoxide, hydrogen sulfide, and oxygen.

These systems are commonly used in underground mines, tunnels, and confined spaces to detect hazardous gas levels and ensure worker safety.

Maintenance:

Regular calibration and testing of gas sensors are essential to ensure accurate and reliable measurements. Sensors should be inspected and maintained according to manufacturer guidelines, and any malfunctioning sensors should be replaced promptly.

Additionally, the integrity of sensor wiring and connections should be checked regularly to prevent signal loss or false alarms.

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2.2.2 Portable Gas Detectors:

Application:

Portable gas detectors are handheld devices used by workers to monitor their immediate environment for hazardous gases while moving through deep environments. They provide personal protection and can alert workers to dangerous gas levels, allowing them to take corrective actions or evacuate if necessary.

Maintenance:

Portable gas detectors should be regularly inspected, calibrated, and bump-tested to ensure proper functioning. Batteries should be checked and replaced as needed, and sensors should be cleaned and maintained according to manufacturer instructions.

Proper training for users on the operation and maintenance of portable gas detectors is also essential.

2.2.3 Real-Time Air Quality Monitoring Systems:

Application:

Real-time air quality monitoring systems collect data from multiple sensors, including gas sensors, particulate matter monitors, and temperature, humidity, and pressure sensors, to provide continuous monitoring of air quality parameters in deep environments.

These systems are used in various applications, including underground mines, tunnels, and offshore platforms, to ensure compliance with safety regulations and protect the health of occupants.

Maintenance:

Real-time air quality monitoring systems require regular calibration, maintenance, and data validation to ensure accurate and reliable measurements. Sensors should be inspected, calibrated, and cleaned according to manufacturer guidelines, and any deviations from expected performance should be investigated and addressed promptly. Additionally, data logging and storage systems should be maintained to ensure the integrity and accessibility of monitoring data.

2.2.4 Remote Monitoring And Telemetry:

Application:

Remote monitoring and telemetry systems transmit air quality data wirelessly from sensors deployed in deep environments to a central control station or monitoring facility. These systems provide real-time access to air quality data, allowing operators to monitor conditions remotely and respond to any deviations from safety standards.

Maintenance:

Remote monitoring and telemetry systems require regular maintenance of communication infrastructure, including antennas, transmitters, and receivers, to ensure reliable data transmission. Power sources, such as batteries or solar panels, should be inspected and maintained to prevent system downtime.

Additionally, data transmission protocols and security measures should be regularly updated to protect against cyber threats and ensure the confidentiality and integrity of monitoring data.

2.3 Disadvantages of Existing System

- Sudden shutdown condition.
- Inconvenience in opening door/window.
- Need a human intervention to open door/ window.

CHAPTER 3

PROPOSED METHOD

3.1 Proposed Methodology

This chapter discusses the different parts that this project uses. This section also provides a brief explanation of the requirements, functionality, and workings of the components utilized in this project.

3.2 Block Diagram

The block diagram of IoT Based Smart Air Purifier is shown in Figure 3.1.

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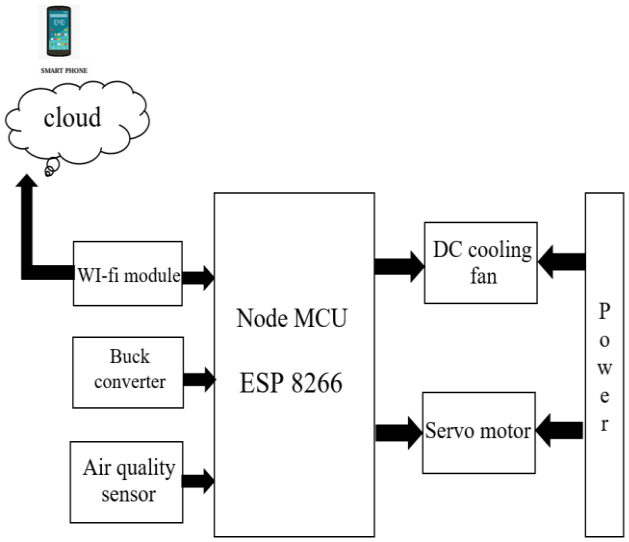

Figure 3.1 Block Diagram

3.3 Circuit Diagram

The circuit diagram of the proposed method is shown in Figure 3.2.

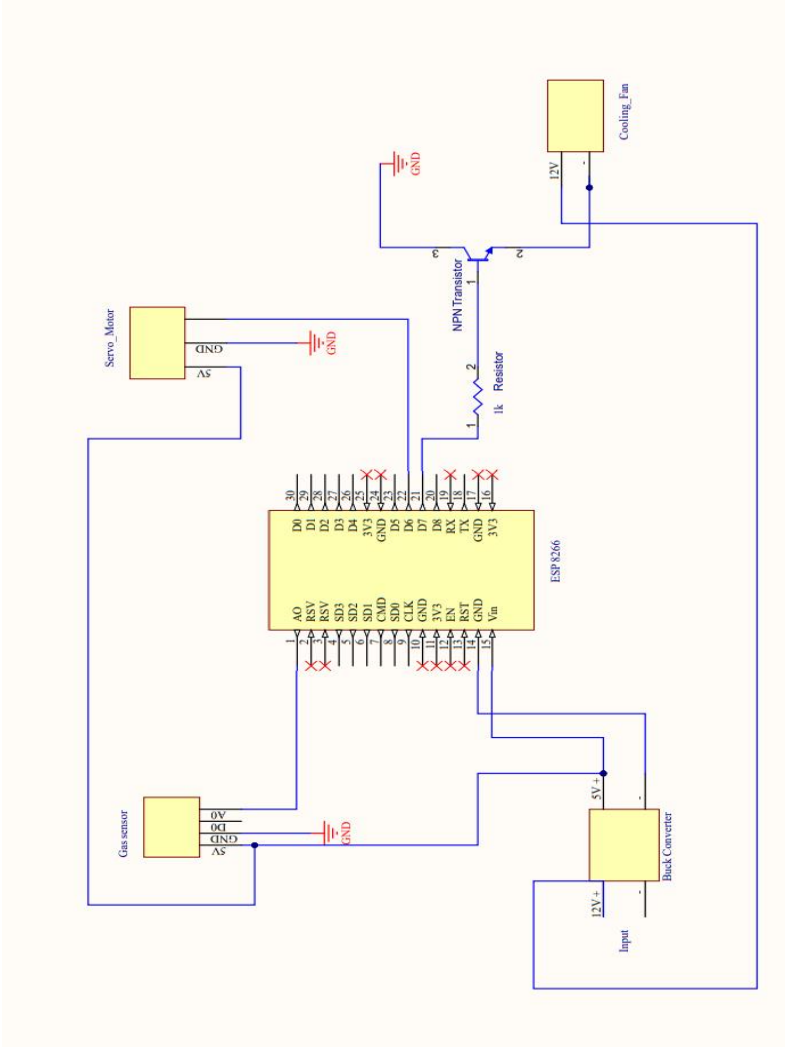

Figure 3.2 Circuit Diagram

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3.4 Block Diagram Description

The proposed system consists of an Node MCU to control the entire system. The model also consists of buck converter, air quality sensor, servo motors, cooling fans, voltage regulator and NPN transistor. The Node MCU is supplied with the 3.3V DC. The gas sensor is also connected with Node MCU which opens the windows, in case of any detection of undesirable gas in vehicle. To inspect the current state of electrical parameters in real time and control them through the Internet of Things, the ESP8266 module linked with the mobile application is also connected.

As soon as the air quality sensor detects the leakage it opens the windows with the help of servo motor for the ventilation in car. All the sensor data are monitored and controlled by a smart phone application.

3.5 Working Of Proposed System

An input of 230V is given to the adopter, which converts 230V AC to 12 V DC. The 12V DC is given to DC-DC voltage buck regulator to adjust the voltage level. The obtained 5 V is sent as the supply to servo motor and DC – cooling fan. Air quality sensor is used to monitor the air quality level and whenever the air quality index crosses a particular level the DC cooling fan starts pushing out the dirt particles out of the vehicle also helps in reducing the heat. The servo motor helps to open the windows of the vehicle whenever the detection of undesirable gas occurs.

A mobile application use used to know the amount of undesirable gas present in the vehicle. As soon the level is known the automated system start working without the need or help of human intervention. This system helps to avoid a sudden shutdown of the running car that prevents road accidents and sudden fire accidents that occurs before the time of precaution.

CHAPTER 4

HARDWARE REQUIREMENTS

4.1 Nodemcu

For Internet of Things applications, NodeMCU is an open-source development board and firmware that has been specifically created with Lua scripting. It consists of hardware based on the ESP-12 module and firmware running on Espressif Systems' ESP8266 Wi-Fi SoC is shown in the figure 4.1.

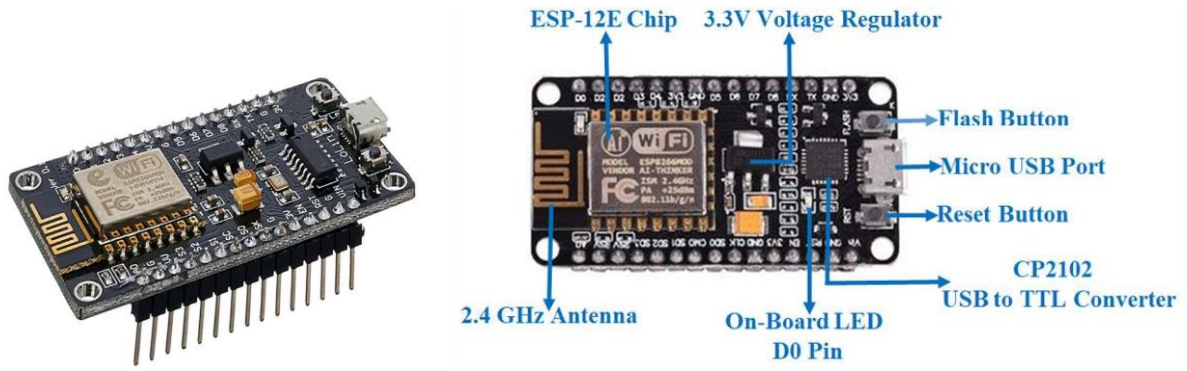

Figure 4.1 NodeMCU

4.1.1 Development Board

The Node MCU ESP8266 development board comes with the ESP-12E module, which houses the ESP8266 chip with Tensilica Xtensa 32-bit LX106 RISC CPU. This microprocessor supports RTOS and operates at a programmable clock frequency of 80MHz to 160MHz. The 4MB Flash memory and 128 KB RAM of the Node MCU are used for storing data and applications.

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Because of its high processing capability, integrated Wi-Fi and Bluetooth, and Deep Sleep operating characteristics, it is ideal for Internet of Things applications. The Micro USB jack and VIN pin (External Supply Pin) can be used to power the Node MCU. It has I2C, SPI, and UART interface capability. Figure 4.2 displays the Node MCU ESP8266.

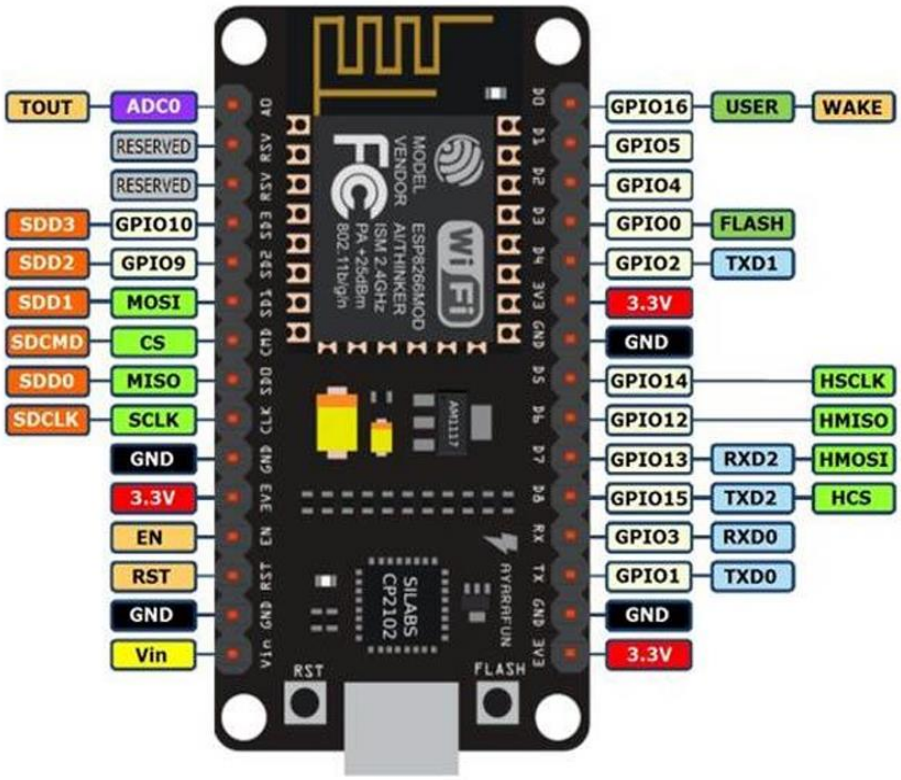

Figure 4.2 NodeMCU Development Board

4.1.2 ESP8266 Specification

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106.
- Operating Voltage: 3.3V.
- Input Voltage: 7-12V.
- Digital I/O Pins (DIO): 16.
- Analog Input Pins (ADC): 1.
- Flash Memory: 4 MB.
- SRAM: 64 KB.
- Clock Speed: 80 MHz.
- USB: Plug and Play is made possible by the onboard TTL based on CP2102 technology.

4.1.3 Brief About NodeMcu Esp8266

The ESP-12E module, which has the ESP8266 chip with ten silica Xtensa 32-bit LX106 RISC microprocessor, is included with the Node MCU ESP8266 development board. This microprocessor runs at a configurable clock frequency of 80MHz to 160MHz and supports RTOS.

For storing data and programmes, the Node MCU features 4MB of flash memory and 128 KB of RAM. It is perfect for Internet of Things projects due to its powerful processing capacity, built-in Wi-Fi and Bluetooth, and Deep Sleep Operating capabilities. The Micro USB jack and VIN pin (External Supply Pin) can be used to power the Node MCU. It has I2C, SPI, and UART interface capability.

4.1.4 Programming Node Mcu Esp8266 With Arduino Ide

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Because the Arduino IDE is user-friendly, programming the Node MCU Development Board is a breeze. The Arduino IDE may be used to programme a NodeMCU in less than five to ten minutes. The Node MCU board itself, the Arduino IDE, and a USB cord are all you need. To get your Arduino IDE ready for NodeMCU, you can refer to this Getting Started Tutorial.

4.1.5 Advantages Of Node Mcu- ESP8266

1. Cost-Effective: NodeMCU boards are relatively inexpensive compared to other microcontroller platforms with WiFi capabilities. This makes them an affordable option for IoT projects, prototyping, and educational purposes.
2. Integrated WiFi: The ESP8266 chip on the NodeMCU board comes with built-in WiFi connectivity, allowing devices to connect to wireless networks and communicate with other devices or the internet. This makes it suitable for IoT applications that require wireless connectivity.
3. Ease of Programming: NodeMCU supports the Arduino IDE, which is widely used and has a large community of developers and libraries. This makes it easy for beginners and experienced developers alike to program NodeMCU boards using familiar Arduino-like syntax and functions.
4. Lua Scripting Support: NodeMCU also supports the Lua scripting language, which provides an alternative programming option for those who prefer scripting languages over traditional C/C++ programming. This flexibility allows developers to choose the programming language that best suits their project requirements.
5. Abundance of Libraries: The NodeMCU ecosystem benefits from a large community of developers who contribute libraries and resources. These libraries cover various functionalities such as WiFi connectivity, sensors, actuators, and communication protocols, making it easier to add features to NodeMCU-based projects.

4.2 Dc Cooling Fan

The offered 12V/24V ATO BLDC motor is designed to satisfy the demand for a tiny motor with great performance. It has outstanding torque characteristics, is three phase and four pole, produces 5000 rpm high speed dynamic operation, and is brushless for extended life. The DC cooling fan is shown in figure 4.3.

Figure 4.3 DC Cooling Fan

4.2.1 Features

1. High-Quality Fan with Good Air Flow.
2. Thermoplastic PBT Material of UL 94V-0.
3. Precise Vapo Bearing System.
4. Four-pole, single-phase brushless DC motor.
5. Easy to use.

4.2.2 Specification

The specification of DC Cooling fan is shown below in table 4.4.

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Rated Speed (RPM)	4000
Operating Voltage (VDC)	12
Operating Current (A)	0.108
Noise Level (dB)	28.5
Operating Temperature (°C)	-10 to 70
Power Consumption (Watt)	1.42
Insulation Class	UL Class A
Width (mm)	10
Height (mm)	60
Weight (gm)	24
Cable Length (cm)	30
Shipment Weight	0.027 kg
Shipment Dimensions	7 × 7 × 1 cm

Figure 4.4 Specification of DC Cooling Fan

4.2.3 Advantage Of Dc Cooling Fan

1. Efficiency:

DC cooling fans are generally more energy-efficient than their AC counterparts. They convert electrical energy into mechanical energy with minimal losses, making them suitable for applications where energy efficiency is important.

2. Variable Speed Control:

DC fans can be easily controlled to adjust their speed according to the cooling requirements of the system. By varying the voltage or using pulse-width modulation (PWM) techniques, the fan speed can be precisely regulated, allowing for optimized cooling performance and reduced noise levels.

3. Compact Size:

DC fans are available in compact sizes, making them suitable for installations where space is limited. This compactness is particularly advantageous in electronic devices, such as computers, servers, and electronic enclosures, where space-saving designs are essential.

4. Low Noise Operation:

Compared to AC fans, DC fans typically produce less noise during operation. This makes them suitable for applications where noise levels need to be minimized, such as in office environments, residential settings, or audio/video equipment.

5. Quick Response Time:

DC fans have a rapid response time, meaning they can quickly ramp up or down in speed in response to changes in temperature or system load. This quick response helps maintain optimal operating conditions and prevents overheating of sensitive components.

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4.3 Buck Converter

In electronics, buck converters, sometimes referred to as step-down converters, are a common kind of DC-DC converter that are used to effectively control voltage levels. It operates by converting a higher input voltage to a lower output voltage while maintaining a relatively constant output current. The buck converter consists of an inductor, a diode, a switching transistor (usually a MOSFET), and a capacitor. During operation, the transistor switches on and off at a high frequency, controlling the flow of current through the inductor.

Figure 4.5 Buck Converter

When the transistor is on, current flows through the inductor, storing energy in its magnetic field. When the transistor is off, the inductor releases its stored energy, supplying power to the load. By varying the duty cycle of the transistor (the ratio of on-time to off-time), the buck converter can regulate the output voltage to the desired level.

One of the key advantages of a buck converter is its high efficiency, especially when compared to linear voltage regulators. Because it operates by rapidly switching the transistor on and off, the buck converter minimizes power loss and heat dissipation, making it suitable for battery-powered applications and other scenarios where energy efficiency is crucial. The figure 4.5 shows the circuit representation of Buck converter.

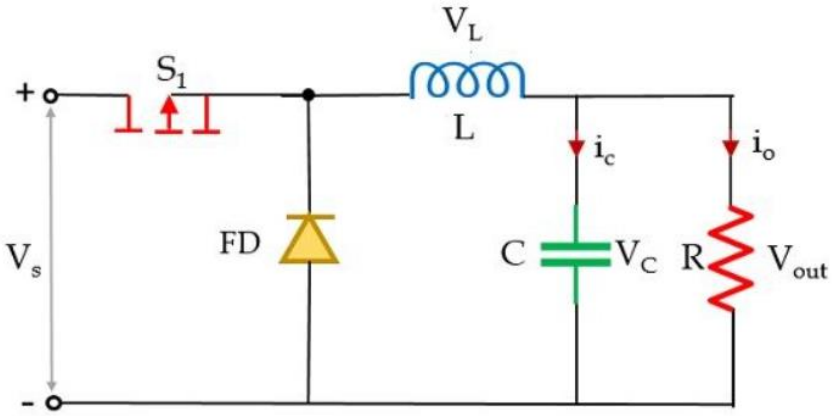

Figure 4.6 Circuit representation of Buck Converter

4.3.1 Specification:

- Input Voltage Range: Usually, 6V to 36V or 9V to 36V.
- Output Voltage: Fixed at 5V.
- Output Current Rating: Ranges from a few hundred milliamps (mA) to several amps (A).
- Efficiency: Typically, 80% to 95% or higher.
- Switching Frequency: Usually in the range of tens of kHz to several MHz
- Voltage Regulation: Provides stable 5V output under varying conditions.
- Protection Features: Includes overcurrent, overvoltage, undervoltage, and thermal protection.

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4.3.2 Pin Configuration

- VIN: Input Voltage
- GND: Ground
- VOUT: Output Voltage (5V)
- EN: Enable (Optional)

4.3.3 Advantage Of Buck Converter

1. Efficiency:

Buck converters are highly efficient, especially when compared to linear voltage regulators. They convert input voltage to a lower output voltage by switching the transistor on and off rapidly, minimizing power loss and heat generation. This efficiency is advantageous in battery-powered devices and applications where energy conservation is critical.

2. Voltage Regulation:

Buck converters provide precise voltage regulation, maintaining a stable output voltage even when the input voltage or load current fluctuates. This ensures reliable operation of connected electronic devices and components, protecting them from voltage variations and fluctuations.

3. Compact Size:

Buck converters are typically compact and lightweight, making them suitable for space-constrained applications where size and weight are important considerations. Their small form factor allows for integration into tight spaces and portable devices without adding significant bulk.

4. Variable Output Voltage:

Buck converters can step down input voltages to a wide range of output voltages, making them versatile solutions for various voltage conversion applications. The output voltage can often be adjusted within certain limits to meet specific requirements, providing flexibility in design and application.

5. Cost-Effectiveness:

Buck converters are cost-effective solutions for voltage regulation and power conversion applications. They are relatively simple in design, using fewer components compared to other voltage regulation techniques, which helps reduce manufacturing costs and overall system expenses.

4.4 Servo Motor

Figure 4.7 Servo Motor

An actuator that rotates and provides accurate control over acceleration, velocity, and angular position is called a servo motor. It is made up of control electronics, a motor, and a feedback sensor (such an encoder or potentiometer). Servo motors are widely utilized in many different applications, including robotics, CNC machines, automotive systems, and aerospace equipment, where precise and controlled motion is necessary.

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Because of their feedback system, which continuously compares the actual position with the desired position and modifies the motor's output appropriately, servo motors have the capacity to retain a set position or follow a predefined trajectory with great accuracy. This is one of their important features.

Servo motors operate based on the principle of closed-loop control, where the control system continuously monitors the feedback signal and adjusts the motor's input voltage or current to minimize any error between the desired and actual positions. This precise control allows servo motors to achieve fast response times, smooth motion, and high positional accuracy.

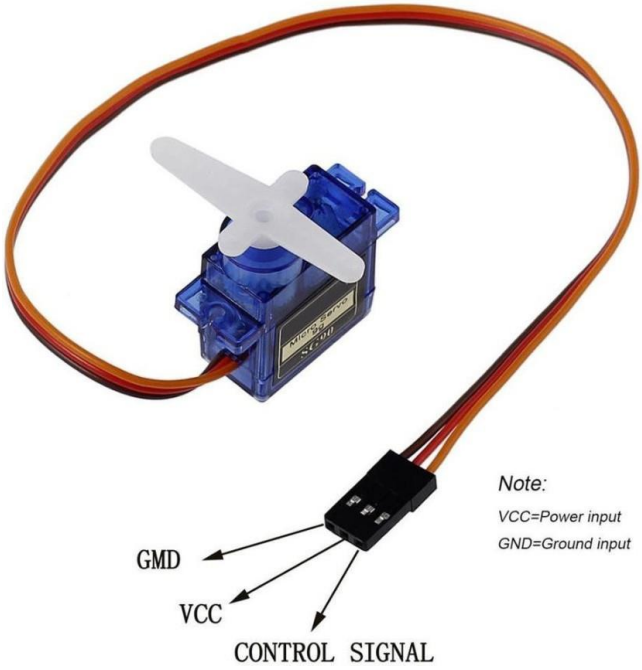

Figure 4.7 Pin Configuration of Servo Motor

4.4.1 Features Of Servo Motor

- Servo can rotate approximately 180 degrees (90 in each direction)
- servo code, hardware or library to control these servos.
- It comes with 3 horns (arms) and hardware.
- Position "0" (1.5 ms pulse) is middle, "90" (~2ms pulse) is middle, is all the way to the right, "-90" (~1ms pulse) is all the way to the left.
- Position "0" (1.5 ms pulse) is middle, "90" (~2ms pulse) is middle, is all the way to the right, "-90" (~1ms pulse) is all the way to the left.

4.4.2 Specification Of Servo Motor

- Torque: Typically, around 1.8 kg-cm (25 oz-in).
- Speed: Typically operates at speeds of 0.1 seconds per 60 degrees.
- Voltage: Operates within a voltage range of 4.8V to 6V.
- Feedback Mechanism: Utilizes a potentiometer feedback mechanism for position sensing.
- Size: Compact dimensions, with approximate dimensions of 22 mm x 11.5 mm x 22.5 mm.
- Control Interface: Compatible with various control signals, including PWM (Pulse Width Modulation).
- Operating Temperature: Suitable for operation within a temperature range of 0°C to 55°C.
- Accuracy: Offers precise control over angular position with high accuracy and resolution.

4.4.3 Advantages Of Servo Motor

The SG90 Micro Servo Motor operates based on the principles of feedback control and electromechanical actuation.

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Internal Components:
The SG90 Micro Servo Motor consists of several key components, including a small DC motor, gears, control electronics, and a potentiometer for feedback.

Control Signal:
The motor receives control signals in the form of PWM (Pulse Width Modulation) from an external controller, such as a microcontroller or servo driver.

Position Control:
The PWM signal determines the position or angle to which the motor shaft should move. The width of the PWM pulse corresponds to the desired position, with wider pulses typically indicating larger angles.

Feedback Mechanism:
As the motor shaft rotates, a potentiometer connected to the output shaft provides feedback on the motor's actual position. The potentiometer's resistance changes as the shaft rotates, allowing the control circuitry to compare the desired position (as indicated by the PWM signal) with the actual position.

4.5 Air Quality Sensor

A wide range of gases, such as NH3, NOx, alcohol, benzene, smoke, and CO2, may be detected by an air quality sensor. Ideal for use in office or factory. MQ135 gas sensor has high sensitivity to Ammonia, Sulphide and Benz steam, also sensitive to smoke and other harmful gases. The air quality sensor is shown in the figure 4.4.

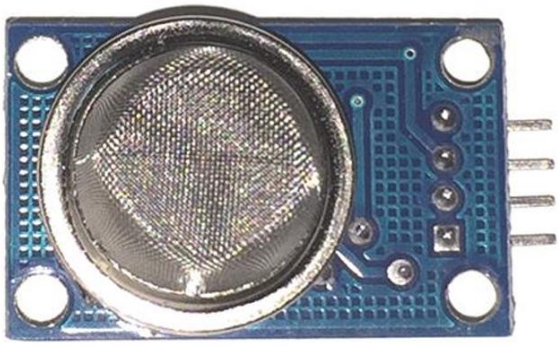
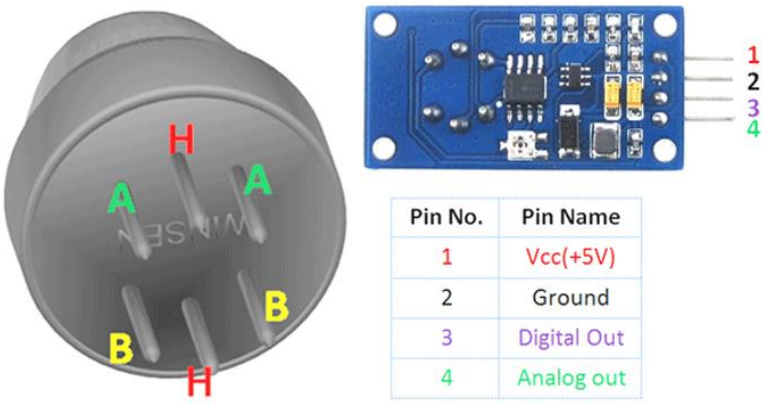


Figure 4.9 Air Quality Sensor

4.5.1 Pin Description

MQ135 air quality sensor pin description is shown below in the figure 4.5.



Pin No.	Pin Name
1	Vcc(+5V)
2	Ground
3	Digital Out
4	Analog out

Figure 4.10 MQ135 Air Quality Sensor Pin Description

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4.5.2 MQ-135 Sensor Features

- Wide detecting scope.
- Fast response and High sensitivity.
- Stable and long life.
- Operating Voltage is +5V.
- Measure/Detect Benzene, Alcohol, NOx, CO2, Smoke, and NH3.
- Analog output voltage: 0V to 5V.
- Digital output voltage: 0V or 5V (TTL Logic).
- Preheat duration 20 seconds.
- Can be used as a Digital or analog sensor.
- The potentiometer may be used to change the digital pin's sensitivity.

4.5.3 Model of Mq-135 Gas Sensor

The MQ-135 Gas sensors are used in air quality control equipment and may measure or detect CO2, NH3, NOx, alcohol, benzene, smoke, and other chemicals. The MQ-135 sensor module's Digital Pin functionality enables the sensor to work even without a microcontroller when trying to detect a single gas.

The analogue pin must be used if the gases need to be measured in parts per million. The analogue pin may be used with most common microcontrollers because it is 5V and TTL operated.

4.5.4 Use of MQ-135 Sensors To Detect Gases

We can either use the digital pin or the analog pin to do this. The module just has to be powered by 5V for the power LED to shine. If no gas is detected, the output LED will stay off, resulting in a 0V digital output pin. Keep in mind that before you may use it, these sensors must be left on for the pre-heating period (discussed in the features above).

The output LED and digital pin need to illuminate as soon as the sensor comes into touch with the gas that has to be detected. If not, move the potentiometer until a high level is reached in the output.The digital pin will thus go high (5V) each time our sensor is exposed to this gas at this specific concentration; otherwise, it will stay low (0V). You can also utilise the analogue pin to achieve the same result.

Read the analogue values (0–5V) using a microcontroller; this value will precisely match the gas concentration that the sensor detects. By experimenting with these values, we can see how the sensor reacts to different gas concentrations and modify your software appropriately.

CHAPTER 5
SOFTWARE REQUIREMENTS

5.1 Blynk Software

Blynk is an IoT platform for iOS and Android devices that allows Internet-based control of Arduino, Raspberry Pi, and NodeMCU. With the help of this program, a graphical user interface (HMI) may be created by gathering and supplying the correct address on the accessible widgets.

The Internet of Things was the target market for Blynk. It has several fascinating features, including remote hardware control, sensor data display, data storage, data visualization, and much more.

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5.2 Blynk Framework

The Blynk framework, an IoT (Internet of Things) platform is shown in the figure 5.1 that provides a comprehensive set of tools and services for building connected devices and applications. It offers a user-friendly environment for prototyping, developing, and deploying IoT projects, allowing users to focus on the functionality and interactions of their devices without worrying about the underlying infrastructure.

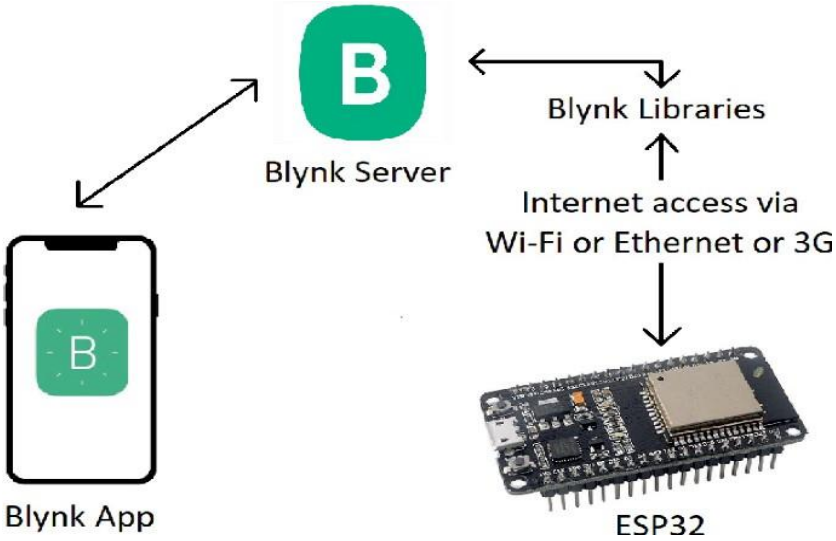

Figure 5.1 Blynk Framework

5.2.1 Blynk App

The Blynk mobile app serves as the primary interface for interacting with IoT projects created using the Blynk platform. It allows users to control and monitor their connected devices remotely, view real-time data, receive notifications, and configure settings. The app is available for both iOS and Android devices.

5.2.2 Blynk Cloud

Blynk provides a cloud-based infrastructure that enables devices to connect to the internet securely. The Blynk Cloud facilitates communication between the Blynk app and the user's IoT devices, allowing for remote access and control from anywhere in the world. It also provides features such as data storage, analytics, and integration with third-party services.

5.2.3 Blynk Libraries

Blynk offers software libraries and SDKs (Software Development Kits) for popular hardware platforms and programming languages, including Arduino, Raspberry Pi, ESP8266/ESP32, Python, and JavaScript. These libraries provide an easy-to-use interface for integrating Blynk functionality into IoT projects, simplifying tasks such as connecting to the Blynk Cloud, handling sensor data, and controlling actuators.

5.2.4 Blynk Server

For users who prefer to host their own infrastructure, Blynk offers an open-source Blynk Server that can be deployed on-premises or in a private cloud environment. The Blynk Server provides the same functionality as the Blynk Cloud, allowing users to maintain full control over their IoT projects and data while benefiting from the flexibility and scalability of the Blynk platform.

5.2.5 Blynk Widgets

Blynk provides a wide range of pre-built widgets that users can add to their IoT projects to create interactive interfaces. These widgets include buttons, sliders, graphs, gauges, displays, and more, allowing users to design custom dashboards tailored to their specific needs. Widgets can be arranged and configured using a drag-and-drop interface in the Blynk app.

5.2.6 Community And Support

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Blynk has a vibrant community of developers, makers, and enthusiasts who contribute to the platform by sharing projects, tutorials, libraries, and support on forums, social media, and other online platforms. Blynk also provides comprehensive documentation, tutorials, and customer support resources to assist users throughout their IoT journey. The detailed Blynk framework is shown in the figure 5.2.

Figure 5.2 Key Components of Blynk Framework

CHAPTER 6

UTILIZATION OF WEB SERVER

6.1 Introduction To Web Server Using Cloud

Machines that handle requests made using HTTP, the foundational network protocol used to disseminate content on the World Wide Web, are known as web servers. The software that receives and manages HTTP requests is particularly referred to by the word, however it can also apply to the complete system.Although cloud servers function similarly to traditional servers, they might offer significantly diverse features.

Instead of renting or buying actual servers, customers that choose cloud hosting are renting virtual server space. Generally, they are paid for by the hour, based on the capacity needed at any given time. The utilization of Blynk cloud and server is shown in the figure 6.1.

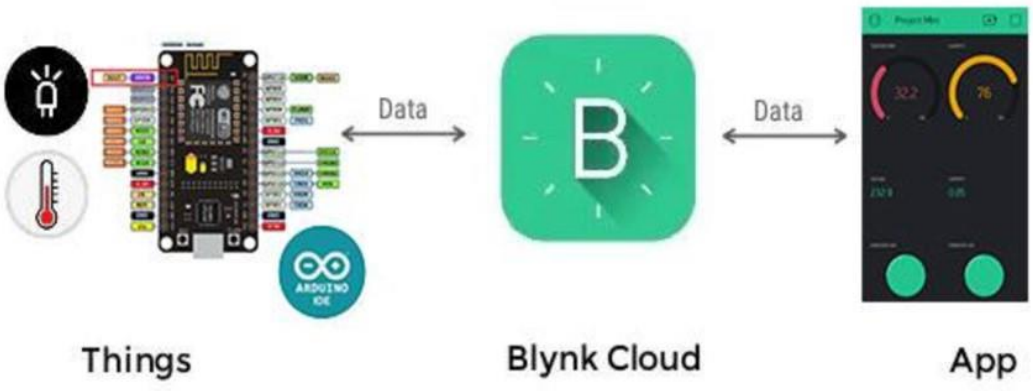

Figure 6.1 Utilization of Blynk Cloud & Server

6.1.1 Benefits Of Web Server

- Flexibility and scalability.
- Cost-effectiveness
- Ease of set up.
- Reliability.

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6.2 Creation Of Blynk Web Server Using Cloud

Creating and using a Blynk Server on the cloud allows us to have full control over our IoT projects and data while leveraging the scalability and reliability of cloud infrastructure providers. Here's a detailed guide on how to set up and use a Blynk Server using cloud services:

6.2.1 Choose A Cloud Provider

Decide which cloud platform that we want to use for hosting our Blynk Server. Popular options include Amazon Web Services (AWS), Google Cloud Platform (GCP), Microsoft Azure, and Digital Ocean.

6.2.2 Set Up A Virtual Machine (Vm) Instance

Create a virtual machine instance on your chosen cloud platform. This instance will host our Blynk Server. Choose the appropriate VM specifications based on our expected workload and resource requirements.

6.2.3 Install Blynk Server

Install the Blynk Server software and there we can find the installation instructions and binaries on the Blynk GitHub repository or official website, follow the provided instructions to download and configure the Blynk Server on our VM.

6.2.4 Configure Server Settings

Edit the server configuration file to customize settings such as port numbers, SSL certificates, database options, and logging preferences. Ensure that the server is configured to accept connections from external devices and clients.

6.2.5 Start Blynk Server

Once the server is configured, start the Blynk Server service using the appropriate command. Monitor the server logs for any errors or warnings during the start-up process.

6.2.6 Create Blynk Account And Projects

Open the Blynk mobile app or web dashboard and create a Blynk account if you haven't already. Create new IoT projects and obtain authentication tokens for each project.

6.2.7 Configure Devices

Update your IoT device firmware or software to use the custom Blynk Server URL and authentication tokens. Ensure that devices are configured to connect to the correct server endpoint and port.

6.2.8 Test And Monitor

Test the connectivity of our IoT devices by sending commands and receiving data through the Blynk app or web dashboard. Monitor server performance, resource usage, and network traffic to ensure smooth operation and scalability.

CHAPTER 7

HARDWARE SETUP

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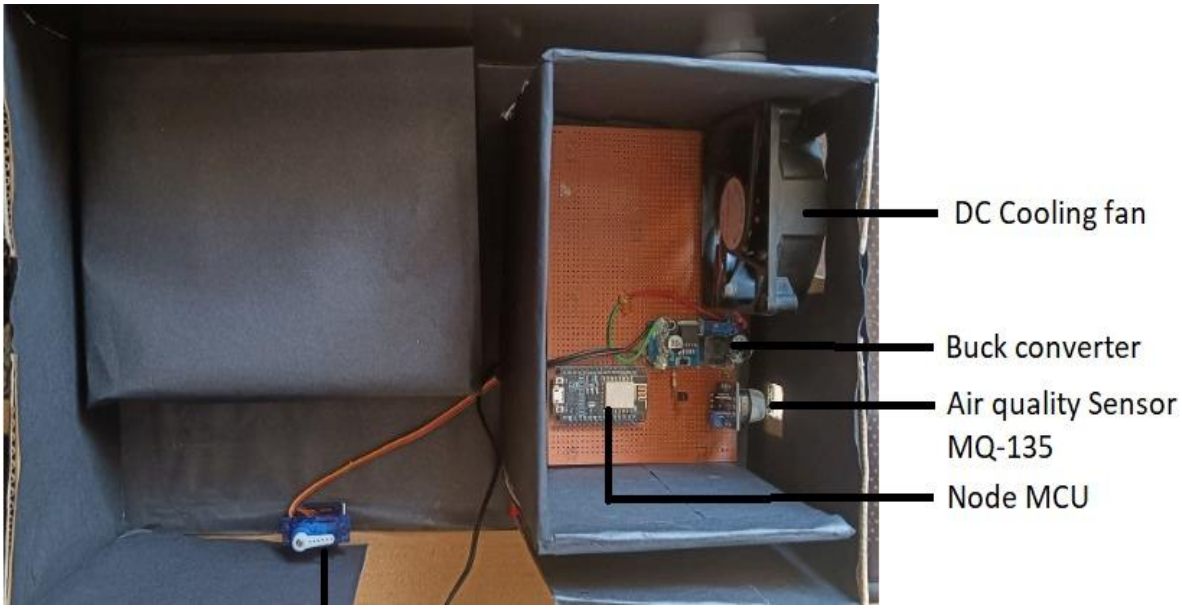
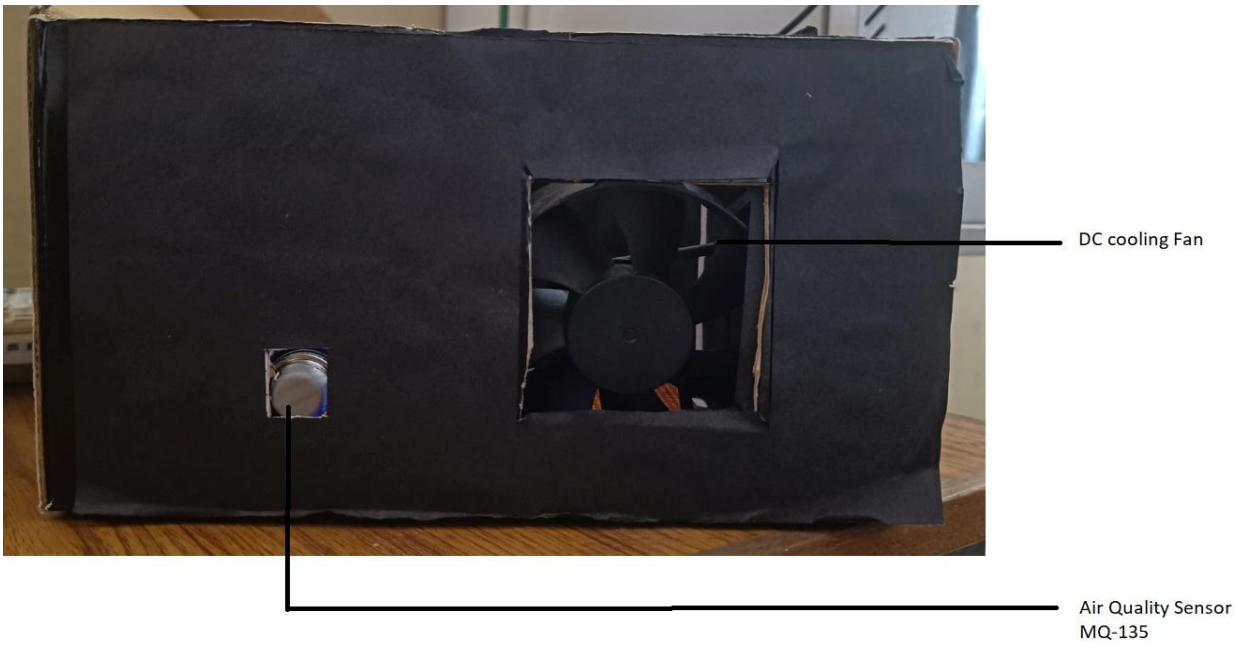


The Hardware setup of IoT based smart air quality monitoring in vehicles is shown in Figure 7.1, 7.2 and 7.3.

An input of 230V is given to the adopter, which converts 230V AC to 12 V DC. The 12V DC is given to DC-DC voltage buck regulator to adjust the voltage level. The obtained 5 V is sent as the supply to servo motor and DC – cooling fan. Air quality sensor is used to monitor the air quality level and whenever the air quality index crosses a particular level the DC cooling fan starts pushing out the dirt particles out of the vehicle also helps in reducing the heat. The servo motor helps to open the windows of the vehicle whenever the detection of undesirable gas occurs.

Figure 7.1 Front view & Components Specification

A mobile application use used to know the amount of undesirable gas present in the vehicle. As soon the level is known the



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automated system start working without the need or help of human intervention. This system helps to avoid a sudden shutdown of the running car that prevents road accidents and sudden fire accidents that occurs before the time of precaution.

Figure 7.2 Rear view

Figure 7.3 Hardware Result

CHAPTER 8

CONCLUSION AND OUTCOMES

8.1 Conclusion

In conclusion, IoT-based smart air quality monitoring systems in vehicles hold immense potential to revolutionize how we perceive and address air pollution inside vehicles and avoids great accidents. By leveraging IoT technology and advanced sensor capabilities, these systems offer real-time insights into vehicle cabin air quality, empowering occupants with knowledge about their immediate surroundings and potential life risks.

As vehicles continue to grapple with the challenges of air quality that's inside vehicles, integrating smart air quality monitoring solutions into vehicles not only enhances occupant well-being but also contributes to cool down the heat produces inside the vehicles and informs policy decisions aimed at reducing accidents and improving air quality without human intervention. With ongoing advancements in IoT infrastructure and data analytics, the future of smart air quality monitoring in vehicles promises to drive meaningful change towards healthier and more sustainable urban mobility solutions.

8.2 Future Scope

Future developments may include enhanced sensor capabilities for detecting a wider range of pollutants, seamless integration with vehicle control systems for automatic adjustments to driving control over vehicle, and collaboration with smart cities infrastructure to create comprehensive urban air quality monitoring networks. These advancements hold the potential to not only provide occupants with real-time insights into air quality conditions but also contribute to broader environmental sustainability initiatives.

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8.3 Expected Deliverables

- Accurate air quality monitoring is done in vehicles.
- Determining the air quality and reduces the heat dissipation inside vehicles.
- Creation of IoT Based Smart Air quality monitoring in vehicles kit is done.
- Utilization of smart air quality monitoring web application using Blynk for android users is done.

8.4 Expected Benefits

- Great accidents are prevented.
- Prevents the inconvenience caused by air pollution while travelling.
- Helps the people to monitor the gases present at the surrounding are safe or not.
- By means of mobile application, the people can monitor the amount of undesirable gas present and automatic ventilation of vehicle is undergone.

8.5 Novelity Of The Project

- This “IoT BASED SMART AIR QUALITY MONITORING IN VEHICLES” utilizing data dashboard mobile application is user friendly.
- This system provides efficient air quality monitoring for both EV nad normal vehicles.
- This project helps people to monitor the air quality in their surroundings even while travelling.

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APPENDIX-I

PROGRAM

```
#define BLYNK_TEMPLATE_ID           "TMPL3PwEWBcpG"
#define BLYNK_TEMPLATE_NAME         "Gas Monitoring"
#define BLYNK_AUTH_TOKEN            "ebKj0M96gyflvmBAomicxK9xQlQZ9E0o"

/* Comment this out to disable prints and save space */
//#define BLYNK_PRINT Serial

#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include <Servo.h>

Servo myservo;
// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "PROJECT";
char pass[] = "withlove";

#define gas A0
#define fan D7
int gas_data;

void setup()
{
  // Debug console
  Serial.begin(115200);
  Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass);
  myservo.attach(D6);
```

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```
  pinMode(gas, INPUT);
  pinMode(fan, OUTPUT);
  myservo.write(90);
}
void loop()
{
  gas_data = analogRead(gas);
  if (gas_data > 60) {
    myservo.write(270);
      digitalWrite(fan, HIGH);
    Blynk.virtualWrite(V3, 1);
  }
else {
    myservo.write(90);
    digitalWrite(fan, LOW);
    Blynk.virtualWrite(V3, 0);
  }
  Serial.println(gas_data);
  Blynk.virtualWrite(V1, gas_data);
  Blynk.run();
}
```

APPENDIX-II

ESP8266 DATASHEET

ESP8266 Description

ESP chips and NodeMCU boards have a crucial role in some areas, such as smart homes and electronics, because they have good features and a reasonable price. These boards are quite useful for various projects. It is also very easy to work with them.

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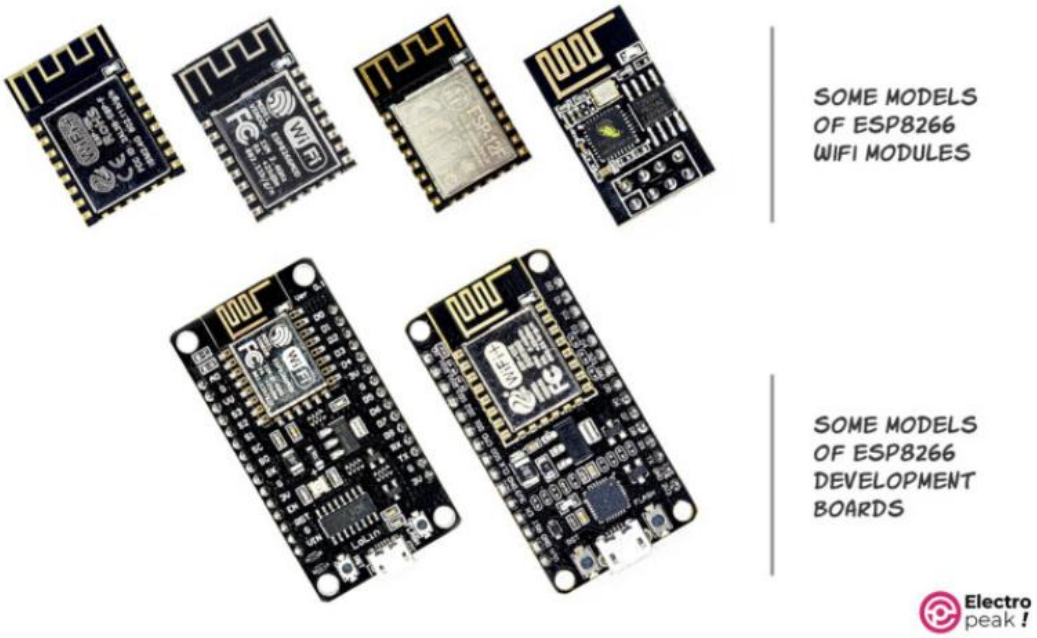

The Arduino IDE software may even be used to program NodeMCU boards. Words like “ESP” and “NodeMCU” might be a bit confusing for beginners who have just stepped into this field as to whether they mean the same thing. Therefore, we will first describe “ESP8266” and “NodeMCU,” their various models, and their differences to help you make the best choice based on your project.

The ESP8266's powerful on-chip processing and storage capabilities allow it to integrate sensors and other application-specific devices through the GPIO port, minimizing system resources during minimal up-front development and operation.

ESP 8266 Features

- The smallest 802.11b/g/n Wi-Fi SOC module
- Low power 32-bit CPU, can also serve as the application processor
- Up to 160MHz clock speed
- Built-in 10 bit high precision ADC
- Supports UART/GPIO/IIC/PWM/ADC
- SMD-22 package for easy welding
- Integrated Wi-Fi MAC/BB/RF/PA/LNA
- Support multiple sleep patterns. Deep sleep current as low as 20uA
- UART baud rate up to 4Mbps
- Embedded LWIP protocol stack
- Supports STA/AP/STA + AP operation mode

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„ Support Smart Config/AirKiss technology

„ Supports remote firmware upgrade (FOTA)

„ General AT commands can be used quickly

„ Support for the two development, integration of windows, Linux development environment.

Product Specification

Module Model	ESP-12F
Package	SMD22
Size	24*16*3(±0.2)mm
Certification	FCC、CE、IC、REACH、RoHS
SPI Flash	Default 32Mbit
Interface	UART/GPIO/ADC/PWM
IO Port	9
UART Baud rate	Support 300 ~ 4608000 bps ， Default 115200 bps
Frequency Range	2412 ~ 2484MHz
Antenna	PCB Antenna
Transmit Power	802.11b: 16±2 dBm (@11Mbps) 802.11g: 14±2 dBm (@54Mbps) 802.11n: 13±2 dBm (@HT20, MCS7)
Receiving Sensitivity	CCK, 1 Mbps : -90dBm CCK, 11 Mbps: -85dBm 6 Mbps (1/2 BPSK): -88dBm 54 Mbps (3/4 64-QAM): -70dBm HT20, MCS7 (65 Mbps, 72.2 Mbps): -67dBm
Power (Typical Values)	Continuous Transmission=>Average：~71mA，Peak：500mA Modem Sleep: ~20mA Light Sleep: ~2mA Deep Sleep: ~0.02mA
Security	WEP/WPA-PSK/WPA2-PSK
Power Supply	Voltage 3.0V ~ 3.6V，Typical 3.3V，Current >500mA
Operating Temperature	-20 °C ~ 85 °C
Storage Environment	-40 °C ~ 85 °C , < 90%RH

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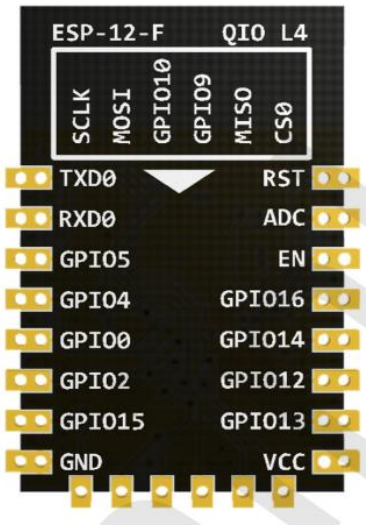
ESP8266 Pin Definition

The ESP-12 module leads to 16 pins.



ADC (Analog-to-Digital Converter) is a unit that converts analog values to digital values. For example, in order to use the output of a sensor with an analog voltage value in a microcontroller, the sensor's output must be read using an analog input and converted into a digital value.

No.	Pin Name	Functional Description
1	RST	Reset Pin, Active Low
2	ADC	AD conversion, Input voltage range 0~1V, the value range is 0~1024.
3	EN	Chip Enabled Pin, Active High
4	IO16	Connect with RST pin to wake up Deep Sleep
5	IO14	GPIO14; HSPI_CLK
6	IO12	GPIO12; HSPI_MISO
7	IO13	GPIO13; HSPI_MOSI; UART0_CTS

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8	VCC	Module power supply pin, Voltage 3.0V ~ 3.6V
9	GND	GND
10	IO15	GPIO15; MTDO; HSPICS; UART0_RTS
11	IO2	GPIO2; UART1_TXD
12	IO0	GPIO0;HSPI_MISO;I2SI_DATA
13	IO4	GPIO4
14	IO5	GPIO5;IR_R
15	RXD	UART0_RXD; GPIO3
16	TXD	UART0_TXD; GPIO1

Power Consumption

The following power consumption data were obtained from the tests with a 3.3V power supply and a voltage stabilizer, in 25°C ambient temperature. All data are based on 50% duty cycle in continuous transmission mode.

Notes:

„ Modem-sleep is used when such applications as PWM or I2S require the CPU to be working. In cases where Wi-Fi connectivity is maintained and data transmission is not required, the Wi-Fi Modem circuit can be shut down to save power, according to 802.11 standards (such as U-APSD). For example, in DTIM3,when ESP8266EX sleeps for 300 ms and wakes up for 3 ms to receive Beacon packages from AP, the overall average current consumption is about 20 mA.

„ Light-sleep is used for applications who's CPU may be suspended, such as Wi-Fi switch. In cases where Wi-Fi connectivity is maintained and data transmission is not required, WiFi Modem circuit and CPU can be shut down to save power, when ESP8266EX sleeps for 300 ms and wakes up for 3 ms to receive Beacon packages from AP, the overall average current consumption is about 2 mA.

„ Deep-sleep is for applications that do not require Wi-Fi connectivity and only transmit data over long time lags, e.g., a temperature sensor that measures temperature every 100s. The current consumption of 20 A was obtained at the voltage of 2.5V.

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Modes	Min	Typ	Max	Unit
Tx 802.11b, CCK 11Mbps, POUT=+17dBm	-	170	-	mA
Tx 802.11g, OFDM 54Mbps, POUT =+15dBm	-	140	-	mA
Tx 802.11n, MCS7, POUT =+13dBm	-	120	-	mA
Rx 802.11b, 1024 bytes packet length , -80 dBm	-	50	-	mA
Rx 802.11g, 1024 bytes packet length , -70 dBm	-	56	-	mA
Rx 802.11n, 1024 bytes packet length , -65 dBm	-	56	-	mA
Modem-sleep①	-	20	-	mA
Light-sleep②	-	2	-	mA
Deep-sleep③	-	20	-	uA
Power Off	-	0.5	-	uA

Electrical Characteristics

Parameter		Symbol	Min	Typ	Max	Unit
Storage temperature		-	-40	Normal	85	℃
Operating temperature		-	-20	20	85	℃
Maximum soldering temperature		IPC/JEDEC J-STD-020	-	-	260	℃
Supply voltage		VDD	2.7	3.3	3.6	V
I/O	V_{IL}/V_{IH}	-	-0.3/0.75VIO	-	0.25VIO/3.6	V
	V_{OL}/V_{OH}	-	N/0.8VIO	-	0.1VIO/N	V
	I_{MAX}	-	-	-	12	V

ESP8266 Pinout: Pins Involved at Boot

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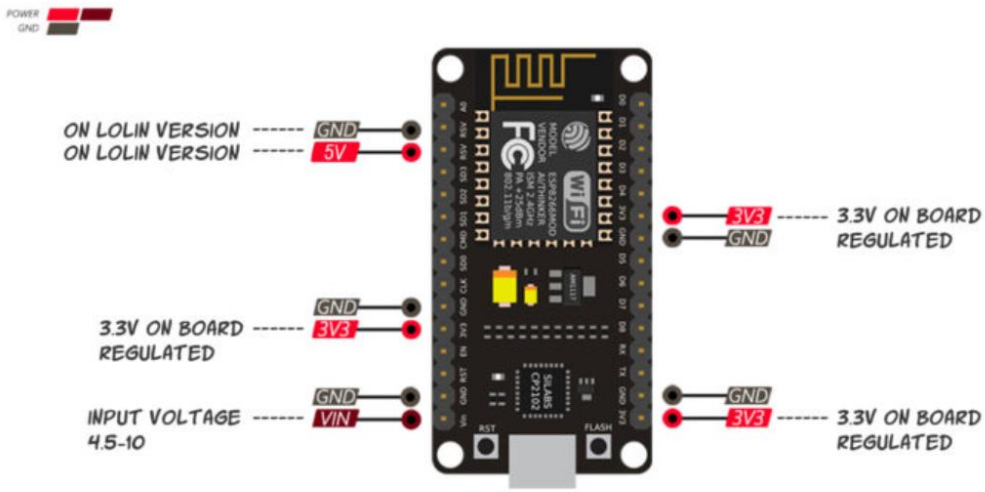
- GPIO16 /D0 pin is high at BOOT
- GPIO0 /D3 boot failure if pulled LOW
- GPIO2 /D4 pin is high at BOOT, boot failure if pulled LOW
- GPIO15 /D8 boot failure if pulled HIGH
- GPIO3 /RX pin is high at BOOT
- GPIO1 /TX pin is high at BOOT, boot failure if pulled LOW
- GPIO10 /SD3 pin is high at BOOT
- GPIO9 /SD2 pin is high at BOOT

ESP8266 Pinout: Power Line Pins

The power line pins are shown in the figure below.



ESP8266 Pinout: Control Pins

EN Pin (Enable):

The ESP chip is active when the EN pin goes HIGH. When LOW, the ESP chip is in the minimum power consumption mode. In some models, the pin's name might be CH_PD.

RST pin (Reset):

The reset pin of ESP8266, or RST, is HIGH by default. When it goes LOW, it instantly resets the ESP8266. It works like pressing the RESET button on the board.

FLASH/ D3/GPIO0 Pin:

- If you hold this pin low and pull the EN pin to low, the board will go into the Flashing Mode.
- If you hold this pin low and pull the RESET button to low, the board will go into the Uploading Mode.