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Industrial Internship Report on:

"IOT based Temperature and Humidity Monitoring System"

Executive Summary
This report provides details of the Industrial Internship provided by upskill Campus and The IoT Academy in collaboration with Industrial Partner UniConverge Technologies Pvt Ltd (UCT).
This internship was focused on a project/problem statement provided by UCT. We had to finish the project including the report in 6 weeks' time.
My project was **IOT based Temperature and Humidity Monitoring System**
This internship gave me a very good opportunity to get exposure to Industrial problems and design/implement solution for that. It was an overall great experience to have this internship.

TABLE OF CONTENTS

1 Preface

Brief about Problem Statement:

A temperature and humidity monitoring system is designed to measure and track the temperature and humidity levels in a given environment. It typically consists of sensors, data loggers or transmitters, and a monitoring platform or software. Here is a summary of how such a system functions:

- Sensors: The system utilizes temperature and humidity sensors placed strategically in the area of interest. These sensors can be standalone devices or integrated into other equipment or devices. They continuously measure the ambient temperature and relative humidity.

- Data Loggers/Transmitters: The sensors are connected to data loggers or transmitters that collect the measurements from the sensors. Data loggers store the information internally, while transmitters send the data wirelessly to a central monitoring system.

- Central Monitoring System: The collected data is sent to a central monitoring system, which can be a computer, a server, or a cloud-based platform. The system receives and processes the temperature and humidity readings from multiple sensors in real-time.

- Data Analysis and Visualization: The monitoring system analyzes the received data and generates reports, graphs, or visual representations of the temperature and humidity trends over time. This information helps identify patterns, anomalies, and potential issues.

- Alarms and Notifications: The monitoring system is often equipped with customizable alarms and notifications. If the temperature or humidity exceeds predefined thresholds, the system triggers alerts to notify relevant personnel through email, SMS, or other communication channels.

- Remote Access: Depending on the system's capabilities, authorized users can remotely access the monitoring system's data and settings. This allows for real-time monitoring and control, even when personnel are not physically present at the location.

- **Data Logging and Compliance:** The system typically includes data logging functionality, allowing for long-term storage and retrieval of temperature and humidity data. This feature is particularly useful in industries where regulatory compliance or record-keeping is required.

- Integration with Other Systems: Temperature and humidity monitoring systems can often integrate with other environmental control systems, such as HVAC (Heating, Ventilation, and Air Conditioning) systems, to optimize energy efficiency and maintain optimal environmental conditions.

Overall, a temperature and humidity monitoring system provides continuous and accurate measurements, data analysis, and real-time alerts, enabling effective environmental monitoring and control in various settings, including laboratories, warehouses, greenhouses, healthcare facilities, and manufacturing plants.

Need of relevant Internship in career development:

Internships play a crucial role in career growth for several reasons:

- Practical Experience: Internships provide an opportunity to apply theoretical knowledge gained in academic settings to real-world scenarios. This practical experience helps interns develop valuable skills and gain industry-specific knowledge. It gives them a chance to understand the nuances of the work environment and gain hands-on experience in their chosen field.

- Skill Development: Internships allow individuals to acquire and enhance essential skills that are highly valued by employers. These skills can include communication, teamwork, problem-

solving, time management, and technical expertise. Internships often provide a platform for professional development, enabling interns to build a strong foundation of skills relevant to their career goals.

- Industry Exposure: Internships expose individuals to the inner workings of specific industries or organizations. They offer insights into industry trends, practices, and the overall business landscape. This exposure helps interns understand different job roles and functions, allowing them to make informed decisions about their career paths.

- Networking Opportunities: Internships provide a valuable opportunity to network with professionals in the field. Building relationships with experienced individuals can lead to mentorship, references, and potential job opportunities. Networking during an internship can expand professional connections and open doors for future career growth.

- Resume Enhancement: Internship experience enhances a candidate's resume, making it more attractive to potential employers. It demonstrates practical skills, industry knowledge, and a commitment to professional development. Having relevant internship experience can differentiate candidates from others with similar educational backgrounds, giving them a competitive edge in the job market.

- Career Clarity: Internships help individuals gain clarity about their career aspirations. By working in a specific industry or role, interns can assess their interests, strengths, and weaknesses. They can determine whether their chosen field aligns with their long-term goals and make informed decisions about their career paths.

- Job Opportunities: Many organizations use internships as a pipeline for hiring full-time employees. Successful interns may be offered permanent positions within the company upon completion of their internships. Internships can serve as a stepping stone to secure future job opportunities, especially when individuals perform well, showcase their abilities, and make valuable contributions to the organization.

In summary, internships provide practical experience, skill development, industry exposure, networking opportunities, resume enhancement, career clarity, and potential job opportunities. Engaging in internships can significantly contribute to career growth by preparing individuals for

the demands of the professional world and giving them a competitive advantage in their chosen field.

Internship Execution TimeLine:

Week 1 – Week 6
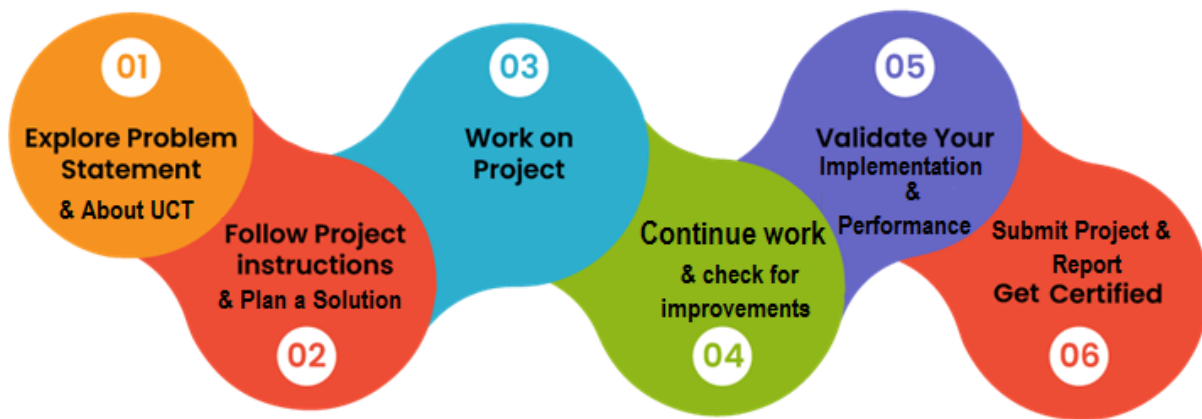
Many Learnings and overall experience:

Learning during an internship is a vital aspect of the experience and contributes significantly to an individual's professional growth. Here are some key areas of learning that occur during my internship:

- Practical Skills: Internships provide an opportunity to develop and refine practical skills specific to the industry or job role. This includes technical skills, such as using industry-specific software or tools, conducting research, analyzing data, or operating equipment. Practical skills can also encompass soft skills like communication, problem-solving, teamwork, and adaptability, which are essential for professional success.

- Industry Knowledge: Internships allow individuals to gain firsthand industry knowledge and insights. They learn about the current trends, challenges, and best practices within
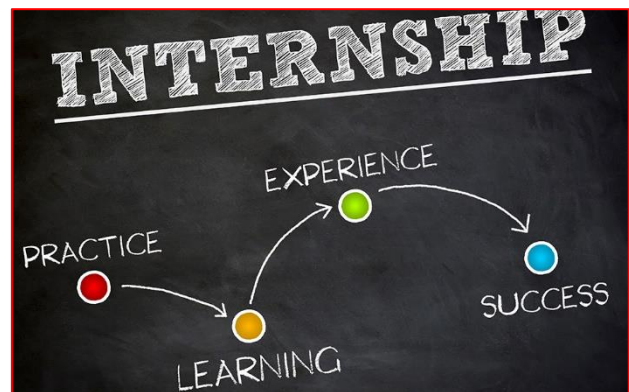
their field of interest. Understanding the industry landscape helps interns develop a broader perspective and become more effective contributors in their chosen career paths.

- Professional Etiquette: Internships provide an opportunity to learn and practice professional etiquette and workplace norms. Interns observe and understand how to interact with colleagues, supervisors, and clients professionally. They learn about workplace protocols, communication styles, and appropriate behavior, helping them navigate future professional environments with confidence.

- Project Management: Many internships involve working on specific projects or assignments. Interns learn how to manage their time effectively, set priorities, and meet deadlines. They gain experience in project planning, organizing tasks, and collaborating with team members to achieve project goals. These project management skills are transferable to future roles and contribute to overall professional competence.

- Networking and Relationship Building: Internships offer valuable opportunities to network and build relationships with professionals in the field. Interns learn how to establish connections, interact with colleagues, and seek mentorship. Networking allows interns to broaden their professional circle, gain insights from experienced individuals, and potentially open doors to future job opportunities.

- Problem-Solving and Critical Thinking: Internships often present interns with real-world challenges and problem-solving opportunities. They learn to think critically, analyze situations, and propose effective solutions. This fosters a problem-solving mindset and enhances their ability to handle complex situations, a skill highly valued in any professional setting.

- Self-Reflection and Career Development: Internships encourage self-reflection and self-assessment. Interns can evaluate their strengths, weaknesses, and areas for improvement. They gain a better understanding of their career interests, values, and goals, which helps shape their professional development plans and make informed decisions about their future career paths.

- Industry-Specific Regulations and Practices: Depending on the field, internships may involve exposure to industry-specific regulations, compliance requirements, or ethical

considerations. Interns learn about legal and ethical practices, ensuring they operate within the boundaries of their profession and contribute to responsible and sustainable work environments.

Overall, the internship provide a rich learning experience that encompasses practical skills, industry knowledge, professional etiquette, project management, networking, problem-solving, self-reflection, and adherence to industry-specific regulations. The learning gained during an internship complements formal education and equips individuals with the necessary tools to excel in their careers.

In this preface, I would take this opportunity to thank to all UCT executives that helped me during my 6-week internship at UCT. Their help was critical for the smooth execution of my internship.

I encourage all my peers to kindly consider intern. It will surely help you in your professional growth.

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 RoI.

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.

i. 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
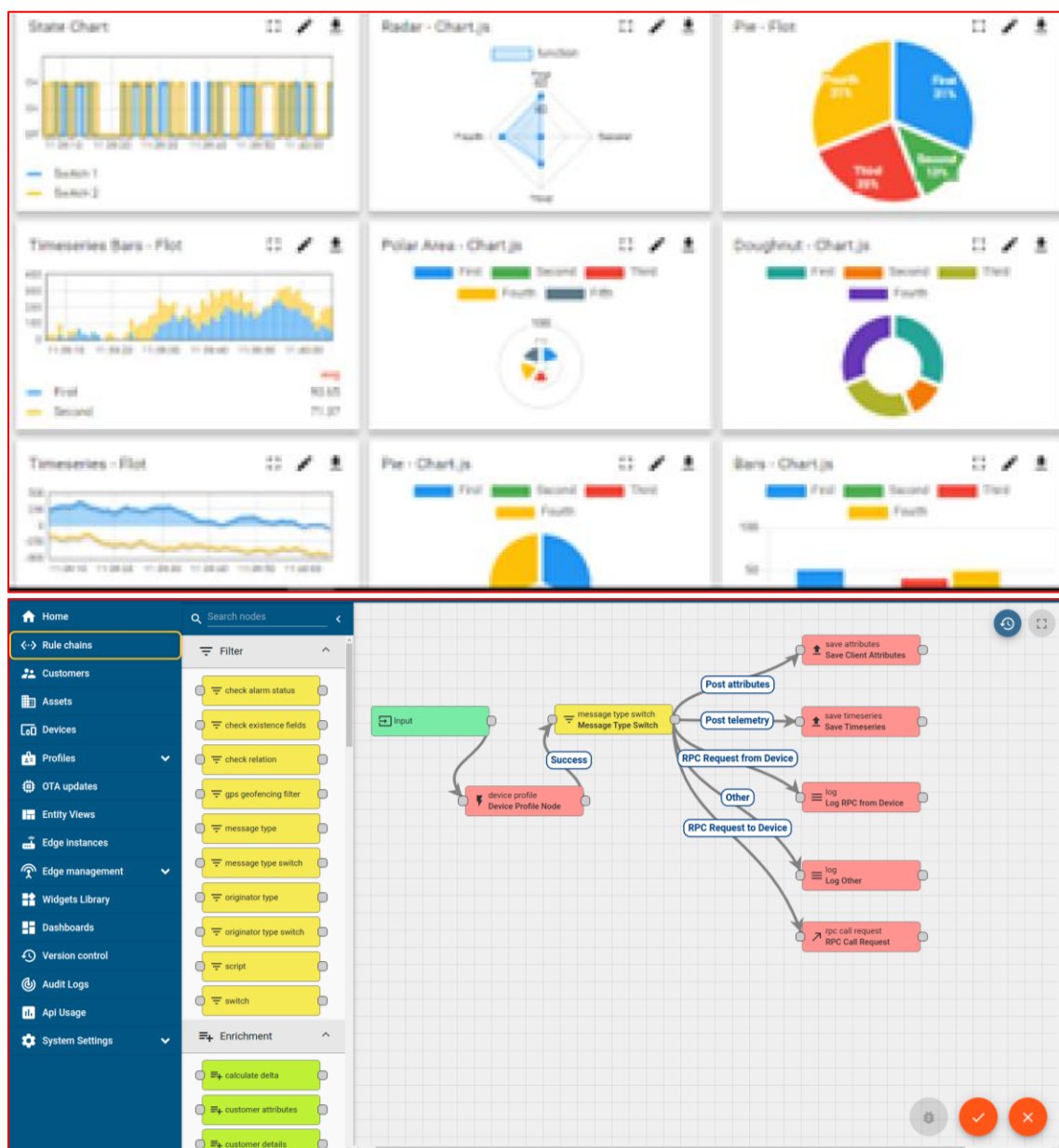
ii. Smart Factory Platform (**FACTORY WATCH**)

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 also 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.

Demo Org Plant Name | **Demo** Plant Name | **0%** Plant utilization | **55%** Average OEE | **4** Capacity | **0** Utilized | **0** Planned Production | **0** Plant Operation

Iso | Front | Back | Right | Left | Top | Bottom

CNC_S7_81 1/1
Direct | Email | Union
Utilization
58% Assist OEE | 522 days Spindle RUL

CNC_S7_82 1/2
Direct | Email | Union
Utilization
53% Assist OEE | 521 days Spindle RUL

CNC_S7_84 1/3
Direct | Email | Union
Utilization
58% Assist OEE | 522 days Spindle RUL

Machine	Operator	Work Order ID	Job ID	Job Performance	Job Progress		Output		Rejection	Time (mins)				Job Status	End Customer
					Start Time	End Time	Planned	Actual		Setup	Pred	Downtime	Idle		
CNC_S7_81	Operator 1	WO0405200001	4168	58%	10:30 AM		55	41	0	80	215	0	45	In Progress	i
CNC_S7_81	Operator 1	WO0405200001	4168	58%	10:30 AM		55	41	0	80	215	0	45	In Progress	i

3D View | 1 | 32 | 12 | 12:30 | Search...

Status: Stopped | Workplace: Workplace Type | Component: 194724_27462-100-A3

Availability
Performance
Quality
OEE
Monitor

	Maximum: 42.23%	Maximum: 400.00v	Maximum: 99.21%	Maximum: 99.21%
	Minimum: 0.00%	Minimum: 0.00v	Minimum: 24.53%	Minimum: 24.53%
	Current: 0.0%	Average: 200.00v	Average: 62.35%	Average: 62.35%

Availability | Performance | Quality | OEE

iii. LoRaWAN based Solution

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

iv. 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 life time of various Machines used in production process.
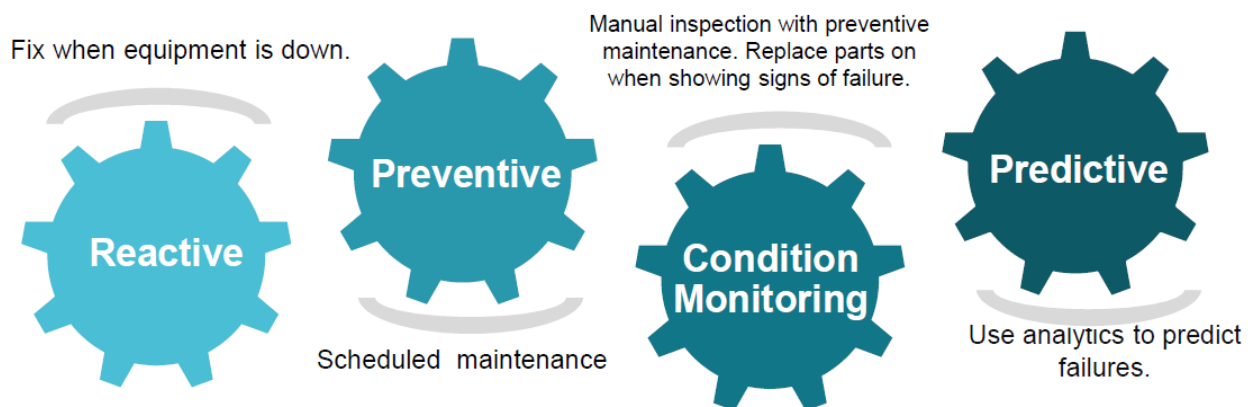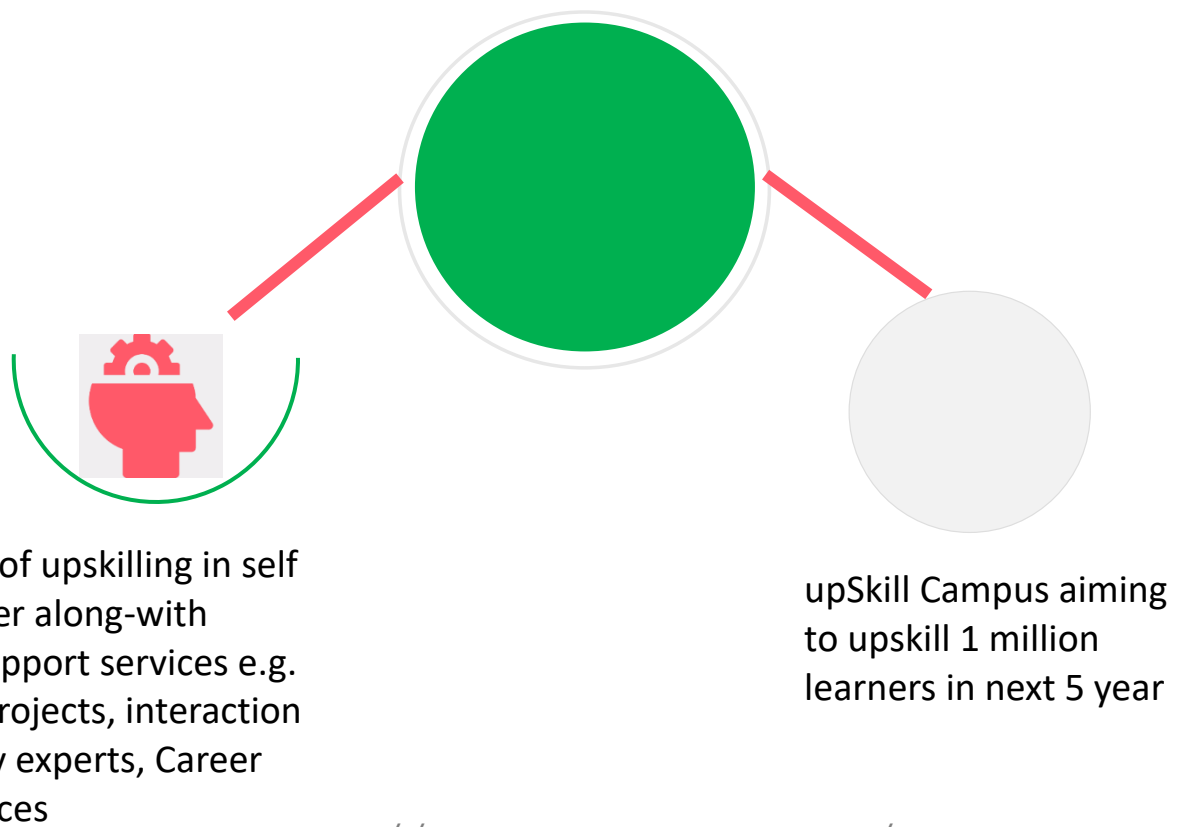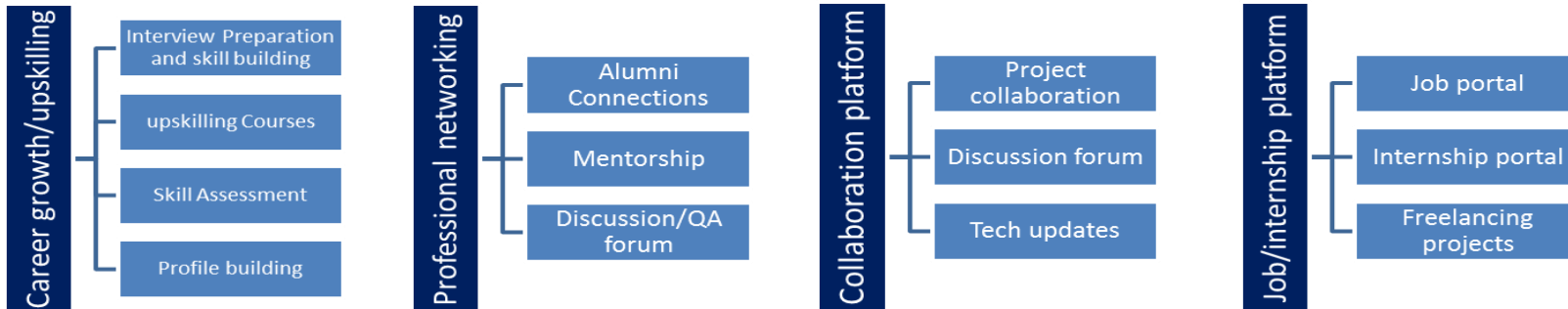
2.2 About upskill Campus (USC)

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.

Seeing need of upskilling in self paced manner along-with additional support services e.g. Internship, projects, interaction with Industry experts, Career growth Services

upSkill Campus aiming to upskill 1 million learners in next 5 year

https://www.upskillcampus.com/

Career growth/upskilling	Professional networking	Collaboration platform	Job/internship platform
Interview Preparation and skill building	Alumni Connections	Project collaboration	Job portal
upskilling Courses	Mentorship	Discussion forum	Internship portal
Skill Assessment	Discussion/QA forum	Tech updates	Freelancing projects
Profile building			

2.3 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.

2.4 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

The problem that was assigned to me was that I have to design a solution for measuring temperature and humidity of some place on a regular interval of time and monitoring that data over the internet.
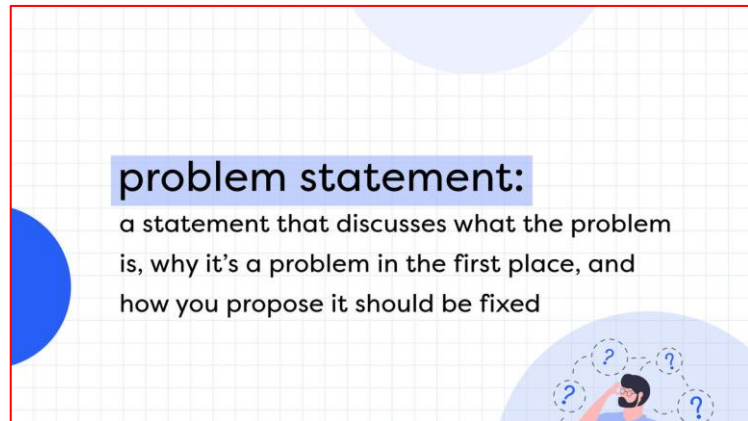
So, in a nutshell:

Aim. Design and implement a model to measure and monitor temperature and humidity of any locality like mall, school, public place, etc. Also, connect it to the internet, so that readings can be monitored over the cloud.

4 Existing and Proposed solution

There are several existing solutions available for monitoring temperature and humidity measurements in various applications. Here are a few commonly used solutions:

1. Wireless Sensor Networks (WSNs): WSNs consist of multiple sensor nodes that can measure temperature and humidity. These nodes communicate wirelessly and transmit data to a central gateway or server for monitoring and analysis. WSNs are often used in large-scale deployments, such as smart buildings, warehouses, or agricultural environments.

2. Data Loggers: Data loggers are standalone devices that can measure and record temperature and humidity over time. They are commonly used in environments where continuous monitoring is required, such as laboratories, cold storage facilities, or transportation of sensitive goods. Data loggers store the collected data internally and can be retrieved later for analysis.

3. Smart Thermostats: Smart thermostats are widely used for monitoring and controlling temperature and humidity in residential and commercial buildings. These devices typically integrate temperature and humidity sensors and provide real-time monitoring and control capabilities through mobile apps or web interfaces.

4. Industrial Automation Systems: In industrial settings, monitoring temperature and humidity is crucial for process control and equipment maintenance. Industrial automation systems often include sensors, data acquisition modules, and supervisory control and data acquisition (SCADA) software to monitor and manage these parameters.

5. Environmental Monitoring Systems: Environmental monitoring systems are designed to measure temperature and humidity in outdoor or environmental settings. These systems are commonly used in weather stations, agriculture, or environmental research. They may include weather sensors, data loggers, and networked infrastructure for data collection and analysis.

It's important to consider factors such as the specific requirements of your application, scalability, data storage and analysis needs, connectivity options, and budget when choosing a monitoring solution for temperature and humidity measurements. Additionally, assessing the accuracy, reliability, and compatibility with existing infrastructure are also critical considerations.

My proposed solution:

IoT-based Monitoring Systems:

Internet of Things (IoT) platforms provide solutions for monitoring temperature and humidity. These systems typically involve sensor nodes that connect to the internet and transmit data to a cloud-based platform. Users can access the data remotely through web or mobile applications, enabling real-time monitoring and data analysis.

Value addition by my contribution:

1. Real-time monitoring: IoT-based systems enable real-time monitoring of temperature and humidity levels. This provides immediate visibility into any deviations from desired conditions, allowing prompt action to be taken to prevent damage or ensure optimal conditions.

2. Remote accessibility: With IoT, temperature and humidity data can be accessed remotely through web or mobile applications. This allows users to monitor conditions from anywhere, enabling timely decision-making and the ability to respond to issues even when not physically present.

3. Alerts and notifications: IoT systems can send alerts and notifications when temperature or humidity levels exceed predefined thresholds. This helps to ensure proactive response

and minimizes the risk of equipment failure, product spoilage, or other potential consequences.

4. Historical data analysis: IoT-based solutions often store historical data, which can be analyzed to identify patterns, trends, and correlations. This data analysis can provide insights into environmental conditions, enabling optimization, predictive maintenance, and energy efficiency improvements.

5. Integration with other systems: IoT systems can integrate with other systems, such as HVAC (Heating, Ventilation, and Air Conditioning), building automation, or predictive maintenance systems. This integration allows for more comprehensive control and automation based on temperature and humidity data.

6. Scalability and flexibility: IoT-based solutions can be easily scaled to accommodate various environments and sizes. Additional sensors can be added or existing sensors can be relocated as needed, providing flexibility to adapt to changing monitoring requirements.

7. Reduced costs and resource optimization: IoT-based systems can lead to cost savings and resource optimization. By actively monitoring and controlling temperature and humidity, energy consumption can be optimized, leading to reduced utility costs. Additionally, predictive maintenance based on data analysis can help prevent equipment failures and reduce downtime.

8. Compliance and regulatory requirements: In certain industries, maintaining specific temperature and humidity conditions is critical to comply with regulations and industry standards. IoT-based systems provide accurate and verifiable data to demonstrate compliance, ensuring adherence to required conditions.

9. Data-driven decision-making: By leveraging the data collected from IoT systems, organizations can make data-driven decisions regarding process optimization, equipment maintenance, and resource allocation. This can lead to increased operational efficiency and improved business outcomes.

10. Environmental monitoring and research: IoT-based temperature and humidity monitoring systems contribute to environmental monitoring and research efforts. Data collected from

widespread deployments can help identify climate patterns, study microclimates, and support environmental research initiatives.

These are some of the values that IoT-based temperature and humidity monitoring systems can provide. The specific benefits and value proposition may vary depending on the application, industry, and organizational requirements.

4.2   Report and Code submission on GitHub:

GitHub is a web-based platform that provides hosting for version control repositories. It is primarily used for managing and collaborating on software development projects. Here are the key aspects and features of GitHub:

- Version control
- Code hosting and collaboration
- Public and private repositories
- Pull requests and code review
- Issue tracking and project management
- Documentation and wikis
- Integration with other tools
- Community and open-source collaboration
- Explore and discover projects
- Extensibility and APIs: GitHub offers APIs that allow developers to extend its functionality and integrate with external tools or services. This allows the development of custom workflows, automation, and integrations with other platforms.

GitHub is widely used in the software development community, serving as a collaborative and version control platform for projects of all sizes, ranging from individual hobby projects to large-scale enterprise applications.
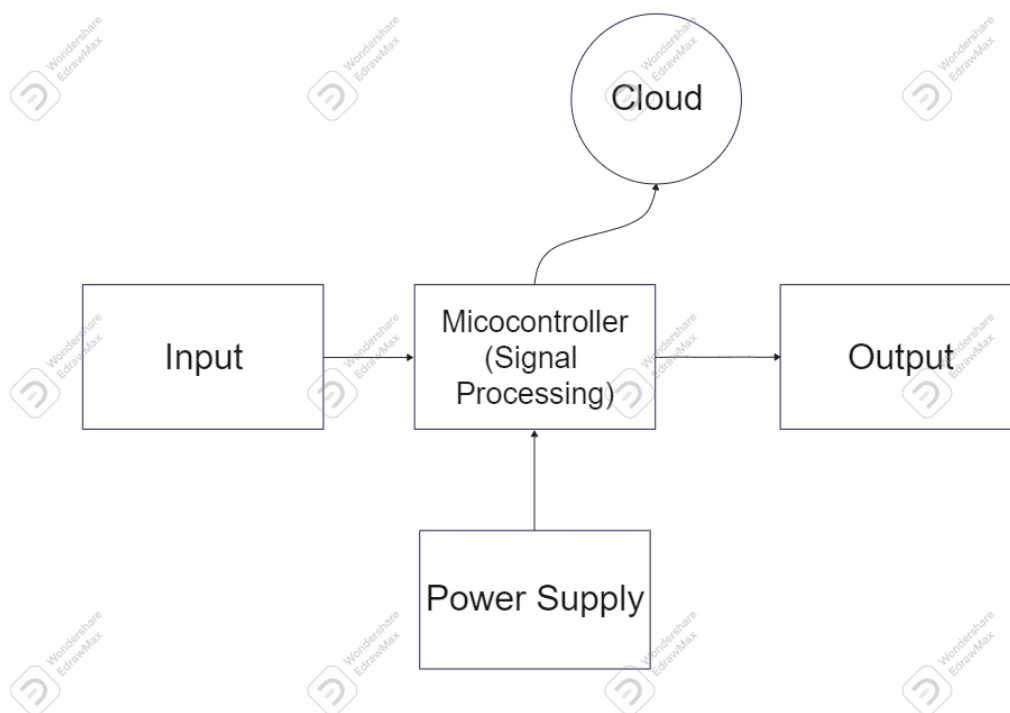
Click here or on image.

5 Proposed Design/ Model

Given more details about design flow of your solution. This is applicable for all domains. DS/ML Students can cover it after they have their algorithm implementation. There is always a start, intermediate stages and then final outcome.

5.1 High Level Diagram

HIGH LEVEL DIAGRAM OF THE SYSTEM

5.2 Interfaces

Interface on Smart Phone:

Blynk provides a user-friendly smartphone interface through its mobile app, available for both iOS and Android platforms. The Blynk app allows users to control and monitor their IoT devices remotely. Here are some key features of the Blynk smartphone interface:

1. Widget-Based Interface: The Blynk app uses a widget-based approach, where users can add and customize various widgets on the app's interface. Widgets are visual elements that represent different functionalities or data points of the IoT devices. Blynk provides a wide range of pre-built widgets such as buttons, sliders, graphs, gauges, LEDs, LCD displays, and more.

2. Drag-and-Drop Customization: Users can easily customize the app interface by dragging and dropping widgets onto the screen. This allows for a highly intuitive and flexible layout design.

3. Real-Time Data Monitoring: Blynk provides real-time data visualization capabilities, allowing users to monitor sensor readings, device statuses, and other data points in real-time. Widgets such as graphs, gauges, and LCD displays can be configured to display and update data dynamically.

4. Device Control: Users can control their IoT devices remotely through the Blynk app. For example, buttons can be used to trigger actions, sliders can adjust values, and switches can turn devices on or off. These control widgets can be customized to send specific commands or data to the IoT devices.

5. Event and Notification Management: Blynk allows users to set up events and notifications based on certain conditions or thresholds. Users can define rules and triggers, and the app
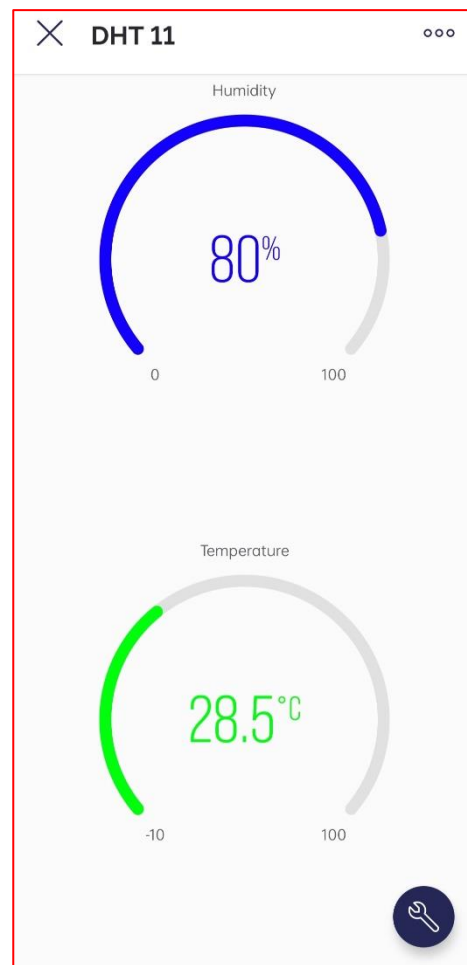
can send notifications (such as push notifications or email alerts) when those conditions are met.

6. Virtual Pins: Blynk introduces the concept of virtual pins, which are virtual data channels that enable communication between the app and the IoT devices. Virtual pins can be linked to specific widgets and used to send and receive data. This allows for flexible and scalable communication between the app and the devices.

7. Project Sharing: Blynk supports project sharing, enabling users to share their app configurations and setups with others. This can be useful for collaboration, demonstrations, or sharing IoT solutions with a wider audience.

The Blynk smartphone interface provides a user-friendly and customizable experience, allowing users to interact with their IoT devices effortlessly from their mobile devices.

Web Interface on BLYNK:
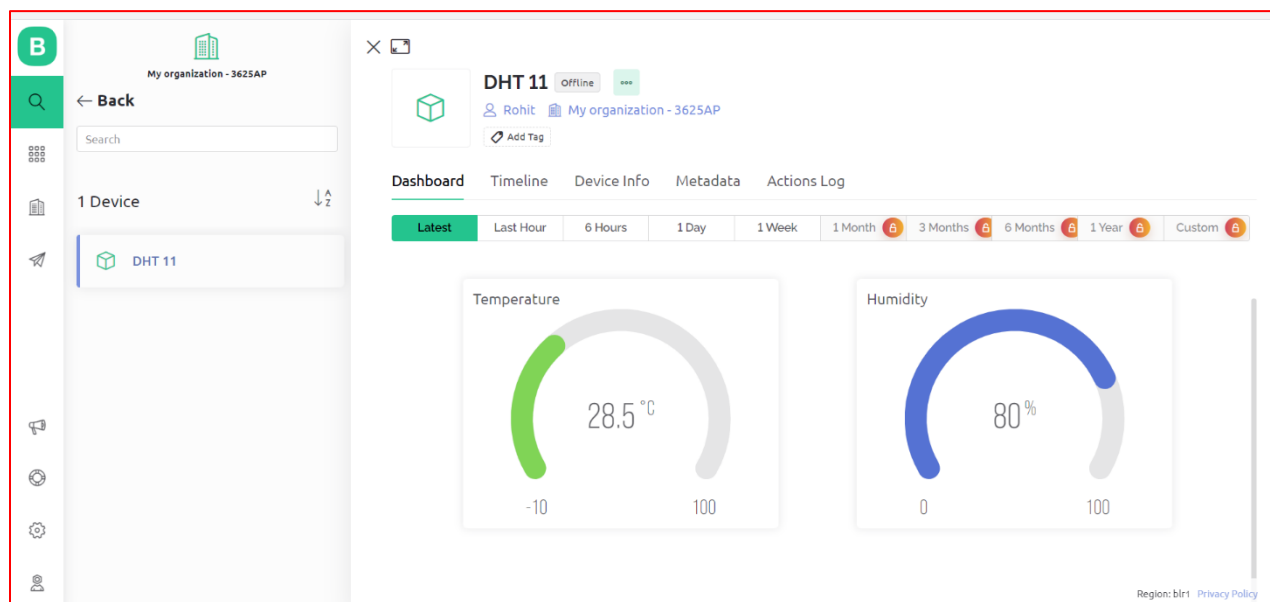
Blynk has also introduced a web interface that allows users to access and control their IoT devices from a web browser on their desktop or laptop. Here are some key features of the Blynk web interface:

1. Dashboard View: The Blynk web interface provides a dashboard view that allows users to see an overview of their connected IoT devices and their associated widgets. The dashboard provides a visual representation of the devices and their current states.
2. Widget Customization: Users can customize and configure the widgets on the Blynk web interface. Similar to the mobile app, users can add, remove, and arrange various widgets such as buttons, sliders, graphs, gauges, and more.

3. Real-Time Data Monitoring: The web interface supports real-time data monitoring, allowing users to view sensor readings, device statuses, and other data points in real-time. Widgets can be set up to display and update data dynamically on the web interface.

4. Device Control: Users can remotely control their IoT devices through the Blynk web interface. The control widgets, such as buttons and sliders, can be used to trigger actions, adjust values, and turn devices on or off.

5. Project Management: The web interface provides project management capabilities, allowing users to create, edit, and manage their Blynk projects. Users can organize their devices, widgets, and configurations within the web interface.

6. Virtual Pins: Blynk's virtual pins concept is also applicable to the web interface. Users can utilize virtual pins to establish communication channels between the web interface and the IoT devices, enabling data exchange and control functionalities.

My own designed Web Interface:

To build the web server we'll use the ESPAsyncWebServer library that provides an easy way to build an asynchronous web server. Building an asynchronous web server has several advantages:

1. Handle more than one connection at the same time.

2. When you send the response, you are immediately ready to handle other connections while the server is taking care of sending the response in the background.

3. Simple template processing engine to handle templates.
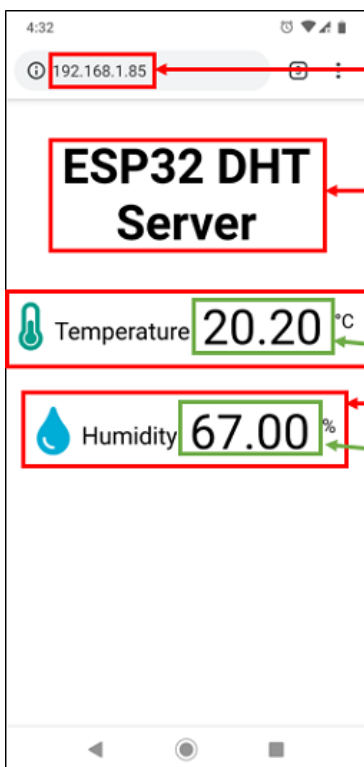
The web server I have build updates the readings automatically without the need to refresh the web page.

6 Performance Test

While IoT-based temperature and humidity monitoring systems offer numerous benefits, there are also some constraints and challenges that need to be considered during the implementation of such projects. Here are some common constraints:

1. Power limitations: IoT devices often operate on battery power or have limited power sources. This constraint can impact the frequency of data transmission, sensor capabilities, and the overall lifespan of the devices. Efficient power management strategies and the use of low-power IoT technologies can help mitigate this constraint.

2. Connectivity issues: IoT devices rely on network connectivity to transmit data. Remote or challenging environments may have limited network coverage or unstable connectivity, resulting in intermittent data transmission or delays. It's important to assess and address connectivity issues to ensure reliable data collection and transmission.

3. Data security and privacy: IoT systems involve the collection and transmission of sensitive data, such as temperature and humidity readings. Protecting this data from unauthorized access, cyber-attacks, and ensuring privacy can be a significant constraint. Implementing robust security measures, such as encryption, authentication, and secure data storage, is crucial to mitigate these risks.

4. Cost considerations: IoT systems encompass various components, including sensors, connectivity, gateways, and cloud infrastructure. The cost of these components and their maintenance can be a constraint, especially for large-scale deployments. Balancing the cost-effectiveness of the system while meeting the desired performance requirements is essential.

5. Scalability and interoperability: As the project expands or integrates with other systems, ensuring scalability and interoperability becomes crucial. Compatibility issues between different devices, protocols, and platforms can pose challenges. Adopting standardized

protocols and ensuring compatibility across devices and systems can help overcome these constraints.

6. Data volume and analytics: IoT systems generate a vast amount of data, including temperature and humidity readings. Processing and analyzing this data in real-time can be computationally intensive. It's important to have efficient data storage, processing, and analytics capabilities to extract meaningful insights and actionable information from the collected data.

7. Regulatory and compliance requirements: Depending on the application and industry, there may be specific regulations and compliance standards related to data collection, storage, and privacy. Complying with these requirements can be a constraint and must be considered during the project implementation.

8. Maintenance and support: IoT systems require regular maintenance, including firmware updates, sensor calibration, and device management. Ensuring proper maintenance and having a support mechanism in place to address any technical issues or failures is essential for the ongoing performance of the system.

By identifying and addressing these constraints early in the project planning phase, it is possible to design and implement a successful IoT-based temperature and humidity monitoring system that meets the desired objectives and delivers optimal performance.

How those constraints were taken care in your design?

What were test results around those constraints?

Constraints can be e.g. memory, MIPS (speed, operations per second), accuracy, durability, power consumption etc.

In case you could not test them, but still you should mention how identified constraints can impact your design, and what are recommendations to handle them.

6.1 Test Plan/ Test Cases

Here are some example test cases for an IoT-based temperature and humidity monitoring system:

1. Test case: Data Accuracy

    Description: Verify the accuracy of temperature and humidity measurements.

    Steps:

    - Place a calibrated temperature and humidity sensor in a controlled environment.
    - Compare the readings from the IoT system with the reference measurements.

    Expected Result: The readings from the IoT system should closely match the reference measurements   within an acceptable tolerance range.

2. Test case: Real-time Monitoring

    Description: Ensure that the system provides real-time monitoring of temperature and humidity levels.

    Steps:

    - Introduce a change in temperature or humidity in the monitored environment.
    - Observe the system dashboard or interface for the updated readings.

    Expected Result: The system should display the updated temperature and humidity readings in real-time, reflecting the changes in the environment.

3. Test case: Threshold Alerts
    Description: Test the system's ability to generate alerts when temperature or humidity exceeds predefined thresholds.

Steps:

- Set threshold values for temperature and humidity.
- Create conditions that exceed the defined thresholds.
- Monitor the system for generated alerts.

Expected Result: The system should generate timely alerts when temperature or humidity levels cross the predefined thresholds.

4. Test case: Remote Accessibility

   Description: Verify the ability to access temperature and humidity data remotely.

   Steps:

   - Access the system dashboard or mobile application from a remote location.
   - 2. Verify if the current temperature and humidity readings are displayed.

   Expected Result: The system should allow remote access, and the current temperature and humidity readings should be accessible from the remote location.

5. Test case: Scalability

   Description: Test the system's ability to handle multiple sensors and locations.

   Steps:

   - Add additional temperature and humidity sensors to the system.
   - Ensure that the system can handle the increased data load and display readings from all the sensors simultaneously.

   Expected Result: The system should be able to scale up and accommodate multiple sensors and locations without significant degradation in performance.

6. Test case: Data Analytics

Description: Validate the system's data analytics capabilities.

Steps:

- Collect a sufficient amount of temperature and humidity data.
- Perform analysis using the system's analytics features.
- Verify if the system generates insights, trends, or predictions based on the collected data.

Expected Result: The system should provide meaningful analytics, such as trends, patterns, and predictions, based on the collected temperature and humidity data.

These are just a few examples of test cases that can be executed to validate the performance and functionality of an IoT-based temperature and humidity monitoring system. The actual test cases may vary based on the specific requirements and features of the system being tested.
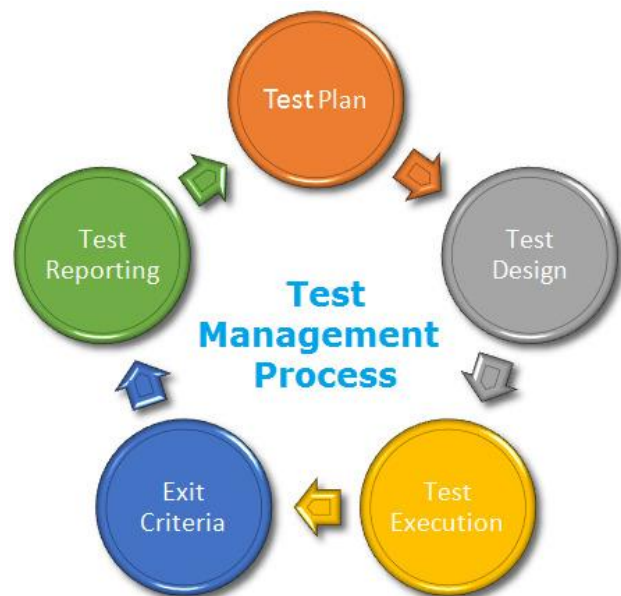
6.2 Test Procedure

Testing an IoT-based temperature and humidity monitoring system typically involves multiple stages and procedures to ensure thorough coverage of its functionality and performance. Here is a general testing procedure that can be followed:

1. Test Planning:

- Define the scope and objectives of testing.
- Identify the key features, functionalities, and performance metrics to be tested.
- Determine the testing approach (e.g., manual testing, automated testing, or a combination).
- Create a test plan outlining the testing strategy, test scenarios, and test cases.

2. Test Environment Setup:

- Set up the hardware and software environment required for testing.
- Install and configure the IoT devices, sensors, and gateways.
- Prepare the test environment with controlled temperature and humidity conditions (if possible).

3. Functional Testing:

- Execute test cases to verify the core functionality of the system.
- Test the ability to collect temperature and humidity data from sensors.
- Validate real-time monitoring and display of data on the system dashboard or interface.
- Verify the accuracy of temperature and humidity measurements against known references.
- Test the system's ability to generate alerts and notifications based on predefined thresholds.
- Ensure proper handling and display of sensor failures or connectivity issues.

4. Performance Testing:

- Assess the system's performance under different scenarios and load conditions.
- Test the system's response time for displaying real-time data.
- Evaluate the system's scalability by adding multiple sensors and monitoring larger areas.
- Measure the impact of increased data load on system performance.
- Validate the system's ability to handle concurrent user access.

5. Security and Privacy Testing:

- Test the system's data security measures, including encryption and authentication.
- Verify the secure transmission and storage of temperature and humidity data.
- Validate user access controls and permissions.
- Assess the system's vulnerability to common security threats and attacks.

6. Integration Testing:

- Integrate the IoT system with other relevant systems or devices (if applicable).
- Test the interoperability between the IoT system and external systems.
- Verify the seamless exchange of data and proper synchronization.

7. Usability Testing:

- Evaluate the user interface and user experience of the system.
- Assess the ease of use and navigation of the system dashboard or mobile application.
- Validate the clarity and effectiveness of system alerts and notifications.

8. Data Analytics Testing:

- Verify the accuracy of data analytics and insights generated by the system.
- Evaluate the system's ability to identify trends, patterns, or anomalies in the temperature and humidity data.

9. Test Reporting and Documentation:

- Document the test results, including any issues or defects encountered.
- Provide clear and detailed test reports with findings and recommendations.
- Maintain proper documentation of test cases, test data, and test environment setup.

It's important to note that the specific testing procedures may vary depending on the system requirements, project constraints, and industry standards. Regular communication with stakeholders, continuous monitoring, and iterative testing can help ensure the system's performance and reliability over time.

6.3   Performance Outcome

The performance outcome of an IoT-based temperature and humidity monitoring system can have several key impacts. Here are some potential performance outcomes:

1. Improved Accuracy: A well-implemented and properly calibrated IoT monitoring system can provide accurate and reliable temperature and humidity measurements. This ensures that the data collected is trustworthy and can be used for decision-making, process optimization, and compliance purposes.

2. Real-time Monitoring and Response: IoT systems enable real-time monitoring of temperature and humidity levels. This allows for immediate detection of deviations or abnormalities, enabling prompt response and intervention to prevent equipment failure, minimize damage, or mitigate risks associated with temperature and humidity fluctuations.

3. Enhanced Efficiency and Productivity: By providing continuous monitoring and automated data collection, an IoT-based system eliminates the need for manual data logging and reduces the chances of human errors. This leads to increased efficiency, improved productivity, and cost savings by optimizing resource allocation, energy consumption, and maintenance schedules.

4. Early Warning and Predictive Maintenance: IoT systems can generate alerts and notifications when temperature or humidity levels exceed predefined thresholds. This early warning capability allows for timely action, such as adjusting equipment settings or initiating maintenance procedures, to prevent potential issues, equipment downtime, or product spoilage. Additionally, advanced analytics and trend analysis can enable predictive maintenance, identifying potential equipment failures or degradation patterns based on historical data.

5. Remote Accessibility and Management: IoT systems provide remote accessibility to temperature and humidity data through web-based dashboards or mobile applications. This enables users to monitor and manage multiple locations or devices from anywhere,
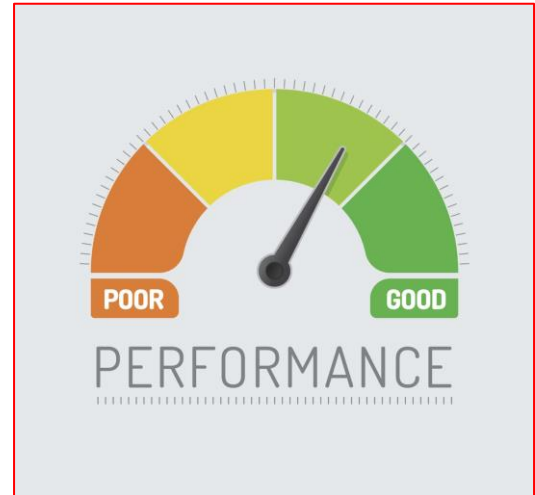
facilitating centralized control, efficient resource allocation, and proactive decision-making.

6. Data-driven Insights and Optimization: By collecting and analyzing large volumes of temperature and humidity data, IoT systems can provide valuable insights and optimization opportunities. Advanced analytics can identify trends, patterns, and correlations, helping businesses optimize processes, identify energy-saving opportunities, enhance product quality, and improve operational efficiency.

7. Regulatory Compliance: In industries where compliance with temperature and humidity regulations is essential, an IoT-based monitoring system can help ensure adherence to standards. By providing accurate and auditable data records, the system helps meet regulatory requirements and simplifies compliance reporting.
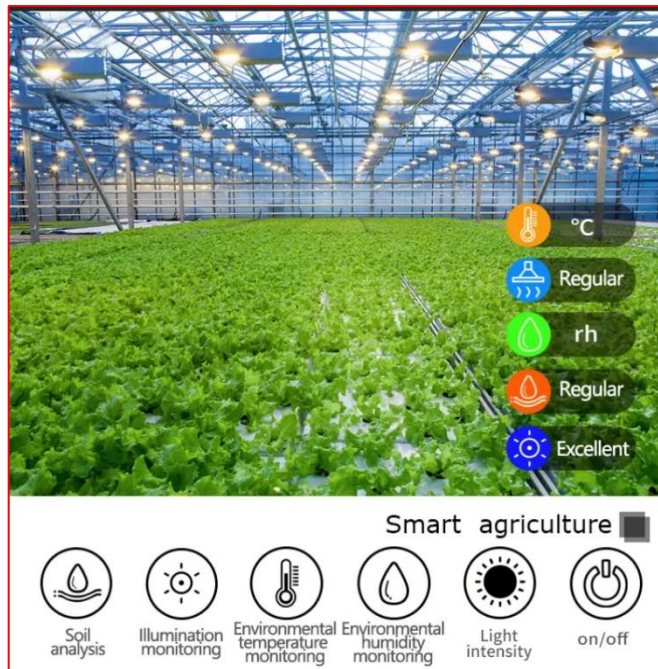
It's important to note that the actual performance outcome of an IoT-based temperature and humidity monitoring system can vary depending on various factors such as the quality of the implementation, the reliability of the sensors used, the effectiveness of data management and analytics, and the overall system architecture. Regular monitoring, maintenance, and continuous improvement efforts are necessary to maximize the performance and benefits of such systems.
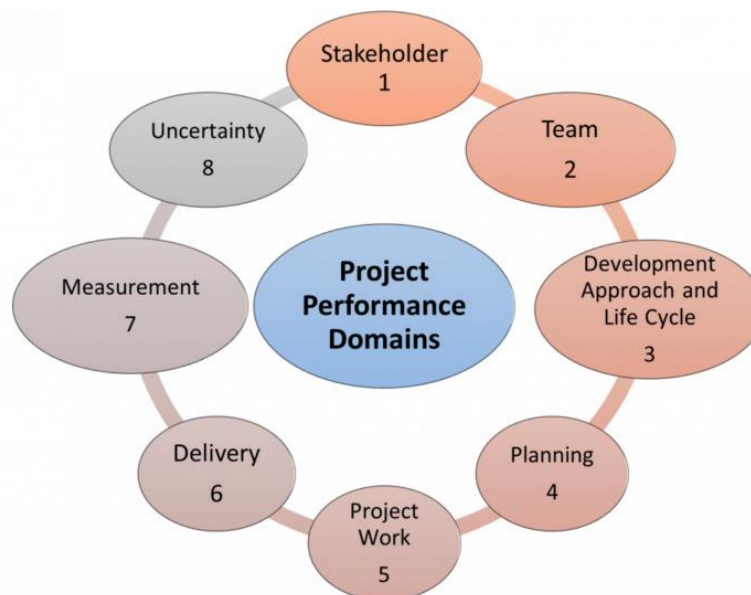
7 Applications of the project

An IoT-based temperature and humidity monitoring system finds applications in various industries and environments where precise environmental monitoring is crucial. Here are some application areas where such a system is commonly used:

1. Agriculture: In greenhouses, farms, and plantations, monitoring temperature and humidity is vital for optimal crop growth. IoT-based systems ensure the ideal environmental conditions for plants, allowing farmers to make data-driven decisions regarding irrigation, ventilation, and pest control.

2. Food Storage and Cold Chain: Temperature and humidity monitoring are critical in food storage facilities, warehouses, and during transportation in the cold chain. IoT systems enable real-time monitoring, ensuring that perishable goods are stored and transported within the required temperature and humidity ranges, preserving their quality and preventing spoilage.

3. Pharmaceutical and Healthcare: Temperature and humidity control are crucial in pharmaceutical manufacturing, storage, and transportation of drugs, vaccines, and medical devices. IoT monitoring systems help maintain compliance with regulatory requirements and prevent damage or degradation of sensitive healthcare products.

4. Laboratories: Research laboratories, scientific facilities, and cleanrooms often require precise temperature and humidity control. IoT-based systems provide continuous monitoring and alerting to ensure stability and optimal conditions for experiments, sample storage, and equipment performance.

5. Data Centers: Temperature and humidity monitoring is vital in data centers to prevent overheating and ensure the reliability of critical infrastructure. IoT systems enable real-time monitoring and proactive measures to optimize cooling efficiency and maintain the desired environmental conditions for servers and IT equipment.

6. HVAC Systems Optimization: IoT-based temperature and humidity monitoring can be integrated with heating, ventilation, and air conditioning (HVAC) systems to optimize energy consumption and indoor comfort. Real-time data analysis enables intelligent control and adjustments based on actual environmental conditions, leading to energy savings and improved occupant comfort.

7. Museums and Archives: Maintaining proper temperature and humidity levels is crucial for preserving artwork, historical artifacts, and delicate documents. IoT-based monitoring systems help ensure that these valuable items are stored in controlled environments, mitigating the risk of deterioration or damage due to unsuitable conditions.

8. Industrial Processes: In manufacturing facilities and industrial processes, monitoring temperature and humidity is essential for quality control and production efficiency. IoT systems provide insights into environmental conditions that may impact product quality, equipment performance, and worker safety, allowing for timely adjustments and preventive maintenance.
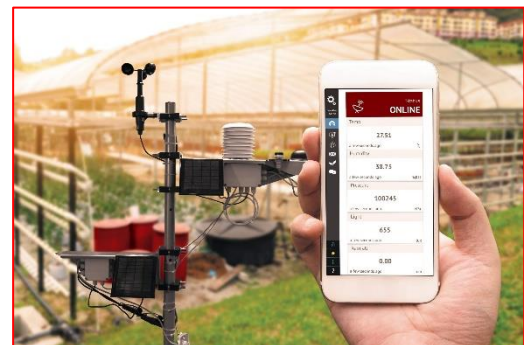

9. HVAC Maintenance and Energy Management: IoT-based monitoring systems can help optimize HVAC maintenance and energy management in commercial buildings. Continuous monitoring allows for predictive maintenance, identifying potential issues before they

become major problems. Additionally, data analysis helps identify energy consumption patterns and optimize HVAC systems for energy efficiency.

These are just a few examples of the wide range of applications for IoT-based temperature and humidity monitoring systems. The versatility and real-time capabilities of these systems make them valuable tools for maintaining optimal environmental conditions in various industries and
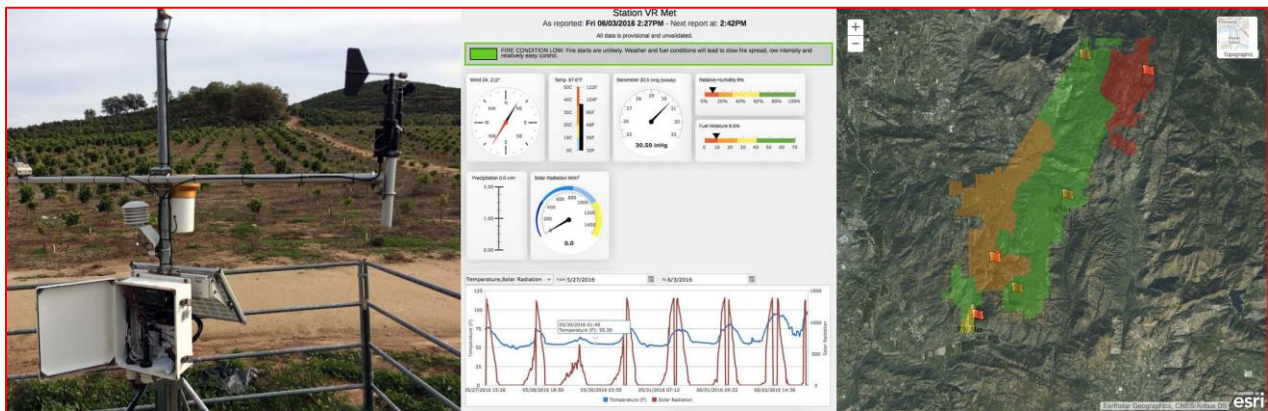
settings.

8 My learnings

During an internship in the field of IoT (Internet of Things), I have gained valuable knowledge and experience in various areas. Here are some of mine learnings:

1. Understanding of IoT concepts: You'll develop a strong foundation in the concepts and principles of IoT, including how devices, sensors, and actuators interact to form a connected ecosystem.

2. Hardware and software integration: You'll learn how to integrate hardware components, such as sensors and microcontrollers, with software platforms to create functional IoT systems. This includes programming languages like C, C++, Python, or JavaScript.

3. Prototyping and development: You'll gain hands-on experience in prototyping IoT devices using development boards like Arduino, Raspberry Pi, or other platforms. This involves designing circuits, assembling hardware components, and writing firmware.

4. Sensor and data management: You'll understand different types of sensors used in IoT applications and learn how to collect, process, and analyze data generated by these sensors. This may involve using platforms like MQTT or CoAP for data transmission and storage.

5. Connectivity and networking: You'll explore various communication protocols and network architectures used in IoT, such as Wi-Fi, Bluetooth, Zigbee, or LoRaWAN. You'll learn how to establish reliable connections between devices and enable seamless data transfer.

6. Security and privacy: You'll become aware of the security challenges associated with IoT deployments and learn best practices to secure IoT systems. This includes implementing authentication, encryption, and access control measures to protect data and devices.

7. Cloud platforms and analytics: You'll gain exposure to cloud-based IoT platforms like AWS IoT, Azure IoT, or Google Cloud IoT Core. You'll learn how to leverage these platforms for data storage, analytics, and real-time monitoring of IoT devices.

8. Industry-specific applications: Depending on your internship focus, you might work on specific IoT applications in areas such as healthcare, agriculture, smart cities, or industrial automation. This will give you insights into the unique challenges and opportunities within each domain.

9. Collaborative skills: You'll develop teamwork and collaboration skills by working with multidisciplinary teams comprising engineers, designers, and data scientists. You'll learn how to effectively communicate and coordinate efforts to deliver IoT projects.

10. Problem-solving and troubleshooting: You'll encounter various technical issues while working on IoT projects, which will help you develop problem-solving and troubleshooting skills. These experiences will enhance your ability to analyze and resolve challenges in real-world scenarios.

Remember that the specific learnings may vary depending on the internship program, organization, and project scope. However, by gaining knowledge in these key areas, I am sure that I will be better equipped to pursue a career in IoT and contribute to the growing field of connected technologies.
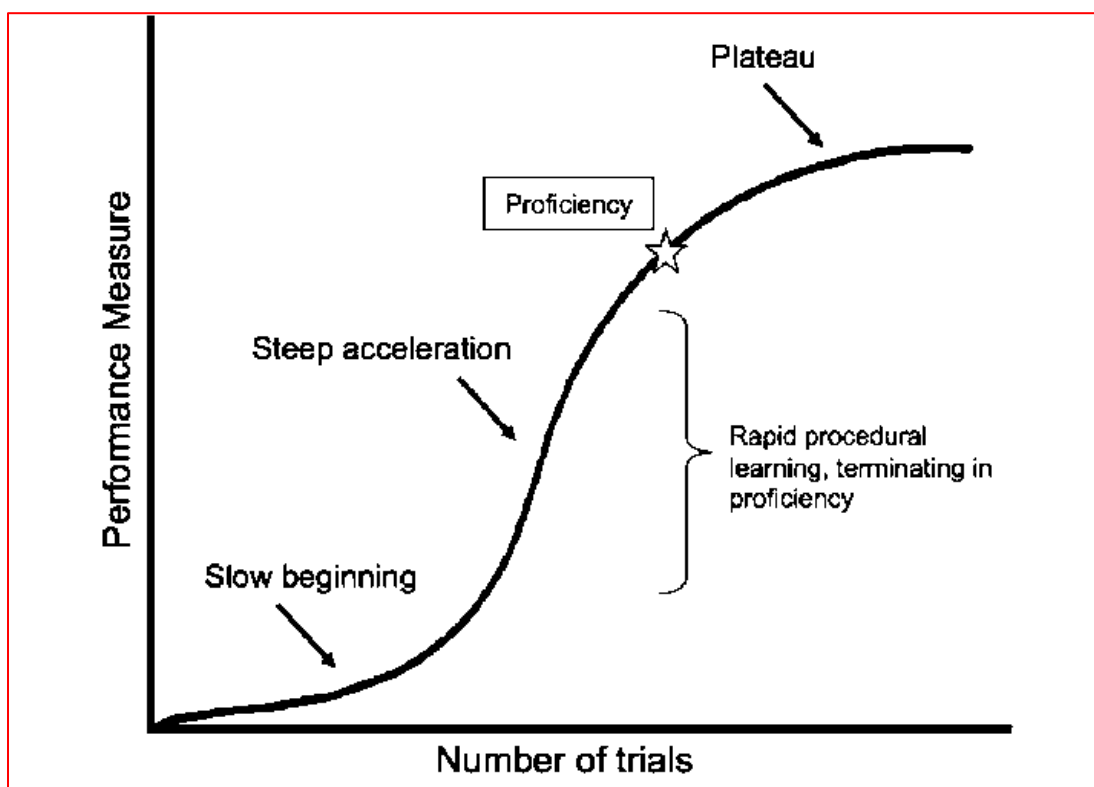
9 Future work scope

During this internship program, I tried to learn many devices and platform. I have successfully learnt Arduino, ESP32, Blynk, oled, mqtt, dht11 sensors, etc.

I have learnt how to make a web server using basic knowledge. I have tried to learn as many new things as possible. I also feel that there is a lot in the field of IOT. I have a lot more to explore.

In the future I want to learn about other IOT technologies like:

- LoRAWAN, other communication protocols
- NodeRed
- Other IOT platform like ThingSpeak
- I will also consider making my own IOT platform for the deployment of various devices.
- Other hardware like Raspberry Pi

10 Some pictures of the project
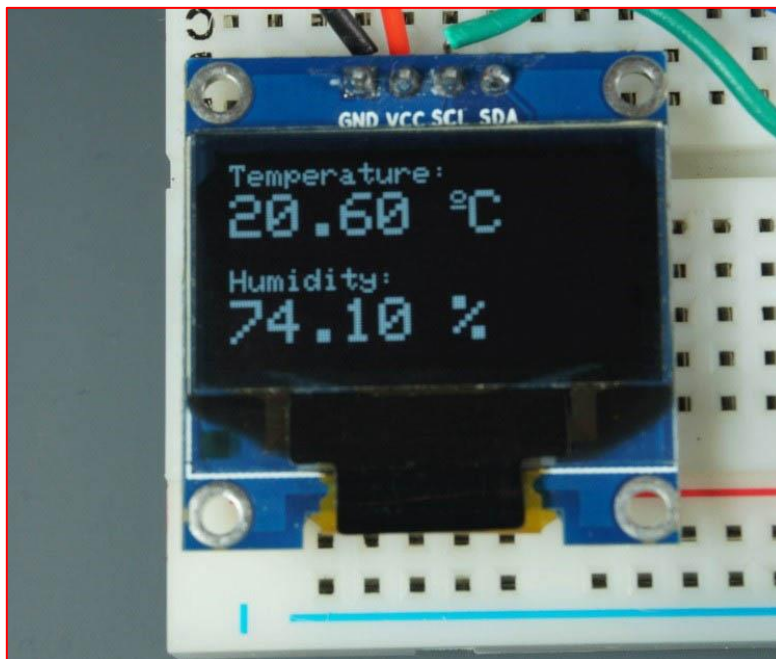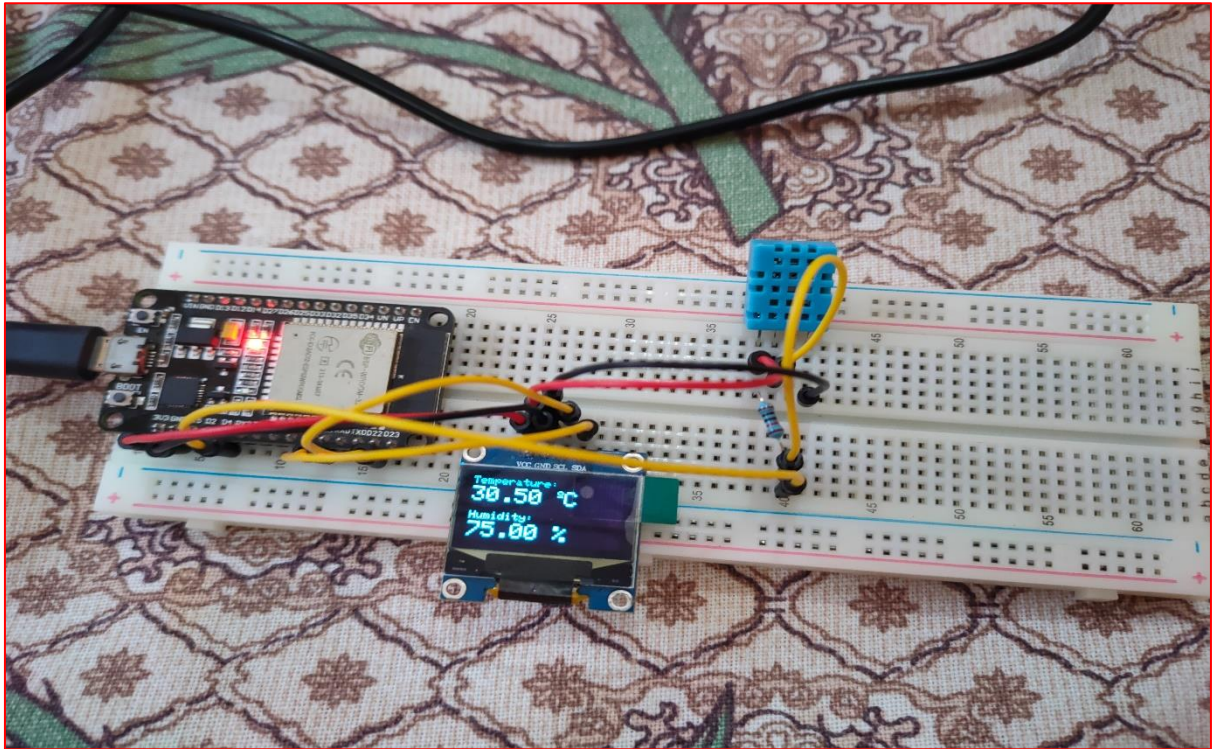
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