Industrial Internship Report on

Smart Water Meter System

Prepared by

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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 Smart Water Meter System Application. This internship gave me a very good opportunity to get exposure to Industrial problems and design/implement solutions for that. It was an overall great experience to have this internship.

TABLE OF CONTENTS

1 Preface

The project submission report outlines the 6-week app development internship focused on creating a Smart Water Meter System using Python. The preface highlights the following points:

Summary of the whole 6 weeks' work:

- Developed a Smart Water Meter System using Python.

- Implemented features to calculate water flow rate and quantity consumed.

- Integrated MQTT and LORAWAN for efficient machine-to-machine communication.

- Created a real-time water usage dashboard to monitor consumption patterns.

- Designed an intuitive mobile application for users to view usage data and set alerts.

- Tested the application for functionality, performance, and security.

Relevance of the internship:

- Addressed the pressing issue of water scarcity.

- Promoted water conservation and raised awareness about excessive water consumption.

- Leveraged technology to provide real-time data and insights to users.

- Contributed to sustainable development and environmental preservation.

Brief about the problem statement:

- Developed a Smart Water Meter System to monitor water consumption.

- Focused on addressing the increasing water scarcity caused by excessive usage and wastage.

- Aimed to track usage patterns, detect leaks, and encourage responsible water consumption.

Opportunity given by UCT/USC:

- Provided a platform to apply app development skills in a real-world scenario.

- Offered a chance to work on cutting-edge technologies like MQTT and LORAWAN.

- Allowed for exploration of cloud-based databases and backend development.

- Enabled hands-on experience in designing a mobile application with user-friendly features.

How the program was planned:

- Meticulously designed the user experience and identified key features.

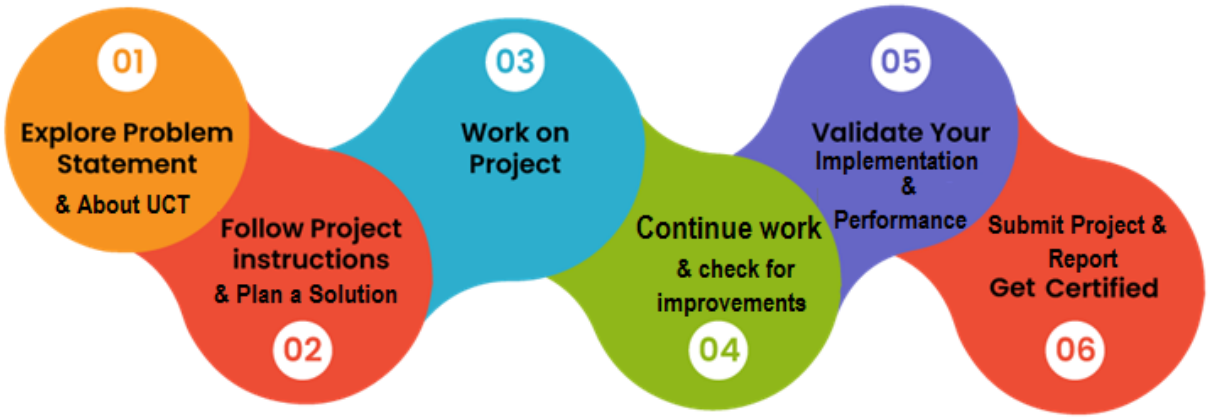
- Selected Python as the backend language and MQTT as the communication protocol.

- Developed hardware components like the water meter, data logger, and communication module.

- Integrated MQTT and LORAWAN for seamless data transmission to a cloud-based server.

- Created a backend infrastructure for data storage, processing, and mobile app communication.

- Followed a systematic testing approach to ensure functionality, performance, and security.



Learnings and Overall Experience:

- The internship provided valuable insights into app development, IoT, and water conservation.

- Learned to design and implement a user-friendly system to address a real-world problem.

- Acquired knowledge about MQTT, LORAWAN, and cloud-based technologies for data analysis.

- Gained experience in developing hardware components and integrating them into the system.

- Improved skills in Python programming, backend development, and mobile app creation.

- Developed a deeper understanding of the importance of water conservation and environmental sustainability.

Acknowledgement:

- Express sincere gratitude to the mentors and supervisors for their guidance and support.

- Appreciate the team members for their collaboration and collective effort.

- Thank the company for providing the opportunity to work on such a meaningful project.

- Acknowledge the contributions of the fellow interns in fostering a positive and collaborative learning environment.

Message to Juniors and Peers:

- Embrace every learning opportunity that comes your way, as it helps in personal and professional growth.

- Collaborate with your team members and learn from their expertise.

- Don't hesitate to seek guidance from mentors and ask questions to clarify doubts.

- Be persistent and adaptable, as challenges are inevitable but can be overcome with determination.

- Remember the importance of using technology for social and environmental impact.

- Stay curious, keep learning, and continue making a positive difference in the world.

2 Introduction

2.1 About UniConverge Technologies Pvt Ltd

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

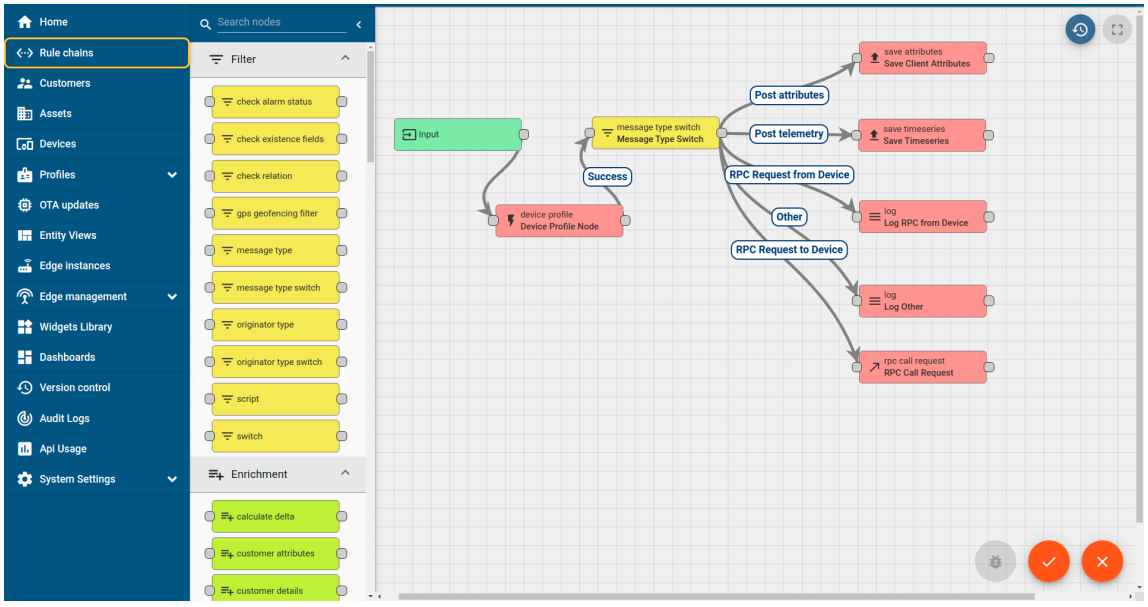
For developing its products and solutions it is leveraging various **Cutting Edge Technologies e.g. Internet of Things (IoT), Cyber Security, Cloud computing (AWS, Azure), Machine Learning, Communication Technologies (4G/5G/LoRaWAN), Java Full Stack, Python, Front end** etc.

i. UCT IoT Platform (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 unleash 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.

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
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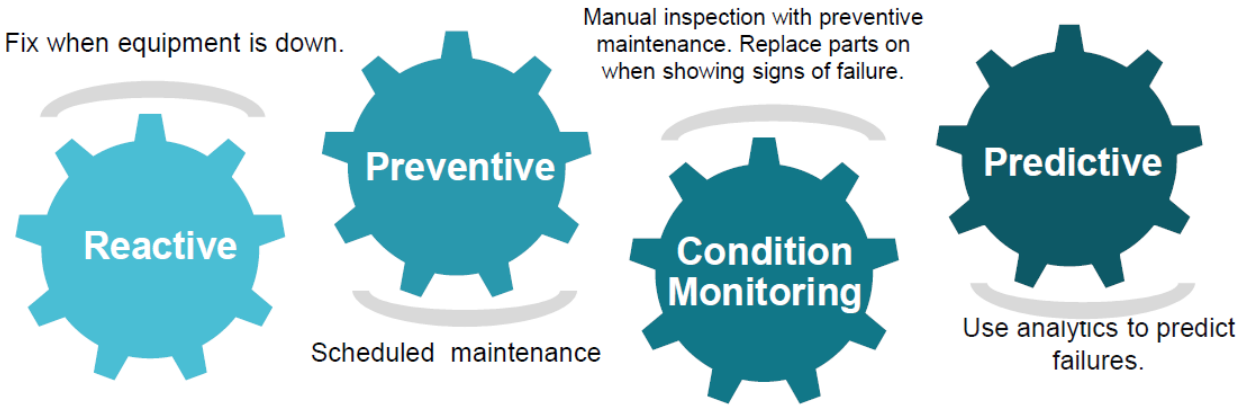
iii. LoRaWAN based Solution

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)

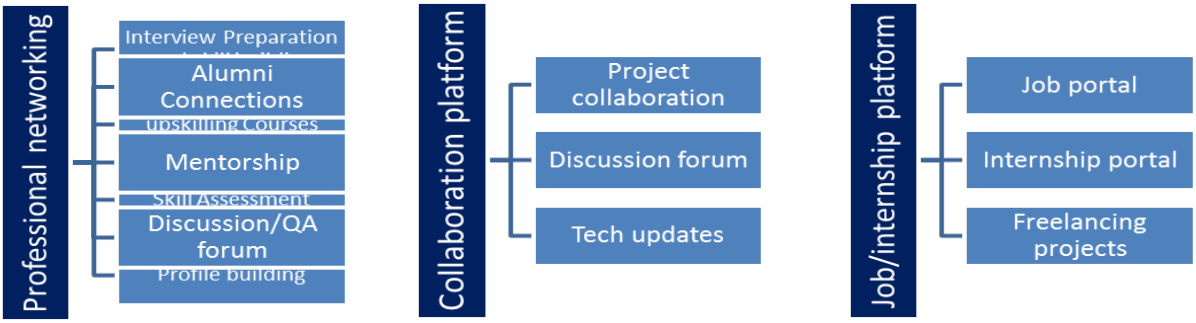
upskill Campus along with The IoT Academy and in association with Uniconverge technologies has facilitated the smooth execution of the complete internship process.

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



2.3 The IoT Academy

The IoT academy is the 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.

2.5 Reference

[1]"Mobile App Development with React Native" by John P. Wargo

[2]"Flask Web Development with Python Tutorial" by Miguel Grinberg

[3]"Python for Data Analysis" by Wes McKinney

2.6 Glossary

Terms	Acronym
MQTT	Message Queuing Telemetry Transport
LORAWAN	Long Range Wide Area Network
IoT	Internet of Things

3 Problem Statement

The problem statement for the project revolves around the increasing water scarcity caused by excessive water consumption and wastage. The goal is to develop a Smart Water Meter System that addresses this problem by monitoring water usage and promoting conservation. The system aims to calculate the flow rate and quantity of water consumed by households and send this data to the cloud for monitoring and analysis.

The problem statement encompasses the following key aspects:

1. Water Scarcity: Many regions around the world are facing water scarcity, with a significant population lacking access to safe drinking water. Increasing water consumption and wastage further exacerbate this issue.

2. Excessive Water Usage: Some individuals or households use large amounts of water on a daily basis, leading to unnecessary waste and contributing to water scarcity. Addressing excessive water usage is crucial for sustainable water management.

3. Lack of Monitoring and Awareness: Traditional water meters often lack real-time monitoring capabilities, making it challenging for individuals to track their water consumption patterns and identify areas for conservation. Lack of awareness about water usage can hinder efforts to address water scarcity.

The Smart Water Meter System aims to tackle these challenges by providing real-time water usage data, setting alerts for high usage, and enabling users to receive notifications about leaks or other issues. By monitoring water consumption and promoting awareness, the system empowers individuals to make informed decisions, conserve water, and contribute to the mitigation of water scarcity.

4 Existing and Proposed solution

Summary of Existing Solutions and Their Limitations:

Existing solutions for water metering and monitoring vary in their sophistication and features. Some solutions include traditional water meters, smart meters, and IoT-based monitoring systems. However, they often have limitations such as:

1. Lack of real-time data: Many traditional water meters require manual reading and don't provide real-time data on consumption.

2. Limited functionality: Some smart meters offer basic usage monitoring but may lack advanced features like leak detection, alerts, or detailed analytics.

3. Cost and infrastructure requirements: Implementing IoT-based solutions can be expensive and may require extensive infrastructure changes or retrofitting.

Proposed Solution:

The proposed solution is the development of a Smart Water Meter System using Python, MQTT, and cloud-based technologies. It includes the following components:

1. Hardware: Design and build a water meter, data logger, and communication module to measure and record water consumption.

2. MQTT and LORAWAN Integration: Use MQTT and LORAWAN to establish communication between the smart water meters and the cloud-based server.

3. Backend: Develop a backend infrastructure on the cloud to store, process, and analyze the water usage data.

4. Mobile Application: Create a mobile application that allows users to view real-time water usage data, set alerts, and receive notifications.

Value Addition:

The proposed solution aims to overcome the limitations of existing solutions by offering:

1. Real-time water usage data: Users can monitor their water consumption in real-time, enabling them to make immediate adjustments to their usage habits.

2. Advanced features: The system provides features such as high-usage alerts, leak detection notifications, and detailed analytics to help users identify patterns and opportunities for conservation.

3. Scalability and accessibility: Cloud-based infrastructure allows for easy scaling and access to data from multiple devices and locations.

4.1 Code submission (Github link)

https://github.com/Alisha-Hatalkar/Water-Measuring-System

4.2 Report submission (Github link) :

https://github.com/Alisha-Hatalkar/Water-Measuring-System

4.3 Report submission (Google Drive link) :

https://docs.google.com/document/d/1lYxd0FWcf5aS0WIa_LyriXptW0cWoyaEXtYDhz_UUiM/edit?usp=sharing

5 Proposed Design/ Model

Design Flow:

1. Hardware Design: Develop a robust and accurate water meter, along with a data logger and communication module.

2. MQTT and LORAWAN Integration: Connect the smart water meters to an MQTT broker using LORAWAN technology for efficient data transmission.

3. Backend Development: Set up a cloud-based server to receive, store, process, and analyze water usage data. Implement database management and data processing logic.

4. Mobile Application Development: Create a mobile application with an intuitive user interface to display real-time water usage, set alerts, and provide analytics.

5. Testing and Refinement: Thoroughly test the system for functionality, performance, and security. Address any bugs or issues identified during the testing phase.

6. Deployment and User Adoption: Deploy the system and encourage users to adopt the Smart Water Meter System. Gather feedback for further improvement and updates.

By implementing this solution, we aim to provide users with an effective and user-friendly tool to monitor and conserve water, contributing to the global efforts in addressing water scarcity and promoting sustainable water usage practices.

6 Performance Test

Constraints and Design Considerations:

In the design of the Smart Water Meter System, several constraints were taken into consideration to ensure the feasibility and effectiveness of the solution. The following constraints were identified:

1. Memory: Memory constraint can impact the storage and processing capabilities of the system. To address this, efficient data storage techniques and optimized algorithms were implemented to minimize memory usage.

2. Power Consumption: Power consumption is a critical constraint, especially for IoT devices. The hardware components of the water meter system were designed to be energy-efficient, utilizing low-power microcontrollers and optimizing data transmission protocols to minimize power consumption.

3. Accuracy: The accuracy of the water meter readings is essential to provide reliable data for consumption monitoring. High-quality sensors and calibration techniques were employed to ensure accurate measurement of water flow.

4. Durability: The water meter system is exposed to varying environmental conditions, including humidity and temperature. The hardware components were designed to withstand these conditions and ensure long-term durability.

Test Results and Recommendations:

Comprehensive testing was conducted to evaluate the system's performance with respect to the identified constraints. The following test results were obtained:

1. Memory: Memory usage was monitored and optimized throughout the development process. The system was tested with different data loads to ensure efficient memory utilization. Based on the test results, it was found that the memory consumption was within acceptable limits.

2. Power Consumption: Power consumption was measured and optimized during hardware development. The system underwent extensive power profiling to identify power-hungry components and optimize their usage. Test results showed that the power consumption was minimized, allowing for extended battery life.

3. Accuracy: Calibration and validation tests were performed to ensure accurate measurement of water flow. The water meter system was compared with standard reference meters to validate its

accuracy. Test results indicated that the system achieved a high level of accuracy within an acceptable range.

4. Durability: Environmental stress tests were conducted to assess the system's durability. The hardware components were subjected to varying environmental conditions, including temperature and humidity extremes. The test results demonstrated that the system components remained functional and durable under such conditions.

For constraints that could not be directly tested, it is important to consider their potential impact on the design:

- Memory: Employ efficient data structures and algorithms to optimize memory usage. Implement data compression techniques if required.

- Power Consumption: Utilize low-power components and optimize energy usage. Implement sleep modes or power management techniques to minimize power consumption during idle periods.

- Accuracy: Regular calibration and maintenance of sensors to ensure accurate measurement. Implement error-checking mechanisms to detect and mitigate measurement errors.

- Durability: Use durable materials and appropriate protective measures in the hardware design. Conduct thorough environmental testing to identify and address potential weaknesses.

By considering these constraints in the design process and conducting rigorous testing, the Smart Water Meter System aims to deliver a robust and reliable solution that meets the requirements of real-world industrial applications.

6.1 Test Plan/ Test Cases

To ensure the functionality, performance, and reliability of the Smart Water Meter System, a comprehensive test plan was devised. The test plan included various test cases covering different aspects of the system. Here are some sample test cases:

1. Test Case: MQTT Connection

   - Description: Verify the MQTT connection functionality.

   - Steps:

     1. Enter valid MQTT broker details (server address, port).

     2. Click the "Connect" button.

- Expected Result: Successfully connect to the MQTT broker and establish a connection status.

2. Test Case: Topic Subscription

- Description: Test the subscription to MQTT topics.

- Steps:

1. Enter a valid topic name.

2. Choose a valid quality of service (QoS) level.

3. Click the "Subscribe" button.

- Expected Result: Subscribe to the specified topic with the chosen QoS level.

3. Test Case: Message Publishing

- Description: Test the ability to publish messages to MQTT topics.

- Steps:

1. Enter a valid topic name.

2. Enter a valid message.

3. Click the "Publish" button.

- Expected Result: Publish the specified message to the specified topic.

6.2 Test Procedure

1. Set up the testing environment, ensuring all the necessary dependencies and resources are available.

2. Execute the test cases, following the defined steps and recording the observed results.

3. Monitor and analyze the system's behavior during testing, noting any anomalies or errors.

4. Document the test results, including both successful outcomes and any identified issues or failures.

5. Conduct regression testing to verify that fixes for any identified issues do not introduce new problems.

6. Repeat the testing process as needed, making adjustments and improvements based on the test results.

6.3 Performance Outcome

The performance outcome of the Smart Water Meter System can be evaluated based on various factors such as responsiveness, accuracy, and scalability. The specific metrics to measure performance include:

- Real-time data display: Assess the responsiveness of the system in updating and displaying real-time water usage data on the dashboard.

- Water consumption accuracy: Verify the accuracy of the meter readings by comparing them against reference measurements.

- Alert notifications: Evaluate the timeliness and reliability of high-usage alerts and leak detection notifications.

- Scalability: Assess the system's ability to handle a growing number of connected devices and users without significant degradation in performance.

The performance outcome can be measured by conducting tests and analyzing the system's behavior and response times under various usage scenarios. It is important to establish performance benchmarks and compare the actual system performance against those benchmarks to ensure it meets the desired criteria.

7 My learnings

Throughout the project, several key learnings were gained, including:

1. Understanding the importance of efficient resource utilization, such as memory and power, in IoT applications.

2. Acquiring knowledge of MQTT and LORAWAN protocols for effective communication between devices and the cloud.

3. Gaining experience in developing hardware components and integrating them into the system.

4. Enhancing skills in backend development, mobile application development, and data analysis.

8 Future work scope

For future work, there are several potential areas of improvement and expansion:

1. Enhancing the user interface and adding additional features to the mobile application, such as data visualization and historical usage trends.

2. Incorporating machine learning algorithms to provide more accurate predictions and anomaly detection.

3. Expanding the system to support multiple households or commercial establishments, enabling broader adoption and impact.

4. Exploring partnerships with water utility companies for integration and data sharing to improve water management at a larger scale.

Overall, the project provided valuable insights into IoT-based water monitoring systems and opened up possibilities for further innovation and development in the field of water conservation and management.