Industrial Internship Report on

" Humidity and Temperature Monitoring System"

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Executive Summary
This report presents the work carried out during the Industrial Internship conducted by **upskill Campus** and **The IoT Academy**, in collaboration with the industrial partner **UniConverge Technologies Pvt. Ltd. (UCT)**. The internship was structured around a project/problem statement defined by UCT and was required to be completed within a duration of six weeks, including system implementation and report submission. The assigned project involved the **design and development of an IoT-based Humidity and Temperature Monitoring System using the ESP8266 microcontroller**. The system integrates a DHT11 sensor for environmental data acquisition, employs the MQTT communication protocol for wireless data transmission, and utilizes Node-RED for real-time data visualization and monitoring. The project aimed to develop a cost-effective, scalable, and reliable solution applicable to real-world industrial and environmental monitoring scenarios. This internship provided valuable exposure to industrial problem-solving approaches and hands-on experience in designing and implementing end-to-end IoT solutions. It significantly enhanced practical knowledge in embedded systems, IoT communication protocols, and data visualization techniques. Overall, the internship was a highly enriching experience that strengthened technical competence and provided meaningful insight into industry-oriented project development.

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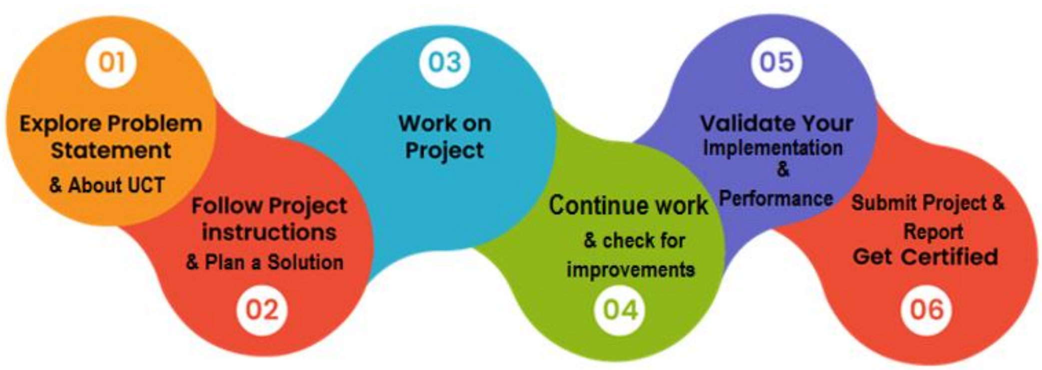
1. Preface

This Industrial Internship was conducted over a duration of six weeks and followed a structured, industry-oriented workflow. The program began with understanding the project problem statement and gaining familiarity with **UniConverge Technologies Pvt. Ltd. (UCT)**, followed by planning the solution as per provided guidelines. The subsequent phases included project implementation, continuous improvement, validation of system performance, and final submission of the project and report.

In today's competitive engineering environment, relevant industrial internships play a crucial role in career development by bridging the gap between theoretical knowledge and practical application. This internship provided valuable exposure to real-world problem-solving and system design methodologies used in the industry.

The assigned project focused on the development of an **IoT-based Humidity and Temperature Monitoring System** using the ESP8266 microcontroller, DHT11 sensor, MQTT protocol, and Node-RED for real-time data visualization. The internship opportunity provided by **upskill Campus (USC)** in collaboration with **The IoT Academy** and **UCT** was well planned and supported with continuous technical guidance.

Overall, the internship enhanced technical skills, problem-solving ability, and understanding of industrial IoT systems. I am grateful to **upskill Campus**, **The IoT Academy**, **UCT**, and all mentors and peers for their support. I strongly encourage juniors and peers to participate in such structured internship programs to strengthen their practical skills and career readiness.



2. Introduction

2.1 About UniConverge Technologies Pvt Ltd

A company established in 2013 and working in Digital Transformation domain and providing Industrial solutions with prime focus on sustainability and Role.

For developing its products and solutions it is leveraging various **Cutting Edge Technologies e.g. Internet of Things (IoT), Cyber Security, Cloud computing (AWS, Azure), Machine Learning, Communication Technologies (4G/5G/LoRaWAN), Java Full Stack, Python, Front end** etc.

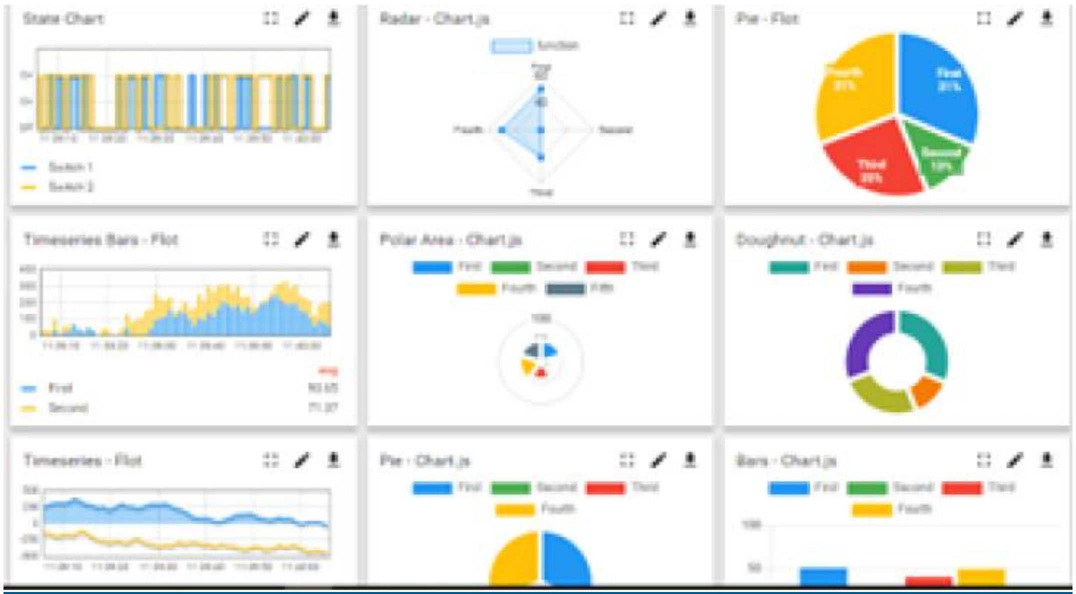
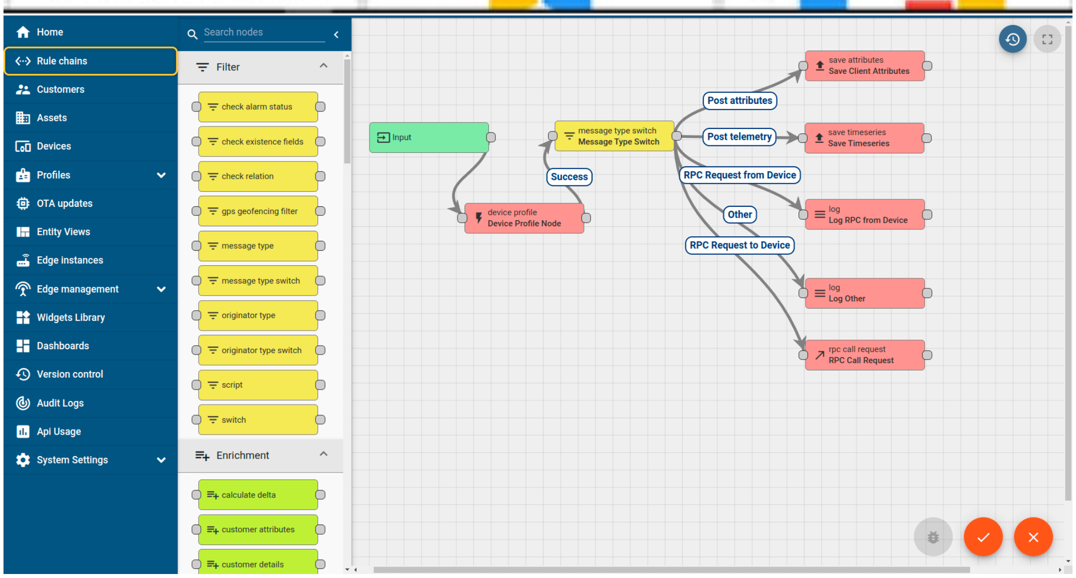
UCT IoT Platform (uct Insight)

UCT Insight is an IOT platform designed for quick deployment of IOT applications on the same time providing valuable "insight" for your process/business. It has been built in Java for backend and ReactJS for Front end. It has support for MySQL and various NoSql Databases.

- It enables device connectivity via industry standard IoT protocols - MQTT, CoAP, HTTP, Modbus TCP, OPC UA
- It supports both cloud and on-premises deployments.

It has features to
• Build Your own dashboard
• Analytics and Reporting
• Alert and Notification

• Integration with third party application (Power BI, SAP, ERP)
• Rule Engine

2.2 Smart Factory Platform (FACTORY WATCH)

Factory watch is a platform for smart factory needs.

It provides Users/ Factory

- with a scalable solution for their Production and asset monitoring
- OEE and predictive maintenance solution scaling up to digital twin for your assets.
- to unleased the true potential of the data that their machines are generating and helps to identify the KPIs and improve them.
- A modular architecture that allows users to choose the service that they what to start and then can scale to more complex solutions as per their demands.

Its unique SaaS model helps users to save time, cost and money.

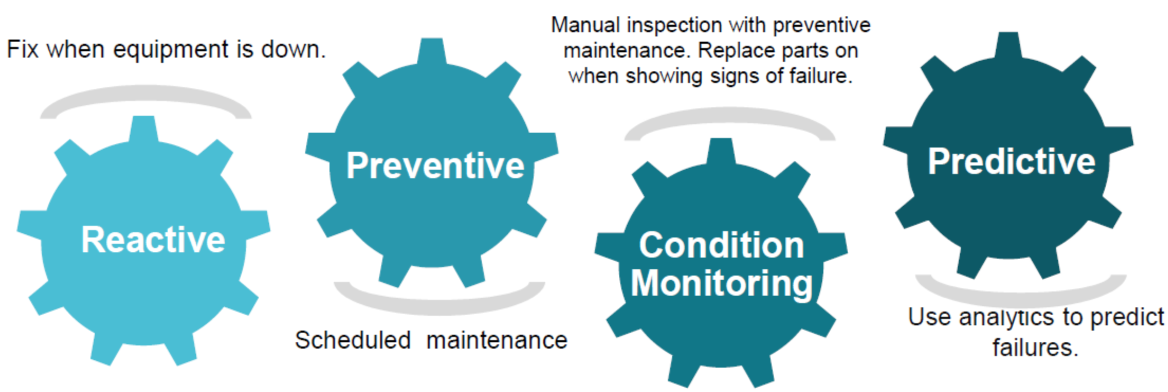

3D View
12:30
Search...
Stopped
Workplace Type
194724_27462-100-A3
Availability
Performance
Quality
OEE
Monitor
Maximum: 42.23%
Minimum: 0.00%
Current: 0.0%
Maximum: 400.00v
Minimum: 0.00v
Average: 200.00v
Maximum: 99.21%
Minimum: 24.53%
Average: 62.35%
Maximum: 99.21%
Minimum: 24.53%
Average: 62.35%
Availability
Performance
Quality
OEE

2.3 LoRa WAN based Solution

UCT is one of the early adopters of LoRaWAN technology and providing solution in Aggrotech, Smart cities, Industrial Monitoring, Smart Street Light, Smart Water/ Gas/ Electricity metering solutions etc.

2.4 Predictive Maintenance

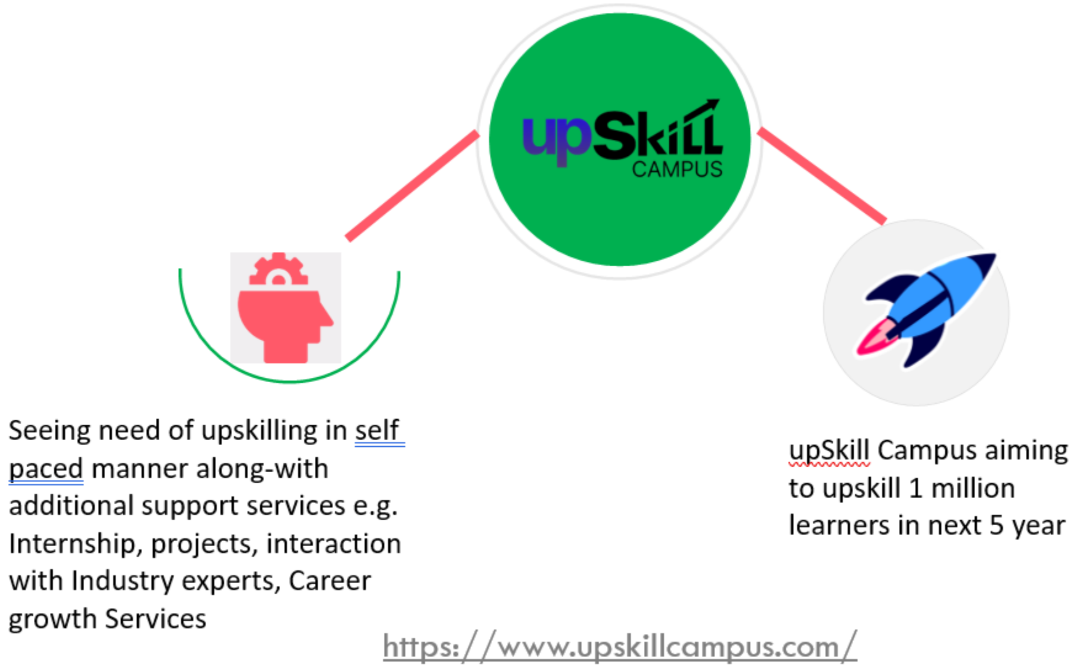
UCT is providing Industrial Machine health monitoring and Predictive maintenance solution leveraging Embedded system, Industrial IoT and Machine Learning Technologies by finding Remaining useful lifetime of various Machines used in production process.

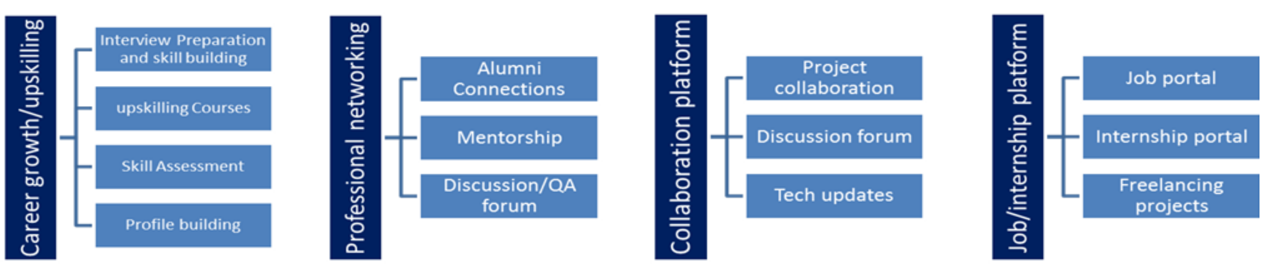


2.5 About Upskill Campus (USC)

upskill Campus along with The IoT Academy and in association with Uniconverge technologies has facilitated the smooth execution of the complete internship process.

USC is a career development platform that delivers **personalized executive coaching** in a more affordable, scalable and measurable way.





2.6 The IoT Academy

The IoT academy is EdTech Division of UCT that is running long executive certification programs in collaboration with EICT Academy, IITK, IITR and IITG in multiple domains.

Objectives of this Internship program

The objective for this internship program was to

☛ get practical experience of working in the industry.

☛ to solve real world problems.

☛ to have improved job prospects.

☛ to have Improved understanding of our field and its applications.

☛ to have Personal growth like better communication and problem solving.

3. Problem Statement

Industries and smart infrastructure systems require continuous and reliable monitoring of environmental parameters such as temperature and humidity to maintain operational efficiency, equipment safety, and process quality. Conventional monitoring approaches often lack real-time data availability, remote accessibility, and scalability, which limits their effectiveness in modern industrial environments.

The assigned problem statement is to **design and implement an IoT-based Humidity and Temperature Monitoring System** that enables real-time data acquisition, wireless data transmission, and centralized visualization. The system must be cost-effective, reliable, and scalable, allowing integration with existing infrastructure. It should support remote monitoring, quick response to environmental variations, and future enhancements such as data analytics and alert mechanisms.

The solution is expected to leverage embedded systems and standard IoT communication protocols to deliver an industry-ready monitoring system suitable for real-world deployment.

4. Existing and Proposed Solution

4.1 Existing Solutions and Their Limitations

Several temperature and humidity monitoring solutions are currently available in the market, ranging from conventional analog instruments to basic digital monitoring systems. Many existing solutions rely on standalone devices that require manual observation and do not support remote monitoring. Some digital systems provide data logging but lack real-time visualization and internet connectivity.

Commercial IoT-based monitoring systems are also available; however, they are often expensive, hardware-dependent, and limited in terms of customization and scalability. Additionally, many existing systems do not offer flexible integration with open-source platforms or standard IoT communication protocols, making them less suitable for adaptive industrial environments.

Key limitations of existing solutions include:

- Lack of real-time remote monitoring
- High implementation and maintenance cost
- Limited scalability and customization
- Absence of user-friendly data visualization

4.2 Proposed Solution

The proposed solution is an **IoT-based Humidity and Temperature Monitoring System** designed using the ESP8266 microcontroller and DHT11 sensor. The system collects real-time environmental data and transmits it wirelessly using the MQTT communication protocol. Node-RED is used as a visualization platform to display temperature and humidity data in real time through an interactive dashboard.

The solution is designed to be low-cost, scalable, and easy to deploy. By using open-source tools and standard IoT protocols, the system ensures flexibility and compatibility with various industrial and smart monitoring applications.

4.3 Value Addition of the Proposed System

The proposed system offers several value additions over existing solutions:

- Real-time monitoring and remote accessibility
- Cost-effective and open-source-based implementation
- Scalable architecture for future expansion
- User-friendly dashboard with graphical visualization

4.4 Code Submission (GitHub Link)

The complete source code developed during the internship has been uploaded to a GitHub repository for version control, easy accessibility, and future enhancements. The repository includes the ESP8266 firmware code, Node-RED flow (JSON file), configuration details, and supporting documentation.

GitHub Code Repository Link:
https://github.com/Arpit-techwhiz/upskillcampus/blob/main/TemperatureHumidityMonitoringSystem.ino

4.5 Report Submission (GitHub Link)

The detailed project report, including system description, block diagrams, flow diagrams, implementation details, results, and screenshots, has also been uploaded to GitHub. This ensures proper documentation, transparency, and ease of review.

GitHub Report Repository Link:
https://github.com/Arpit-techwhiz/upskillcampus/blob/main/TemperatureHumidityMonitoringSystem_Arpit_USC_UCT.pdf

5. Proposed Design / Model

The proposed design follows a structured and modular approach to develop an IoT-based Humidity and Temperature Monitoring System. The system architecture is designed to ensure reliable data acquisition, efficient communication, and real-time visualization. The overall design flow is divided into three main stages: **data acquisition**, **data transmission**, and **data visualization**, resulting in a complete end-to-end IoT solution.

The design begins with the sensing of environmental parameters using a temperature and humidity sensor. These sensor readings are processed by a microcontroller and transmitted wirelessly using a lightweight communication protocol. The received data is then visualized on a dashboard for monitoring and analysis. This modular design allows easy scalability and future enhancements.

Design Flow of the Proposed System

1. ### Start Phase
   The system initializes by powering up the ESP8266 microcontroller and connecting it to the available Wi-Fi network. Simultaneously, the temperature and humidity sensor is initialized for data acquisition.

2. ### Intermediate Processing Phase
   The sensor continuously measures temperature and humidity values and sends the data to the ESP8266. The microcontroller processes the sensor data and publishes it to an MQTT broker using predefined topics. This publish–subscribe mechanism ensures efficient and reliable data transmission.

3. ### Final Outcome Phase
   The MQTT broker forwards the sensor data to subscribed clients. Node-RED subscribes to the relevant topics, processes the incoming data, and displays it in real time using gauges and graphs on a web-based dashboard. This enables remote monitoring and analysis of environmental conditions.

5.1 High Level Diagram

The high-level diagram represents the overall architecture and data flow of the proposed system. It illustrates the interaction between the hardware components, communication protocol, and visualization platform.

Description of the High-Level Diagram:

- The **DHT11 sensor** measures temperature and humidity from the environment.
- The **ESP8266 microcontroller** reads sensor data and connects to the internet using Wi-Fi.
- The **MQTT broker** acts as an intermediary, enabling publish–subscribe communication between devices.
- **Node-RED** subscribes to the MQTT topics and processes the data.

- The **Node-RED dashboard** displays real-time temperature and humidity values in graphical and numeric form.

This high-level design ensures simplicity, reliability, and scalability, making the system suitable for real-world industrial and IoT applications.

Figure-1: High Level Diagram

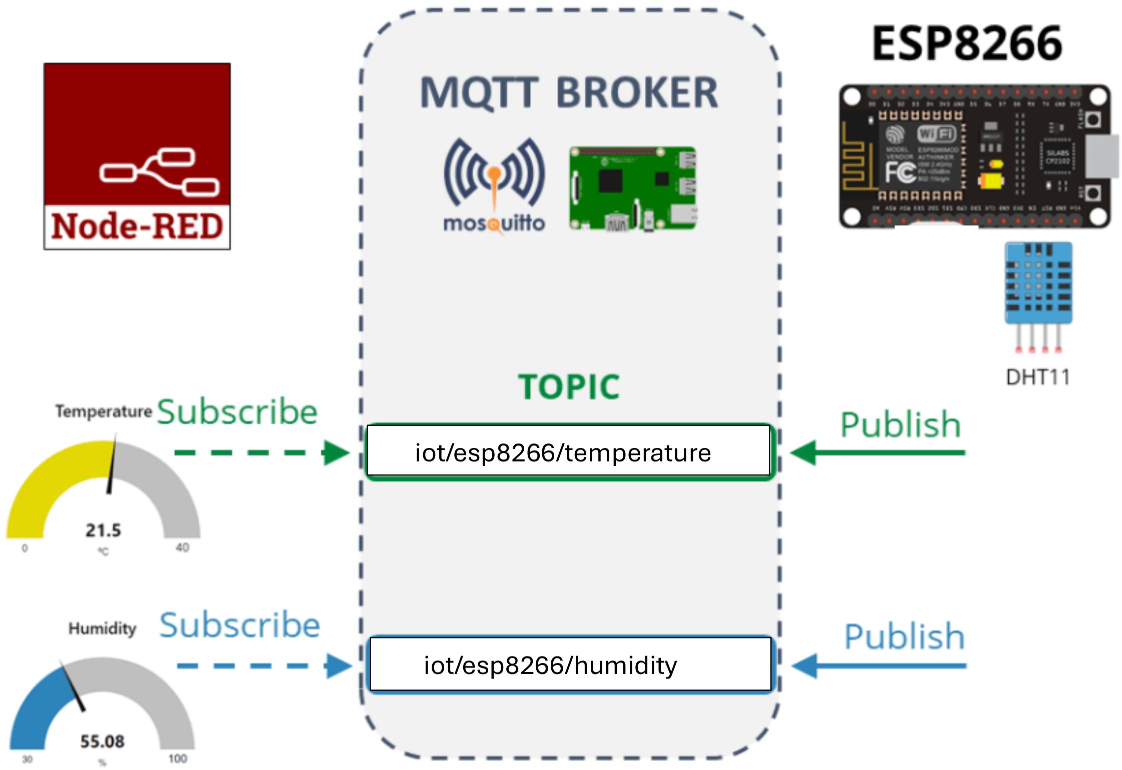


Figure-2: Node-RED Flow

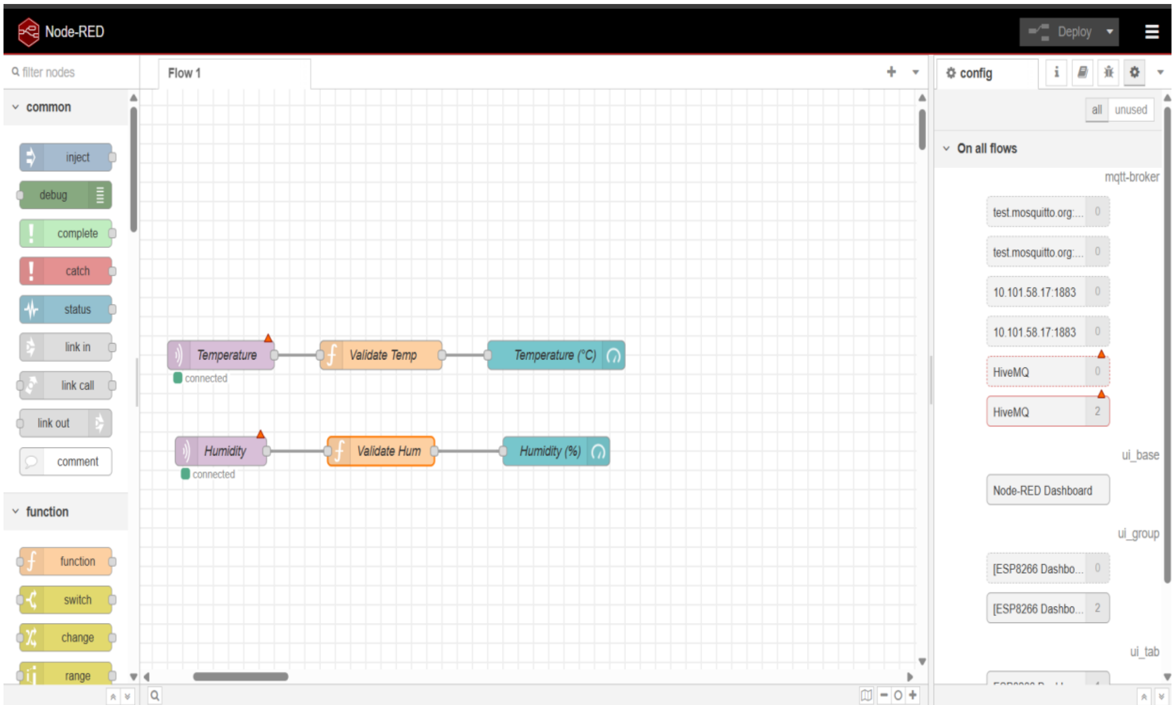
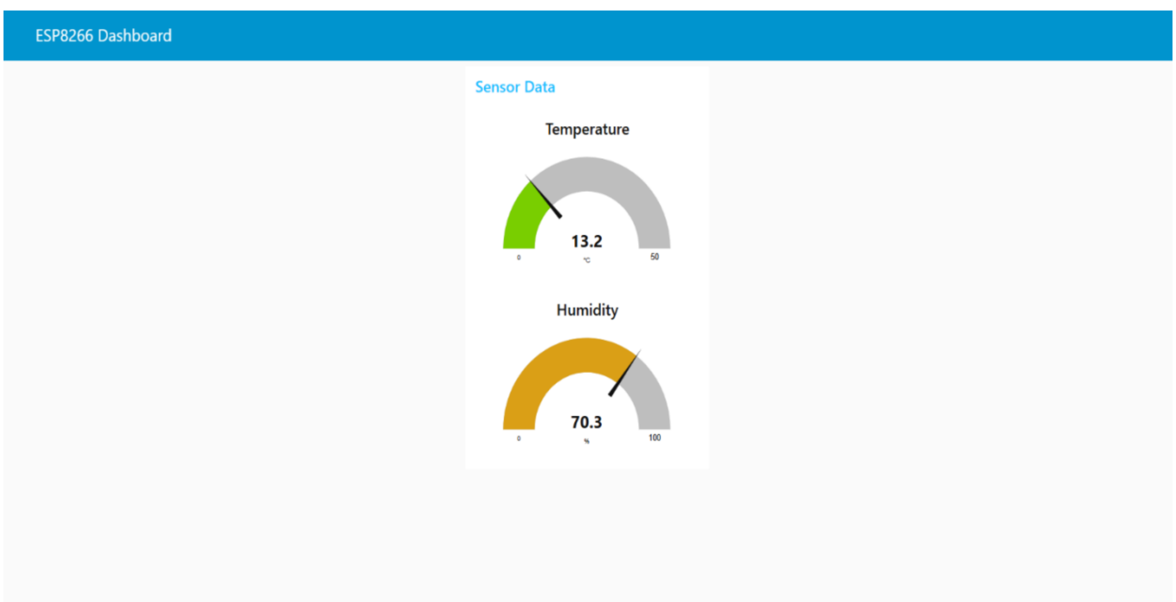


Figure-3: Dashboard



6. Performance Test

Performance testing is a critical phase of the proposed system, as it validates the reliability, efficiency, and industrial applicability of the solution. Unlike academic prototypes, real-world IoT systems must operate under multiple constraints such as limited memory, processing capability, network dependency, accuracy, and power consumption.

For the proposed **IoT-based Temperature and Humidity Monitoring System**, key performance constraints were identified during the design phase. The system was tested to evaluate its behaviour under these constraints and to ensure stable and continuous operation in real-time monitoring scenarios.

Identified Constraints

The following constraints were identified for the system:

- **Processing speed and responsiveness** of the ESP8266
- **Memory limitations** of the microcontroller
- **Accuracy of sensor readings (DHT11)**
- **Network dependency and MQTT latency**
- **System reliability during continuous operation**
- **Power consumption considerations**

6.1 Test Plan / Test Cases

The test plan was designed to evaluate the system against the identified constraints. Multiple test cases were executed to verify accuracy, reliability, communication efficiency, and visualization performance.

Test Case ID	**Parameter Tested**	**Test Objective**
TC-01	Sensor Accuracy	Verify correctness of temperature and humidity readings
TC-02	Data Transmission	Check reliability of MQTT data transfer
TC-03	System Response Time	Measure delay between sensing and dashboard update
TC-04	Continuous Operation	Test stability during long-term operation
TC-05	Network Dependency	Observe system behaviour during network interruption
TC-06	Visualization Performance	Verify dashboard update without data loss or errors

6.2 Test Procedure

1. The ESP8266 microcontroller was powered on and connected to a stable Wi-Fi network.
2. The DHT11 sensor was initialized and allowed to stabilize before readings were taken.
3. Temperature and humidity data were read periodically and published to the MQTT broker.
4. Node-RED subscribed to the MQTT topics and displayed the data on gauges and line charts.
5. The system was allowed to run continuously for extended durations to observe stability.
6. Network interruptions were simulated to analyze reconnection behaviour and data recovery.
7. Sensor readings were compared with ambient conditions to evaluate accuracy.

All observations were recorded and analysed to assess system performance.

6.3 Performance Outcome

The performance testing demonstrated that the proposed system satisfies the requirements of a real-world IoT monitoring application:

- ### Processing & Speed:
  The ESP8266 handled sensor reading, MQTT communication, and Wi-Fi connectivity efficiently without noticeable delay. Real-time updates were observed on the dashboard with minimal latency.
- ### Memory & Resource Utilization:
  The system operated within the memory constraints of the ESP8266. Lightweight libraries and MQTT protocol ensured low resource consumption.
- ### Accuracy:
  The DHT11 sensor provided reasonably accurate temperature and humidity readings suitable for environmental monitoring applications. Minor variations were within acceptable tolerance limits for low-cost sensors.
- ### Reliability:
  The system remained stable during continuous operation. MQTT reconnection logic ensured reliable data transmission even after temporary network disruptions.
- ### Visualization Performance:
  Node-RED dashboards displayed real-time values and graphs smoothly without crashes or undefined data errors, confirming robust data handling.
- ### Power Considerations:
  Although detailed power measurements were not performed, the system design supports low-power operation. Power consumption can be further optimized by increasing data transmission intervals or implementing deep-sleep modes.

Impact of Constraints and Recommendations

While the system performed well, certain constraints may impact scalability:

- **Sensor Accuracy:** For industrial-grade applications, higher-precision sensors (e.g., DHT22 or BME280) are recommended.
- **Network Dependency:** Deployment in critical environments should include backup connectivity or local data logging.
- **Power Consumption:** Battery-powered deployments should use sleep modes and optimized publish intervals.

7. My Learnings

This industrial internship provided significant learning opportunities by bridging the gap between academic knowledge and real-world engineering practices. Through the design and implementation of the IoT-based Temperature and Humidity Monitoring System, I gained practical exposure to end-to-end system development, including hardware interfacing, communication protocols, data processing, and visualization.

From a technical perspective, the internship enhanced my understanding of **embedded systems** and **IoT architecture**, particularly in working with the ESP8266 microcontroller, sensor interfacing, and Wi-Fi-based communication. I developed hands-on experience with the **MQTT publish–subscribe model**, which is widely used in industrial IoT applications due to its efficiency and scalability. Additionally, working with **Node-RED** improved my skills in real-time data handling, dashboard creation, and debugging of distributed systems.

Beyond technical skills, the internship strengthened my **problem-solving ability**, especially in identifying system constraints, debugging communication issues, and optimizing system performance under real-world conditions. I also gained experience in **version control and documentation** through GitHub, which is essential for collaborative development and professional project management.

Overall, this internship contributed significantly to my career growth by providing industry-relevant skills, improving my practical understanding of IoT systems, and preparing me to design scalable and reliable solutions. The experience has strengthened my interest in embedded systems and IoT-based applications and has equipped me with competencies that will be valuable in future professional and industrial roles.

8. Future Work Scope

Although the proposed IoT-based Temperature and Humidity Monitoring System successfully meets the current project objectives, there are several enhancements that can be implemented in the future to improve functionality, scalability, and industrial applicability. Due to time and resource constraints during the internship period, these features could not be fully explored but present strong potential for future development.

One important enhancement is the integration of **cloud-based data storage**, such as Thing Speak, Firebase, or Influx DB, to enable long-term data logging and historical analysis. This would allow trend analysis and performance monitoring over extended periods.

The system can also be enhanced by implementing **alert and notification mechanisms**, such as email, SMS, or mobile app notifications, to provide immediate warnings when temperature or humidity exceeds predefined thresholds. This feature is particularly useful in industrial environments, cold storage, and agriculture applications.

Future versions of the system can incorporate **higher-accuracy sensors** (e.g., DHT22 or BME280) to improve measurement precision and reliability. Additionally, the system can be extended to support **multiple sensors and nodes**, enabling monitoring across larger areas.

Further optimization can be achieved by implementing **power management techniques**, such as deep sleep modes and adaptive data transmission intervals, making the system suitable for battery-powered deployments. Security enhancements, including MQTT authentication and encrypted communication, can also be incorporated to meet industrial cybersecurity requirements.

Overall, these future enhancements will transform the proposed system into a more robust, secure, and scalable industrial IoT solution.

THANK YOU