# PROJECT REPORT

# ON

# “Remote Monitoring System for Real Time Industrial Parameter”

Submitted in the partial fulfillment of the requirements

for the PG Diploma

In

**Embedded System and Design(PG-DESD)**

By

**Guru Harsh Vijay (E2_HARSH_87014)**

**Mayur Dinesh Patil (E2_MAYUR_87051)**

**Satyam Vilasrao Bhalerao (E2_SATYAM_87284)**

**Anil Choudhary (E2_ANIL_87302)**

SUNBEAM

Sunbeam Institute of Information Technology, Pune and Karad

Year: August - 2024

# Sunbeam Institute of Information Technology, Pune and Karad

## CERTIFICATE

Certified that the Project Progress report entitled , **“Remote Monitoring System for real time industrial parameter”** is a bonafied work done by

**Guru Harsh Vijay (E2_HARSH_87014)**

**Mayur Dinesh Patil (E2_MAYUR_87051)**

**Satyam Vilasrao Bhalerao (E2_SATYAM_87284)**

**Anil Choudhary (E2_ANIL_87302)**

In partial fulfillment of the requirements for the award of PG Diploma in Embedded System and Design (PG-DESD)

Date: 12/02/2025

# ACKNOWLEDEMENT

I dream it a great pleasure and privilege to have an opportunity to take up the project work under the guidance of **Prof. Devendra Dhande** and **Prof. Sohail Inamdar**, of **“Sunbeam Institute of Information Technology, Pune and Karad”** and empress gratitude for rendered excellent guidance and valuable suggestions.

Finally, I thank all friends for their valuable help and all those who directly or indirectly helped me for completion of this project report.

Guru Harsh Vijay (E2_HARSH_87014)

Mayur Dinesh Patil (E2_MAYUR_87051)

Satyam Vilasrao Bhalerao (E2_SATYAM_87284)

Anil Choudhary (E2_ANIL_87302)

# TABLE OF CONTENT

# ABSTRACT


In modern industrial environments, real-time monitoring of critical parameters is crucial for maintaining operational efficiency, ensuring safety, and optimizing resource utilization. This project, titled "Remote Monitoring System for Real-Time Industrial Parameters," presents an advanced Internet of Things (IoT)-based solution that continuously tracks and analyzes essential industrial parameters such as temperature, smoke levels, pressure, water flow rate, and humidity.

The system is built around an STM32F407 microcontroller, which acts as the central processing unit, interfacing with multiple sensors to collect data at regular intervals. The acquired data is then processed and transmitted wirelessly to the ThingSpeak cloud platform via an ESP8266 Wi-Fi module. This cloud-based architecture enables real-time remote access to industrial parameters, allowing plant operators, engineers, and decision-makers to monitor conditions from anywhere using a web interface or mobile application.

By integrating IoT technology, the system eliminates the need for manual monitoring, thereby reducing human error and increasing overall efficiency. Additionally, real-time alerts and data visualization tools allow for proactive maintenance, helping to prevent equipment failures, reduce downtime, and enhance workplace safety. The system also contributes to energy efficiency by providing insights into industrial conditions, enabling optimized resource management.



(**Keyword:** STM32F407, ESP8266 Node MCU, Sensors, Communication Protocol, IoT.)

## Chapter 1

# INTRODUCTION

### 1.1 INTRODUCTION

In industrial settings, continuous monitoring of critical parameters such as temperature, smoke levels, pressure, water flow rate, and humidity is essential for ensuring operational efficiency, equipment longevity, and workplace safety. Traditional monitoring systems often rely on manual inspections, which can be time-consuming, prone to human error, and inefficient. To address these challenges, this project introduces a Remote Monitoring System for Real-Time Industrial Parameters using IoT technology.

The system is built around an STM32F407 microcontroller, which interfaces with multiple sensors to collect and process real-time data. The gathered information is then transmitted to the ThingSpeak cloud platform via an ESP8266 Wi-Fi module, enabling remote access through web-based dashboards or mobile applications. This cloud-based monitoring allows industrial personnel to track, analyze, and respond to changes in environmental conditions from anywhere, ensuring better decision-making and preventive maintenance.

By integrating IoT for real-time data transmission and remote access, the system enhances industrial automation, reduces downtime, and improves safety measures. It provides timely alerts and insights that help optimize resource management and production efficiency, making it a cost-effective and scalable solution for modern industrial applications.

### 1.2 OBJECTIVES

The objective of this project are as follows:

- Real-Time Monitoring – To continuously track industrial parameters like temperature, smoke, pressure, water flow rate, and humidity for improved efficiency and safety.
- Remote Access – To transmit sensor data to the ThingSpeak cloud via ESP8266 Wi-Fi, enabling remote monitoring through web or mobile applications.

- Automation & Efficiency – To reduce manual monitoring and enhance industrial automation using IoT technology.
- Enhanced Safety – To detect hazardous conditions and trigger alerts, preventing potential industrial risks.
- Minimized Downtime – To send real-time alerts, enabling quick corrective actions and reducing production losses.
- Data Logging & Analysis – To store and analyze historical data for predictive maintenance and performance optimization.

## Chapter 2

# LITERATURE SURVEY

**IoT-Based Industrial Monitoring Systems:** In the study conducted by Jayashree et al. (2019), titled "IoT-Based Industrial Monitoring Systems: Enhancing Efficiency and Automation", the authors present a detailed analysis of wireless sensor networks (WSNs) in industrial applications. The paper highlights how IoT-enabled monitoring systems help in real-time data collection, reducing human intervention and improving operational efficiency. The study further discusses the role of sensor networks in providing accurate and continuous monitoring of industrial parameter

**STM32 in Industrial Automation:** A study by Kumar et al. (2021), "Microcontroller-Based Industrial Automation: A Case Study on STM32", examines the use of STM32 microcontrollers for real-time industrial data acquisition. The research highlights the microcontroller's high processing speed, multiple peripheral interfaces, and low power consumption, making it an ideal choice for industrial applications. The study concludes that STM32-based systems offer reliability and precision in sensor data acquisition.

**Wireless Data Transmission Using ESP8266:** In their work, Gupta et al. (2018), titled "Wireless IoT Communication Using ESP8266: A Low-Cost Solution", analyze the efficiency of the ESP8266 Wi-Fi module for transmitting sensor data in industrial environments. The authors discuss its low power consumption, cost-effectiveness, and stable connectivity, making it a widely adopted solution in IoT applications. The paper highlights its reliability in real-time industrial monitoring and integration with cloud platforms.

**Cloud-Based Data Transmission and Storage:** The research by Patil et al. (2020), titled "Cloud Computing for Industrial IoT: A Case Study on ThingSpeak", explores the integration of ThingSpeak with IoT-based industrial monitoring systems. The paper discusses various advantages of cloud computing, including real-time accessibility, remote data visualization, and predictive analytics. The authors emphasize that cloud-based monitoring improves decision-making and reduces downtime by enabling remote alerts and historical data analysis.

Chapter 3

# METHODOLOGY

## 3.1 BLOCK DIAGRAM

Figure 3.1 show the block diagram of IoT-based Remote Monitoring System for real timer Industrial Parameters using the STM32F407 microcontroller. Various sensors are interfaced with the microcontroller to collect real-time data, which is then transmitted to the ThingSpeak cloud using the ESP8266 Wi-Fi module for remote monitoring.

The STM32F407 microcontroller collects sensor data and transmits it to the cloud via the ESP8266 Wi-Fi module for remote monitoring. The system includes DHT11 for temperature and humidity, MQ-135 for air quality, HX701B for pressure, and YF-S201 for liquid flow monitoring, ensuring efficient industrial parameter tracking.

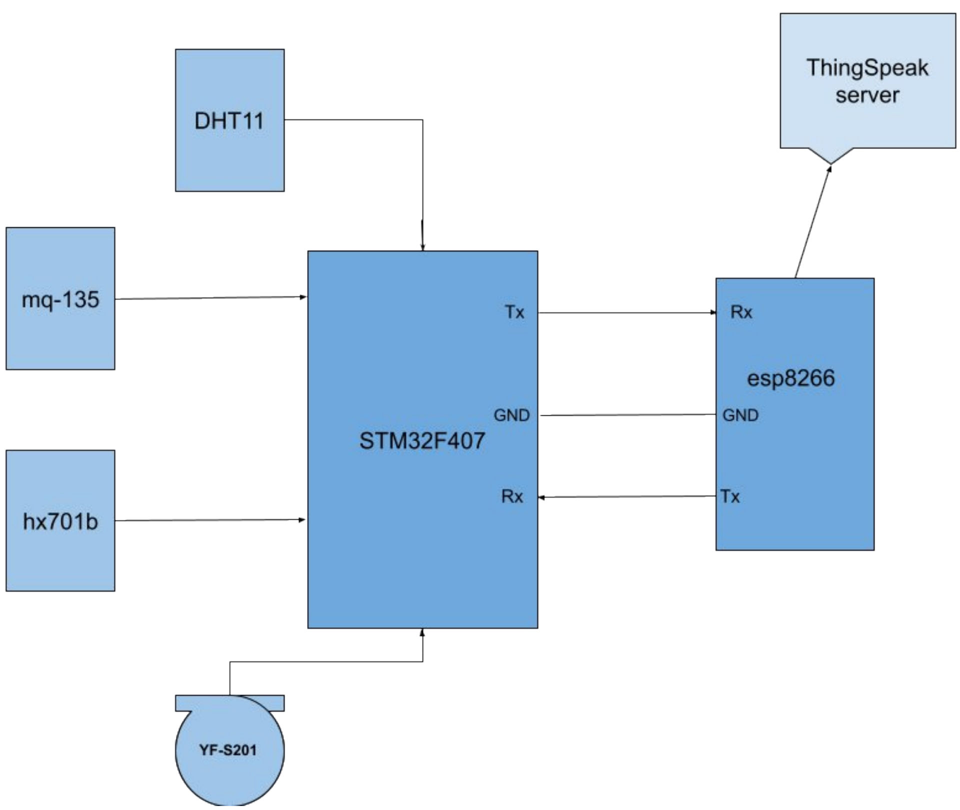



Figure 3.1 Block Diagram

## Chapter 4

# PROPOSED SYSTEM

### 4.1 CIRCUIT DIAGRAM

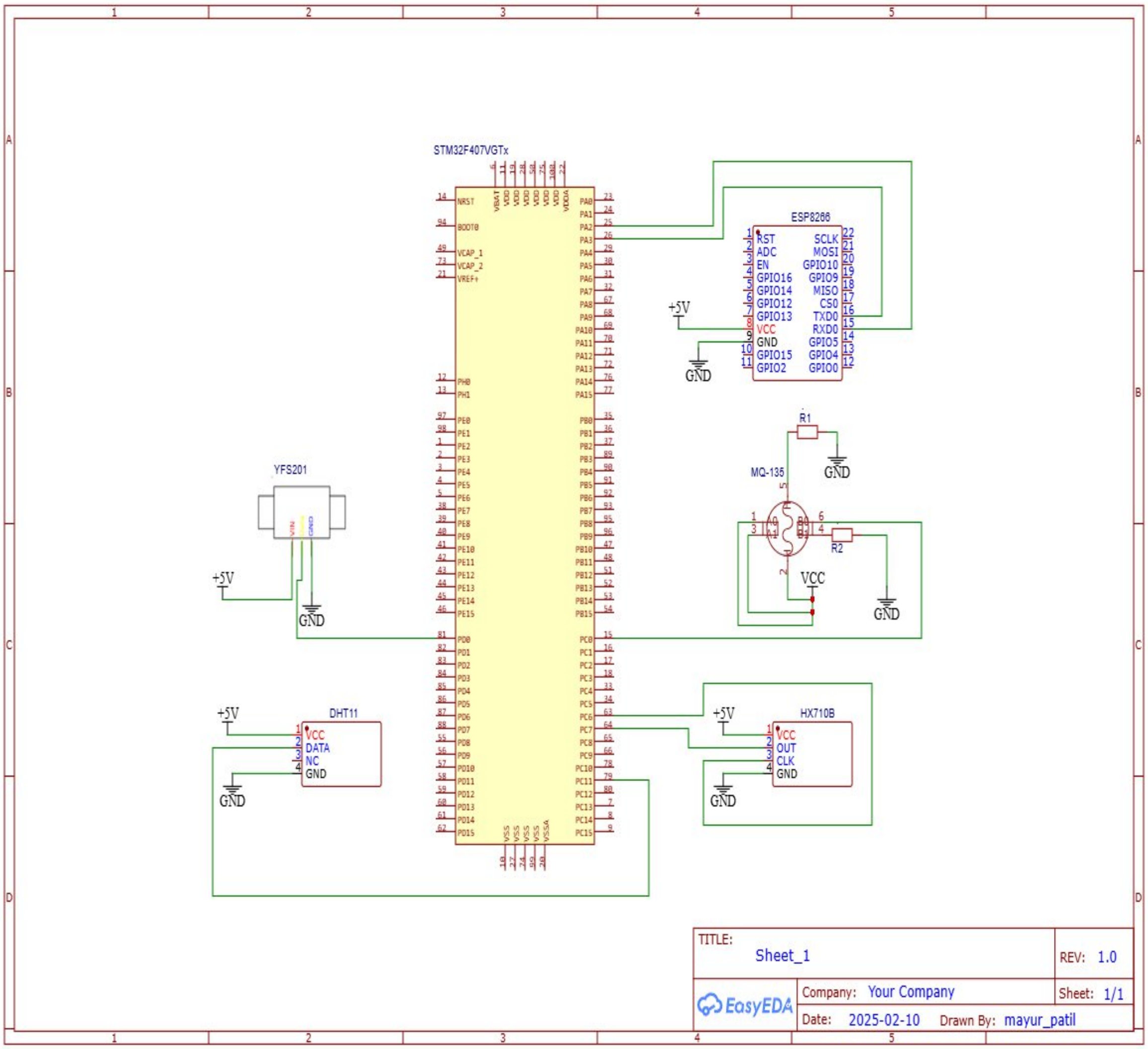



Figure 4.1 Circuit Diagram

## 4.2 STM32F407VGT6 PIN CONFIGURATION

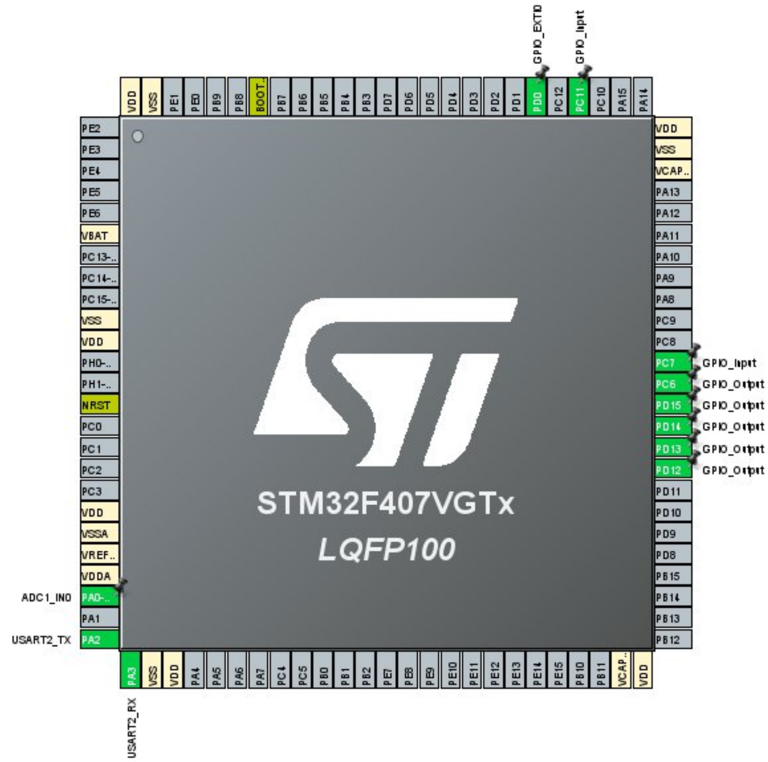



Figure 4.2 STM32F407VFT6 pin diagram

## 4.3 HARDWARE AND COMPONENTS

### 4.3.1 STM32F407VGT6

The STM32F407VGt6 microcontroller is a high-performance ARM Cortex-M4 based microcontroller unit (MCU) manufactured by STMicroelectronics. It offers a wide range of features and peripherals suitable for various embedded applications, including industrial control systems, consumer electronics, and IoT devices.

The STM32F407VGt6 MCU serves as the central processing unit for the system,handling data acquisition, processing, and communication tasks.It features a powerful ARM Cortex-M4 core running at up to 168 MHz, providing sufficient processing power for real-time sensor data processing and control algorithms.

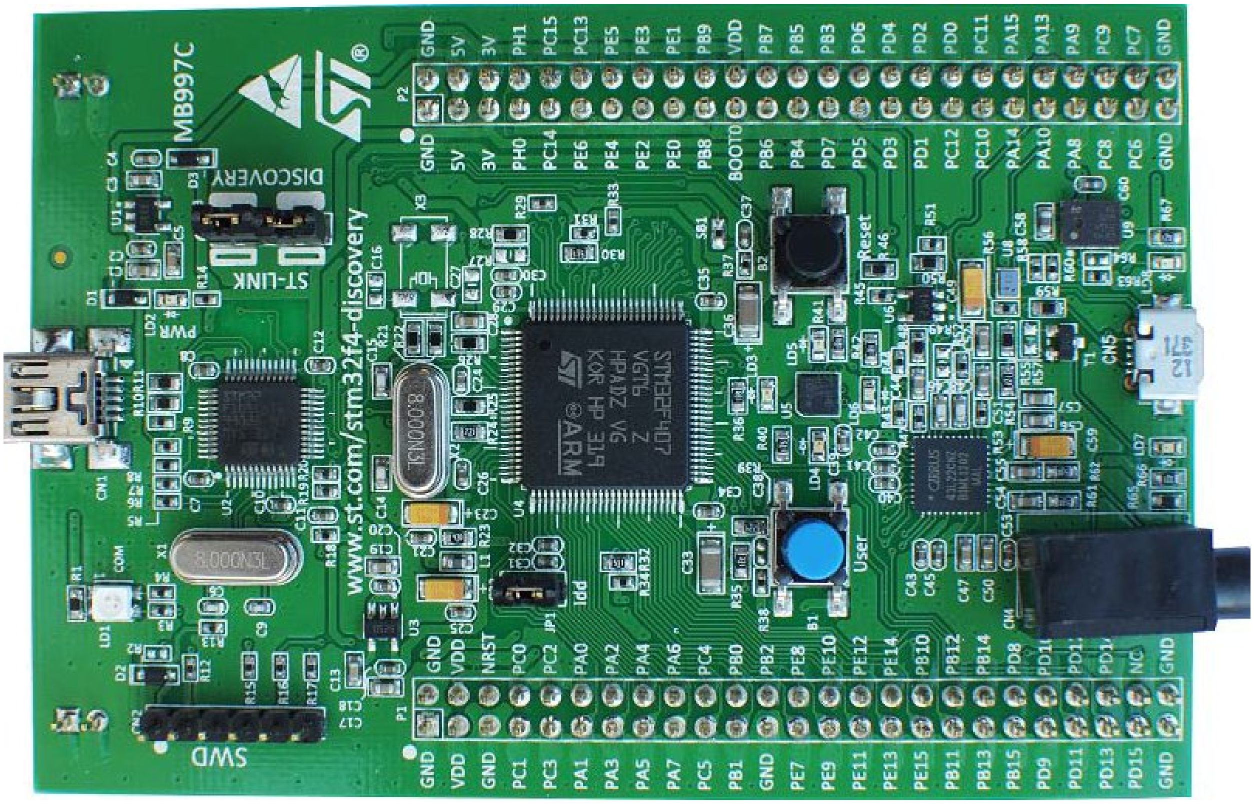



Figure 4.3 STM32F407VFT6 discovery board

The STM32F407VGt6 MCU serves as the central processing unit for the system,handling data acquisition, processing, and communication tasks.It features a powerful ARM Cortex-M4 core running at up to 168 MHz, providing sufficient processing power for real-time sensor data processing and control algorithms.

### 4.3.2 NODE MCU  ESP8266

As show in figure 4.4  ESP8266 Wi-Fi module plays a pivotal role in enabling wireless communication for the industrial remote monitoring system. This low-cost module integrates a full TCP/IP stack, allowing it to handle internet connectivity tasks efficiently. By providing Wi-Fi connectivity, the ESP8266 ensures real-time data transmission from industrial sensors to remote cloud servers or monitoring stations. It supports standard Wi-Fi communication protocols, enabling stable and secure data transfer over the internet. This capability makes the ESP8266 ideal for IoT applications, where remote accessibility and real-time monitoring are essential.


Figure 4.4 Node mcu esp8266

### 4.3.3 DHT11 SENSOR

The DHT11 sensor is a low-cost, digital sensor used for measuring temperature and humidity in industrial applications. It utilizes a thermistor for temperature sensing and a capacitive humidity sensor to provide accurate readings. The sensor’s ability to provide digital output simplifies integration with microcontrollers, such as Arduino, and is ideal for IoT-based monitoring systems.

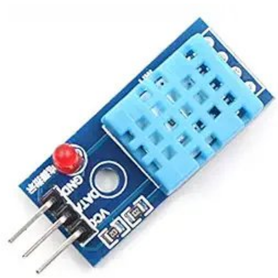


Figure 4.5 DHT11

The temperature range of the DHT11 spans from 0°C to 50°C, with an accuracy of ±2°C, while the humidity range covers 20% to 90% RH, with an accuracy of ±5%. These measurements are suitable for environments where moderate precision is acceptable, such as in warehouses or climate-sensitive industrial areas.

### 4.3.4 MQ-135 sensor

The MQ-135 sensor is a versatile and widely used gas sensor designed for detecting a variety of harmful gases, including ammonia ($NH_3$), benzene ($C_6H_6$), alcohol ($C_2H_5OH$), carbon dioxide ($CO_2$), and other volatile organic compounds (VOCs) in the environment. This sensor is commonly used in industrial, agricultural, and environmental monitoring systems to detect air quality levels and ensure a safe working environment.

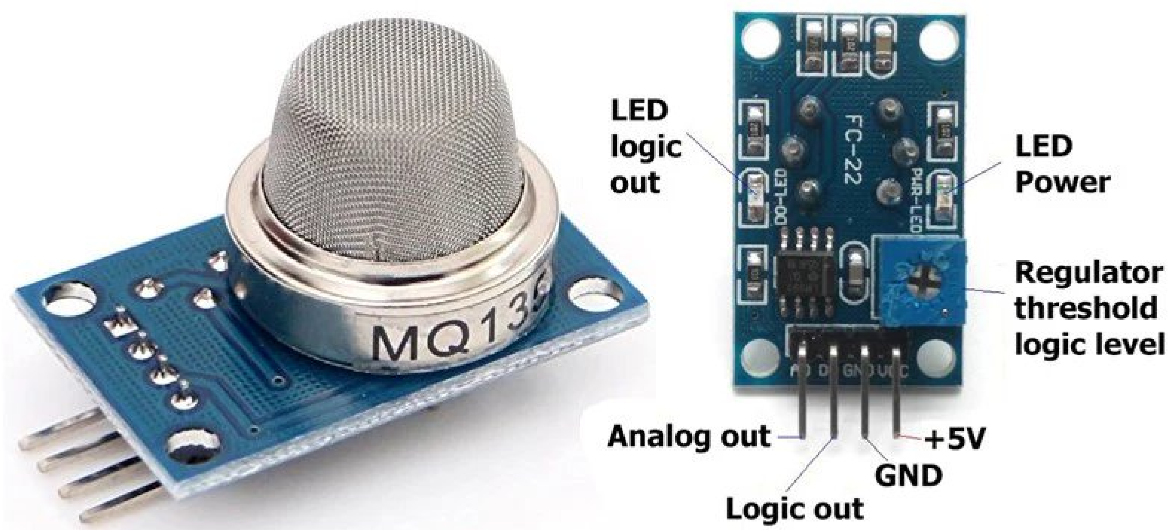



Figure 4.6 MQ-135 Gas sensor

The MQ-135 sensor uses a heating element and a semiconductor metal oxide layer to detect gases. The sensor's resistance changes in response to the concentration of gases in the air, and the data is processed by a microcontroller to determine the concentration level. The sensor sensitivity can be adjusted by changing the resistance of the sensor's heating element, making it adaptable to various detection ranges.

### 4.3.5 Hx 710B PRESSURE SENSOR

The HX710B Atmospheric Pressure Sensor Module is a precision device designed to measure barometric pressure and altitude in various environmental conditions. This sensor module utilizes a high linearity pressure sensor and a 24-bit analog-to-digital converter (ADC) to provide accurate digital readings of atmospheric pressure and temperature. It is ideal for applications such as weather forecasting, altitude measurement, and cyclone detection by monitoring the pressure of wind during extreme weather events

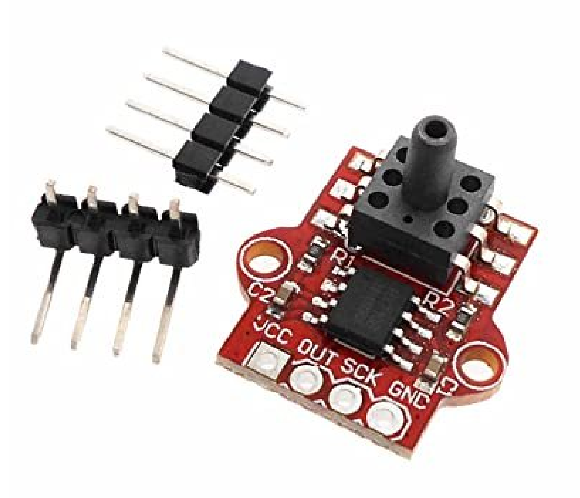



Figure 4.7 hx 710b pressure sensor

The HX710B sensor operates in the 0-40KPa pressure range, making it suitable for a variety of atmospheric pressure-related applications. With high accuracy and low power consumption, this sensor is particularly optimized for use in altimeters and variometers, offering an impressive altitude resolution of 10 cm. This makes it an excellent choice for devices that require precise altitude measurement or pressure data in a wide range of environmental conditions.

### 4.3.5 YS-S201 Water Flow sensor

The YS-S201 Water Flow Sensor is a highly reliable and cost-effective device used for measuring the flow rate of water or other liquids in various industrial, agricultural, and IoT-based applications. This sensor operates based on the principle of turbine rotation. As water flows through the sensor, it causes an internal turbine to spin. The rotation of the turbine is detected by a Hall effect sensor, which generates a pulse signal proportional to the volume of liquid passing through. This pulse signal is then processed by a microcontroller to determine the flow rate. The sensor's ability to convert the mechanical motion of the turbine into a digital pulse makes it easy to integrate into monitoring systems, providing real-time flow data.


Figure 4.8 YS-S201 Water Flow sensor

The YS-S201 sensor is designed to measure flow rates in the range of 1 to 30 liters per minute, making it suitable for a wide range of applications. It offers an accuracy of ±10% or better, ensuring reliable measurements for most water flow monitoring tasks. The sensor operates with a 5V DC power supply, and it outputs a digital pulse signal that can be easily read by microcontrollers such as Arduino or ESP32/ESP8266. One of the key advantages of the YS-S201 sensor is its durability, as it is constructed from corrosion-resistant materials that make it ideal for use in harsh environments, ensuring long-term performance.

# Chapter 5
# SOFTWARE

## 5.1 STM32CubeIDE

STM32CubeIDE, an integrated development environment (IDE) crafted by STMicroelectronics, serves as a pivotal tool in the project's software development journey targeting STM32 microcontrollers. This environment provides a holistic platform with an array of tools and features aimed at expediting firmware development. Its seamless integration with the STM32CubeMX configuration tool streamlines the process of configuring STM32 peripherals, pin assignments, and middleware components. By visually configuring the MCU's parameters through STM32CubeMX, developers can swiftly generate initialization code, significantly reducing the workload associated with peripheral setup.

Furthermore, STM32CubeIDE offers robust project management capabilities, facilitating efficient organization of source files, libraries, and resources within projects. With built-in debugging and testing functionalities, including support for hardware debugging using ST- LINK or JTAG/SWD debug probes, developers can effectively debug firmware code using features like breakpoints and watchpoints. Additionally, STM32CubeIDE comes bundled with the GNU Arm Embedded Toolchain, providing a robust compiler and toolchain optimized for ARM Cortex-M-based microcontrollers. This toolchain supports advanced compiler optimizations and debugging features, enhancing code efficiency and reliability. Integrated seamlessly with STM32Cube middleware components and software libraries, the IDE enables developers to easily incorporate middleware functionalities into their projects, further accelerating the development process. Through STM32CubeIDE's comprehensive suite of features, developers can efficiently develop, debug, and deploy firmware for STM32 microcontroller-based projects, including the envisioned wireless data transmission system.

### 5.2 STM32Cube Programmer

STM32Cube Programmer stands as an essential tool within the STM32 ecosystem, offering crucial functionalities for programming STM32 microcontrollers and configuring their embedded memories. This versatile tool stream lines the process of flashing firmware onto STM32 devices and managing their memory configurations. By supporting various programming modes, including UART, USB, and CAN, STM32Cube Programmer accommodates diverse deployment scenarios and ensures compatibility with a wide range of STM32 microcontrollers. Its intuitive user interface simplifies the task of selecting programming options and configuring device settings, enabling efficient and error-free programming operations.

Moreover, STM32Cube Programmer integrates seamlessly with STM32CubeIDE and other development environments, providing a seamless workflow for firmware development and device programming. With support for batch programming and scripting capabilities, the tool enhances productivity and scalability, enabling developers to streamline production processes and automate repetitive tasks. STM32 Cube Programmer is a tool for programming and configuring STM32 microcontrollers, supporting firmware updates and memory operations via JTAG, SWD, and UART interfaces Overall, STM32Cube Programmer plays a crucial role in the development lifecycle of STM32based embedded systems, offering robust programming capabilities and streamlined device management functionalities.

### 5.3 Arduino IDE

The Arduino IDE serves as a fundamental software tool for programming Arduino microcontroller boards, providing an accessible and user-friendly platform for developing embedded projects. Designed with simplicity in mind, the IDE offers a straightforward integrated development environment suitable for both beginners and experienced developers. With its intuitive interface and extensive library support, the Arduino IDE simplifies the process of writing, compiling, and uploading code to Arduino boards. Developers can leverage the IDE's built-in code editor, which features syntax highlighting, auto-completion, and error checking functionalities to facilitate code development.

Additionally, the IDE offers a diverse selection of prebuilt libraries and example code, enabling developers to easily integrate complex functionalities into their projects without the need for extensive programming knowledge. Furthermore, the Arduino IDE supports a wide range of Arduino compatible boards, allowing developers to choose the most suitable hardware platform for their applications. Overall, the Arduino IDE plays a pivotal role in the Arduino ecosystem, empowering developers to unleash their creativity and bring innovative ideas to life through embedded programming.

### 5.4 Cloud Platform

The ThingSpeak cloud platform stands as a robust and versatile solution for building and deploying IoT applications, offering a comprehensive suite of features and functionalities for device management, data visualization, and application development. As a highly scalable and customizable platform, ThingSpeak facilitates the seamless integration of IoT devices, sensors, and gateways, enabling users to collect, process, and analyze real-time data from connected devices. With its intuitive dashboard builder and drag-and-drop interface, ThingSpeak empowers users to create dynamic and interactive dashboards to visualize sensor data, monitor device performance, and track key metrics in real-time.

Moreover, the platform offers advanced data processing capabilities, including rule chains, complex event processing, and integration with external systems, enabling users to implement custom business logic and automate decision-making processes based on incoming data streams. Additionally, ThingSpeak provides robust security features, including role-based access control, encryption, and device authentication, ensuring the confidentiality, integrity, and availability of IoT data throughout the entire lifecycle. Furthermore, ThingSpeak supports seamless integration with third-party services and applications through its extensive set of APIs and connectors, enabling users to leverage existing infrastructure and tools within their IoT ecosystem. Overall, ThingSpeak serves as a powerful and flexible cloud platform for building and deploying scalable and feature-rich IoT solutions across a wide range of industries and use cases.

## Chapter 6

# COMMUNICATION PROTOCOL

### 6.1 USART Communication in STM32F407 and ESP8266

In this project, USART (Universal Synchronous Asynchronous Receiver Transmitter) communication is used to establish a reliable data transfer link between the STM32F407 microcontroller and the ESP8266 (NodeMCU) Wi-Fi module. USART is a widely used serial communication protocol that enables efficient data exchange between microcontrollers and peripheral devices.

The STM32F407 collects real-time sensor data and transmits it to the ESP8266 using its UART (Tx, Rx) pins. The ESP8266 then forwards this data to the ThingSpeak cloud platform via Wi-Fi for remote monitoring. The communication is asynchronous, meaning data is transmitted without a shared clock signal, making it suitable for low-power and long-distance applications.

To ensure smooth communication, both devices must be configured with the same baud rate, data bits, stop bits, and parity settings. In this project, a baud rate of 9600 bps is typically used for faster and stable data transmission. USART communication ensures real-time data exchange, low latency, and efficient integration between the STM32F407 and ESP8266, enabling seamless IoT-based industrial monitoring.

Chapter 7

# RESULT

## 7.1 PROPOSED MODEL

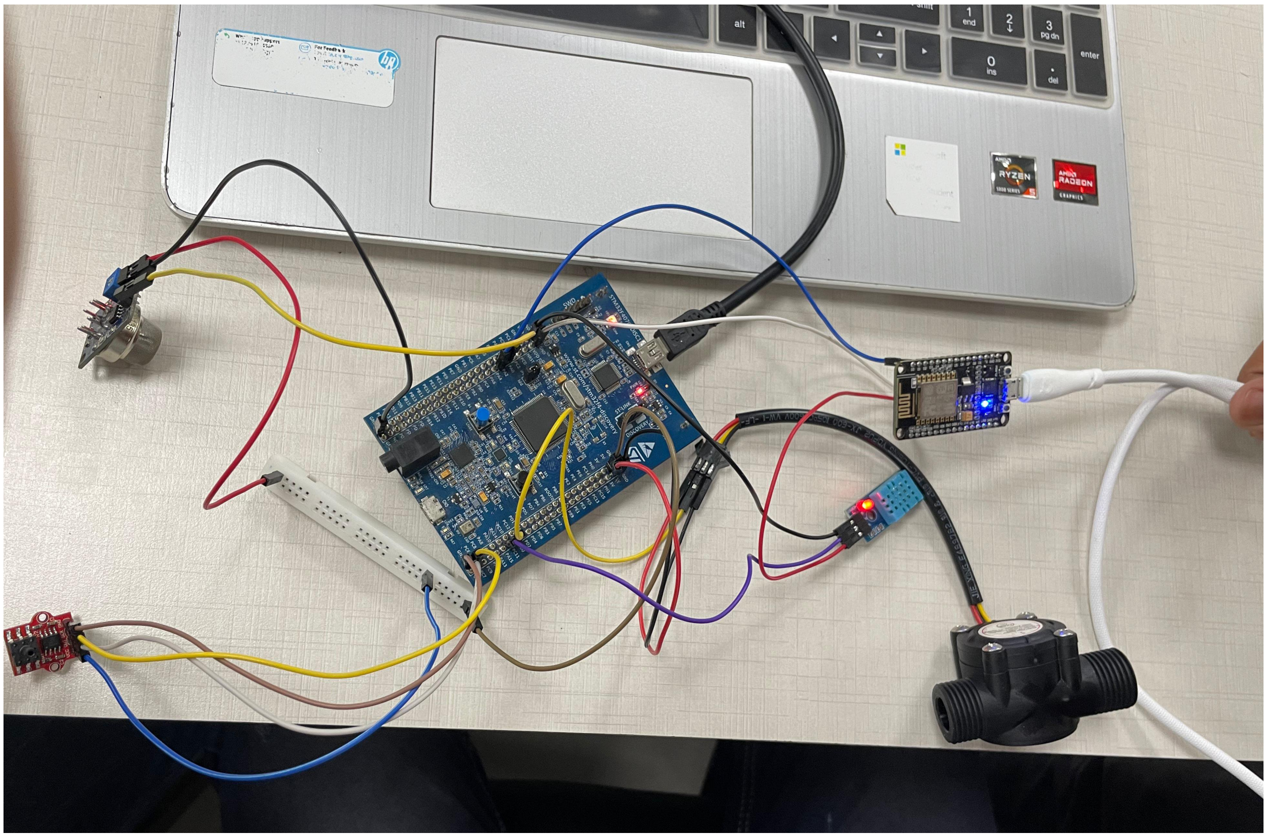
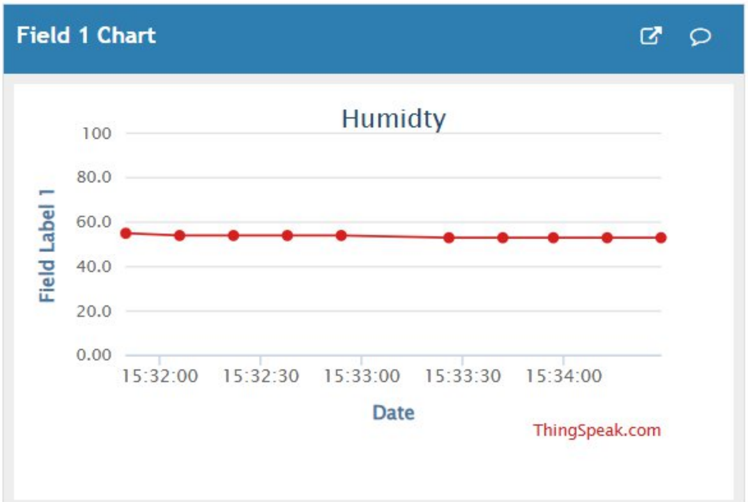
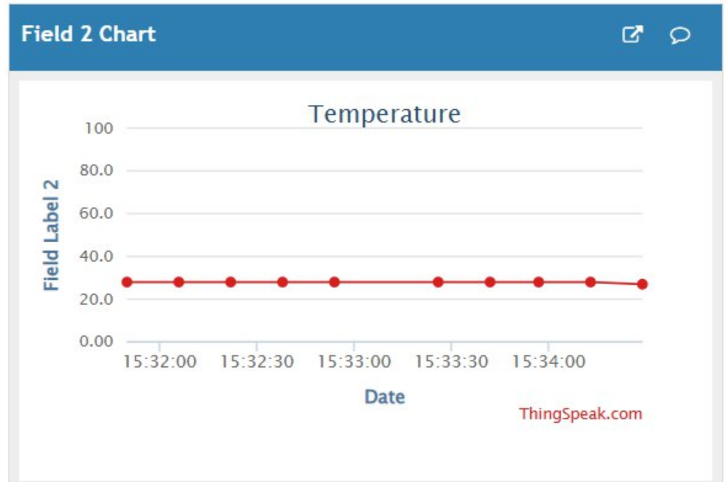
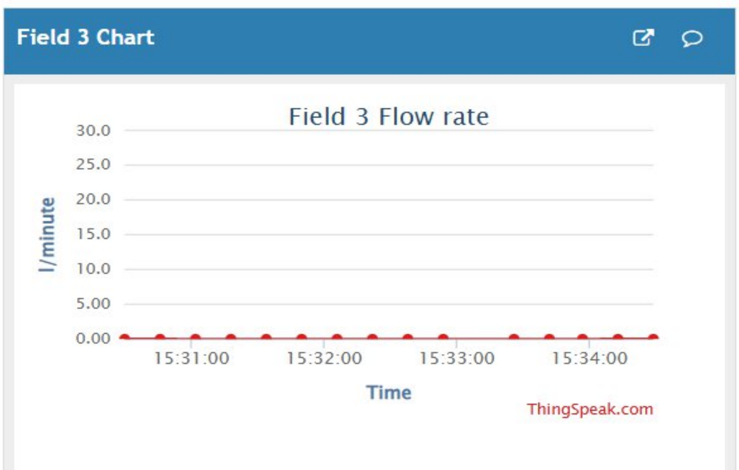


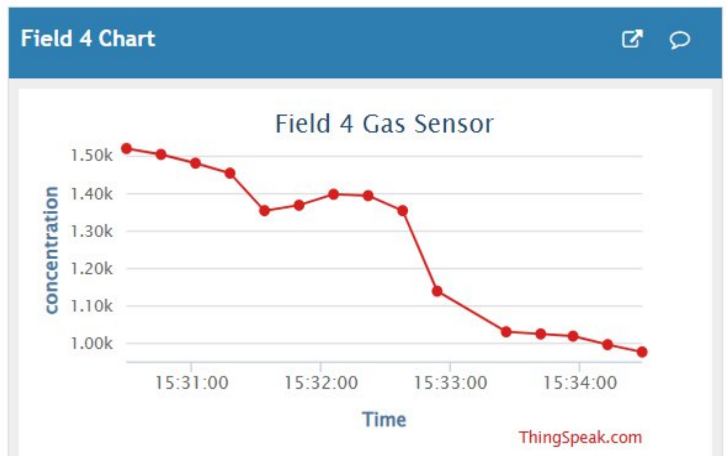

Figure 7.1 Proposed model

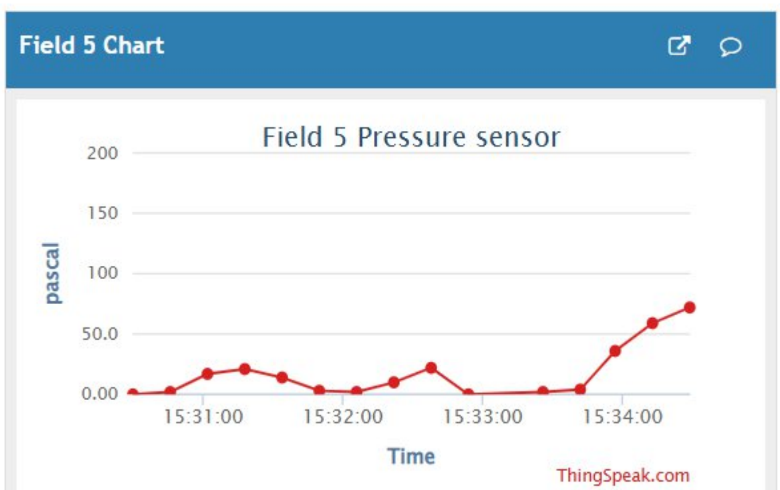
## 7.2 THINGSPEAK OUTPUT WINDOW



# Chapter 8
# CONCLUSION

## 8.1 CONCLUSION

The IoT-based Remote Monitoring System for Industrial Parameters successfully enables real-time tracking of critical environmental and operational factors such as temperature, humidity, air quality, pressure, and water flow. By integrating the STM32F407 microcontroller with various sensors and utilizing the ESP8266 Wi-Fi module, the system efficiently transmits data to the ThingSpeak cloud platform for remote access and analysis.

This project enhances industrial automation by reducing manual monitoring efforts, improving decision-making, and ensuring better safety and efficiency. The use of USART communication between STM32 and ESP8266 ensures reliable data transfer, making the system cost-effective, scalable, and adaptable for various industrial applications. Future enhancements can include additional sensors, predictive analytics, and machine learning for better anomaly detection and preventive maintenance.

## Chapter 9

# FUTURE SCOPE

**Expansion to Industrial Automation:** Integrate with industrial control systems (PLC/SCADA) for automated responses based on sensor data. Enable remote control functionalities to adjust parameters dynamically.

**Enhanced Connectivity & Security:** Upgrade to LoRaWAN, NB-IoT, or 5G for better connectivity and reduced latency in large-scale deployments. Implement robust cybersecurity measures to prevent unauthorized access and data breaches.

**Scalability for Smart Manufacturing:** Extend monitoring capabilities to additional parameters like vibration, gas levels, and power consumption. Adapt the system for multiple industries such as oil & gas, water treatment, and food processing.

**Cloud and Edge Computing Integration:** Leverage edge computing for real-time data processing, reducing dependency on cloud connectivity.Enable multi-cloud compatibility for improved data redundancy and scalability.

**Integration with AI & Machine Learning:** Implement predictive analytics to anticipate equipment failures and optimize maintenance schedules. Use anomaly detection algorithms to identify irregular patterns and prevent potential hazards.