SMART WATER METER IMPLEMENTATION FOR ENHANCED UTILITY AND CONSERVATION

Minor project-II report submitted
in partial fulfillment of the requirement for award of the degree of

Bachelor of Technology
in
Computer Science & Engineering

By

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Under the guidance of
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DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
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VEL TECH RANGARAJAN DR. SAGUNTHALA R&D INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University Estd u/s 3 of UGC Act, 1956)
Accredited by NAAC with A++ Grade
CHENNAI 600 062, TAMILNADU, INDIA

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CERTIFICATE

It is certified that the work contained in the project report titled ”SMART WATER METER IMPLEMENTATION FOR ENHANCED UTILITY AND CONSERVATION” by ”GUDA MANIKANTA (21UECS0203), KOLLA REVANTH KUMAR (21UECS0296), Y.S.D.S.KRISHNA TARUN (21UECS0697)” has been carried out under my supervision and that this work has not been submitted elsewhere for a degree.

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Institute of Science & Technology
May, 2024

Signature of Professor In-charge
Computer Science & Engineering
School of Computing
Vel Tech Rangarajan Dr. Sagunthala R&D
Institute of Science & Technology
May, 2024

DECLARATION

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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APPROVAL SHEET

This project report entitled SMART WATER METER IMPLEMENTATION FOR ENHANCED UTILITY AND CONSERVATION by GUDA MANIKANTA (21UECS0203), KOLLA REVANTH KUMAR (21UECS0296), Y.S.D.S.KRISHNA TARUN (21UECS0697) is approved for the degree of B.Tech in Computer Science & Engineering.

Examiners **Supervisor**

Dr.R.Aruna M.Tech.,Ph.D.,

Date: / /

Place:

ACKNOWLEDGEMENT

We express our deepest gratitude to our respected **Founder Chancellor and President Col. Prof. Dr. R. RANGARAJAN B.E. (EEE), B.E. (MECH), M.S (AUTO),D.Sc., Foundress President Dr. R. SAGUNTHALA RANGARAJAN M.B.B.S.** Chairperson Managing Trustee and Vice President.

We are very much grateful to our beloved **Vice Chancellor Prof. S. SALIVAHANAN,** for providing us with an environment to complete our project successfully.

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ABSTRACT

In response to the growing concern over water scarcity and the need for sustainable water management practices, the idea proposes the development of a Smart Water Meter with Offsetting Integration. The aim to deploy smart water meters to revolutionize household water usage monitoring by providing real-time data insights and facilitating user engagement in water conservation efforts. The core component of the proposed system is a smart water meter designed to accurately track and record real-time water consumption within households. The innovative system will enable real-time tracking of household water usage, providing users with valuable insights into their consumption patterns. Additionally, the meter will be equipped with Offsetting Integration, allowing users to contribute directly to water conservation projects to offset their water footprint. By combining accurate monitoring with offsetting opportunities, the system seeks to empower users to take proactive measures towards water conservation. Leveraging IoT technology, the meter will seamlessly integrate with a web page, enabling users to monitor their water usage patterns conveniently from their smartphones. The web page has a dashboard of water consumed and will not only display comprehensive water consumption data but also offer personalized water-saving tips based on individual usage patterns. Through this integration, the project aims to revolutionize household water management, fostering a culture of responsible water usage and contributing to the preservation of water resources for future generations.

Keywords: Offsetting, revolutionize, proactive, comprahensive, leveraging, integrating, consumption, innovative

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

AI	Artificial intelligence
GDPR	General Data Protection Regulation
IDE	Integrated Development Environment
IoT	Internet ot Things
ICT	Information and Communications Technology
NGO	Non-governmental organization
ROI	Return On Investment
UAR	User Access Review
USB	Universal Serial Bus
WQM	Water Quality Monitoring
WSN	Wireless Sensor Network

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Chapter 1

INTRODUCTION

1.1 Introduction

Water scarcity is a global challenge exacerbated by population growth, urbanization, and climate change, highlighting the urgent need for sustainable water management solutions. Traditional water meters often lack the capabilities to provide real-time monitoring, hindering users' ability to track consumption accurately. To address this, the Smart Water Meter with Offsetting Integration offers a promising solution.

At its core, the Smart Water Meter accurately measures water flow within households, providing users with real-time data on their consumption patterns. This empowers users to make informed decisions about their water usage. However, what sets this meter apart is its integration of offsetting initiatives. Users can directly contribute to water conservation projects to offset their water footprint, actively engaging in sustainable practices.

The integration of IoT technology further enhances user experience. The meter seamlessly connects to a web page accessible via smartphones, allowing users to monitor usage patterns, receive alerts. The web page serves as a central hub, displaying comprehensive data and facilitating user interaction.

The user experience is enriched through dashboard insights, offering a clear overview of water consumed, usage trends, and historical data. This enables users to identify areas for improvement and optimize their water habits. Additionally, personalized water-saving tips based on individual usage further enhance the user experience, fostering a culture of responsible water usage.

The Smart Water Meter aims to create a lasting impact on water conservation. Users become active participants in conservation efforts, contributing to the preservation of this vital resource.

1.2 Aim of the project

The aim of the proposed project is to fundamentally transform household water management practices through the deployment of innovative smart water meters with Offsetting Integration. These smart meters are designed to revolutionize the way water consumption is monitored and managed within households by providing accurate, real-time data insights into usage patterns.

By accurately tracking and recording water consumption in real-time, the smart water meters offer users valuable insights into their individual consumption habits. This empowers users to make informed decisions about their water usage, identify areas where conservation efforts can be enhanced, and ultimately, reduce water waste.

Furthermore, the integration of offsetting opportunities directly within the smart water meters represents a proactive approach to water conservation. Users are given the ability to contribute directly to water conservation projects, effectively offsetting their own water footprint. This not only encourages individual accountability but also facilitates collective action towards safeguarding water resources for future generations.

1.3 Project Domain

The project operates within the domain of sustainable water management and conservation, addressing the urgent need to mitigate water scarcity and promote responsible usage practices at the household level. By deploying smart water meters with Offsetting Integration, the project seeks to revolutionize traditional household water management systems. These advanced meters are designed to accurately monitor and record real-time water consumption, providing users with invaluable insights into their usage patterns. The integration of offsetting opportunities represents a novel approach, enabling users to actively participate in water conservation efforts by contributing directly to relevant projects. Leveraging Internet of Things (IoT) technology, the system ensures seamless integration with user-friendly interfaces accessible via smartphones, thereby facilitating user engagement and empowerment. Ultimately, the project aims to foster a culture of awareness and responsibility surrounding water usage, contributing significantly to the preservation of precious water resources for the benefit of current and future generations.

1.4 Scope of the Project

The scope of the proposed project encompasses the development and deployment of smart water meters with Offsetting Integration to revolutionize household water management practices. The project will focus on creating smart meters capable of accurately tracking and recording real-time water consumption within households, offering users valuable insights into their usage patterns. The integration of offsetting opportunities will enable users to directly contribute to water conservation projects, effectively offsetting their water footprint and promoting environmental sustainability. Leveraging Internet of Things (IoT) technology, the system will aim to foster a culture of responsible water usage by providing users with convenient access to their consumption data and personalized conservation tips via smartphones and web platforms. The project's scope also includes the implementation of measures to ensure scalability and adaptability to various household settings, ultimately contributing to the preservation of water resources for future generations.

Chapter 2

LITERATURE REVIEW

[1]Manmeet Singh and Suhaib Ahmed,(2021) stated water is an all-important need of all living beings. With the exponential growth of the human population, the need for conservation of water resources is gaining greater importance. Many water management systems have been proposed in the past using different technologies to address the issue which are high in cost and energy consumption. With the advent of the Internet of Things (IoT), the pursuit of the smart water management system is gaining momentum. This study first discusses the architecture and various components of IoT based water management system in detail followed by in-depth survey of all existing IoT based water management systems. Various measurement parameters such as water level, pH level, turbidity, salinity, etc. used in different water management systems proposed in the literature have also been identified and a comparison of various systems based on these parameters has also been presented. Finally, based on the survey, list of various essential attributes of these systems are framed which must be incorporated in future designs. In addition to this, an architecture of a smart water management system based on IoT and Machine learning has also been proposed as future scope which addresses all these essential attributes and also uses machine learning based predictions which can increase the efficiency of the smart management system.
[2]Farmanullah Jan et al,(2021) summarized safe water is becoming a scarce resource, due to the combined effects of increased population, pollution, and climate changes. Water quality monitoring is thus paramount, especially for domestic water. Traditionally used laboratory-based testing approaches are manual, costly, time consuming, and lack real-time feedback. Recently developed systems utilizing wireless sensor network (WSN) technology have reported weaknesses in energy management, data security, and communication coverage. Due to the recent advances in Internet-of-Things (IoT) that can be applied in the development of more efficient, secure, and cheaper systems with real-time capabilities, we present here a survey aimed at summarizing the current state of the art regarding IoT based smart water quality monitoring systems (IoT-WQMS) especially dedicated

for domestic applications. In brief, this study probes into common water-quality monitoring (WQM) parameters, their safe-limits for drinking water, related smart sensors, critical review, and ratification of contemporary IoT-WQMS via a proposed empirical metric, analysis, and discussion and, finally, design recommendations for an efficient system. No doubt, this study will benefit the developing field of smart homes, offices, and cities

[3] Zhenjiang Yang et al,(2021) proposed few data are available regarding comprehensive or quantitative assessment of fish feed considering both the environmental and feeding impacts. Aiming to fill the gap, an experimental study to investigate the effects of three fish feeds on concentrations of nutrients and crucian carp (*Carassius carassius*) growth was conducted in laboratory aquariums in the presence and absence of prometryn. Results showed that weight gain rates of crucian carp treated with Tong Wei (TW) feed were 106.3% and 2.0% higher than that of Zhong Shan (ZS) and Zhong Liang (ZL) feeds, a possible explanation was that the quality of protein in TW feed was highest as evidenced by the protein efficiency ratios. Meanwhile, TW feed posed relatively lighter effects on water qualities (between ZL and ZS). Prometryn significantly inhibited the growth of crucian carp and thus affected concentrations of nutrients in water indirectly. The relationships between weight gain rates of fish and concentrations of nutrients in water ($R2$ = 0.929–0.990) were developed. In sum, this study suggested that it is realizable to obtain better fish growth performance with lesser degrading effects on water qualities by producing and selecting appropriate feed regardless of prometryn existence, and the developed equations could be used as a basis for future studies.

[4]A. Salamet ,(2020) described the goal of the water security IoT chapter is to present a comprehensive and integrated IoT based approach to environmental quality and monitoring by generating new knowledge and innovative approaches that focus on sustainable resource management. Mainly, this chapter focuses on IoT applications in wastewater and stormwater, and the human and environmental consequences of water contaminants and their treatment. The IoT applications using sensors for sewer and stormwater monitoring across networked landscapes, water quality assessment, treatment, and sustainable management are introduced. The studies of rate limitations in biophysical and geochemical processes that support the ecosystem services related to water quality are presented. The applications of IoT solutions based on these discoveries are also discussed.

[5]X. Y. Shen,et al,(2020) stated A hotel intelligent guidance system based on ZigBee technology was designed, which was mainly composed of a portable handheld module and a guidance module installed in guestroom corridor. Room guidance data stored in the guidance module are updated and transmitted by the ZigBee network. When users carrying the handheld module approach to guestroom corridor, ZigBee, with the stable function of ad hoc network, will connect the handheld module with the nearest automatic guidance module automatically, and show the location of guestroom in the guidance module, to realize the function of automatic sensing guidance, so as to guide users to locate their guestrooms. In addition, the guidance system is also able to indicate the direction of exit in the emergency case, to enhance the security of hotels. The device effectively enhances the customers' check-in experience and thus improving the competitiveness of hotels, so it has a good application prospect in the market.
[6]C Li, et al,(2019) proposed In the current scenario, around 35 billion Internet of Things (IoT) devices is connected to the internet. By 2025, it is predicted that the number will grow between 80 and 120 billion devices connected to the internet, supporting to generate 180 trillion gigabytes of new sensor data that year. The IoT sensor data is generated from various heterogeneous devices, communication protocols, and data formats that are enormous in nature. This huge amount of sensor data is unable to acquire and analyze manually. This is a significant problem for IoT application developers to make the integration of IoT sensor data automatically. However, the large amount of data has led to the inadequacy of the manual data acquisition and stressed the urgency into the research of IoT based frameworks in automatic.,(2019) proposed automatic reading for water meter is one of the practical demands in smart city applications. Due to the high cost, it is not feasible to replace the old mechanical water meter with a new embedded electronic device. Recently, image recognition based meter reading methods have become research hotspots. However, illumination, occlusion, energy and computational consuming in IoT environment bring challenges to these methods. In this paper, we design and implement a smart water meter reading system to handle this issue
[7]X J Li and P H J. Chong,(2019) described smart cities require interactive management of water supply networks and water meters play an important role in such a task. As compared to fully mechanical water meters, electromechanical water meters or fully electronic water meters can collect real-time information through automatic meter reading (AMR), which makes them more suitable for smart cities

applications. In this paper, we first study the design principles of existing water meters, and then present our design and implementation of a self-powered smart water meter. The proposed water meter is based on a water turbine generator, which serves for two purposes to sense the water flow through adaptive signal processing performed on the generated voltage and, to produce electricity to charge batteries for the smart meter to function properly. In particular, we present the design considerations and implementation details. The wireless transceiver is integrated in the proposed water meter so that it can provide real-time water flow information. In addition, a mobile phone application is designed to provide a user with a convenient tool for water usage monitoring.

[8]Li,et al,(2019) proposed throughout the past years, governments, industries, and researchers have shown increasing interest in incorporating smart techniques, including sensor monitoring, real-time data transmitting, and real-time controlling into water systems. However, the design and construction of such a smart water system are still not quite standardized for massive applications due to the lack of consensus on the framework. The major challenge impeding wide application of the smart water network is the unavailability of a systematic framework to guide real-world design and deployment. To address this challenge, this review study aims to facilitate more extensive adoption of the smart water system, to increase effectiveness and efficiency in real-world water system contexts. A total of 32 literature pieces including 1 international forum, 17 peer-reviewed papers, 10 reports, and 4 presentations that are directly related to frameworks of smart water system have been reviewed. A new and comprehensive smart water framework, including definition and architecture, was proposed in this review paper. Two conceptual metrics (smartness and cyber wellness) were defined to evaluate the performance of smart water systems. Additionally, three pieces of future research suggestions were discussed, calling for broader collaboration in the community of researchers, engineers, and industrial and governmental sectors to promote smart water system applications

[9]S. Balakrishna,et al,(2019) proposed in the current scenario, around 35 billion Internet of Things (IoT) devices is connected to the internet. By 2025, it is predicted that the number will grow between 80 and 120 billion devices connected to the internet, supporting to generate 180 trillion gigabytes of new sensor data that year. The IoT sensor data is generated from various heterogeneous devices, communication protocols, and data formats that are enormous in nature. This huge

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[10]M. V. Ramesh,et al,(2017) stated Water distribution systems are one of the critical infrastructures and major assets of the water utility in a nation. The infrastructure of the distribution systems consists of resources, treatment plants, reservoirs, distribution lines, and consumers. A sustainable water distribution network management has to take care of accessibility, quality, quantity, and reliability of water. As water is becoming a depleting resource for the coming decades, the regulation and accounting of the water in terms of the above four parameters is a critical task. There have been many efforts towards the establishment of a monitoring and controlling framework, capable of automating various stages of the water distribution processes. The current trending technologies such as Information and Communication Technologies (ICT), Internet of Things (IoT), and Artificial Intelligence (AI) have the potential to track this spatially varying network to collect, process, and analyze the water distribution network attributes and events. In this work, we investigate the role and scope of the IoT technologies in different stages of the water distribution systems. Our survey covers the state-of-the-art monitoring and control systems for the water distribution networks, and the status of IoT architectures for water distribution networks. We explore the existing water distribution systems, providing the necessary background information on the current status. This work also presents an IoT Architecture for Intelligent Water Networks - IoTA4IWNet, for real-time monitoring and control of water distribution networks. We believe that to build a robust water distribution network, these components need to be designed and implemented effectively.

Chapter 3

PROJECT DESCRIPTION

3.1 Existing System

Traditionally, water usage was tracked with mechanical meters. These devices housed internal mechanisms, like turbines or gears, that translated water flow into rotations on a physical dial. Meter readers, the backbone of this system, would visit properties periodically to record the current dial reading and subtract the previous one to determine water usage for billing. This reliance on human labor made the system expensive and time-consuming, especially for geographically spread out meters.

Furthermore, the data collected was limited. It only provided a total consumption reading at a specific point in time, offering no insights into water usage patterns. This lack of detail made it difficult to identify leaks or pinpoint times of high water consumption. Additionally, human error during meter reading and data recording could lead to inaccurate billing. These inefficiencies highlighted the need for a more advanced and automated system to monitor water usage effectively.

3.2 Proposed System

The proposed system, a Smart Water Meter with Offsetting Integration, represents a significant advancement in household water management. At its core is a smart water meter designed to accurately track and record real-time water consumption within households. This meter employs cutting-edge Internet of Things (IoT) technology, enabling seamless integration with a user-friendly web page accessible via smartphones.

The system's primary function is to provide users with real-time insights into their water consumption patterns, empowering them to make informed decisions about their usage. By displaying comprehensive data on water consumption, users can identify areas where they can reduce waste and optimize their usage habits.

One of the most innovative features of the system is its Offsetting Integration capability. This functionality allows users to directly contribute to water conservation projects to offset their water footprint. By participating in these projects, users can take proactive steps towards mitigating the environmental impact of their water usage.

The web page interface not only presents users with detailed consumption data but also offers personalized water-saving tips based on individual usage patterns. This personalized guidance enhances user engagement and encourages the adoption of more sustainable water management practices.

Overall, the proposed system aims to revolutionize household water management by promoting responsible usage and contributing to the preservation of water resources for future generations. Through the combination of accurate monitoring, offsetting opportunities, and personalized guidance, this system represents a significant step towards sustainable water conservation.

3.3 Feasibility Study

3.3.1 Economic Feasibility

The economic feasibility study for the Smart Water Meter system is a comprehensive analysis that balances costs and benefits to ascertain its viability. The initial investment encompasses research, development, and deployment expenses, while ongoing operational costs include maintenance and integration with existing infrastructure. Conversely, potential benefits range from water savings and reduced bills to positive environmental impacts.By quantifying the anticipated water savings and assessing the economic outcomes of integrating offsetting initiatives, the study determines the system's return on investment (ROI) and scalability potential. Moreover, environmental benefits, such as mitigated water stress and energy conservation, are factored into the analysis, further enhancing the system's appeal.Risk assessment plays a critical role in identifying and mitigating potential technical, regulatory, and market risks, thereby ensuring the project's resilience and success. Additionally, sensitivity analysis tests the economic model under various scenarios, providing insights into the system's adaptability and robustness.Ultimately, the primary objective of the study is to demonstrate that the benefits derived from the Smart Water Meter system outweigh its costs.

3.3.2 Technical Feasibility

The technical feasibility of the Smart Water Meter with Offsetting Integration is critical for its effective deployment. The design and hardware of the meter must prioritize accurate water flow measurement, necessitating the selection of suitable sensors like ultrasonic or electromagnetic variants. Integration with existing water supply infrastructure, particularly retrofitting for mechanical meters, is essential for seamless implementation.Data communication and IoT integration are pivotal for real-time monitoring. Establishing reliable communication between the smart meter and a central system using IoT protocols ensures efficient data transmission, even in challenging environments. Moreover, robust security measures, including encryption and authentication protocols, must be implemented to protect user data and comply with privacy regulations like GDPR.Web page development plays a vital role in user engagement. Creating an intuitive interface that displays real-time consumption data and provides personalized tips requires thoughtful design and interactivity. Similarly, database management is crucial for storing historical usage data efficiently and ensuring scalability to handle a large user base.Offsetting integration involves developing mechanisms for users to contribute to conservation projects and integrating offsetting options within the web page.

3.3.3 Social Feasibility

Ensuring the social feasibility of the Smart Water Meter with Offsetting Integration is crucial for its effective implementation. User acceptance and behavior change are pivotal, requiring comprehensive education on benefits like real-time insights and cost savings, alongside effective communication strategies to encourage sustainable practices. Community engagement, involving local stakeholders and organizations, fosters awareness and active participation in water conservation efforts, promoting widespread acceptance. Equity and accessibility considerations prevent exclusion, addressing affordability and digital literacy challenges for diverse demographics.Transparent handling of privacy concerns regarding personal data collection is essential to build user trust. Behavioral nudges, integrated into the system interface, incentivize positive water-saving behaviors, further motivating user adoption. Tailoring messaging and outreach efforts to local cultural contexts enhances relevance and effectiveness. Stakeholder engagement with water utilities, governments, and NGOs facilitates partnerships for successful system implementation and support.

3.4 System Specification

3.4.1 Hardware Specification

- Water flow sensor.
- NodeMCU v8266
- Programmer (Arduino Type-B USB-UAR adaptor)
- SmartPhone or PC
- Water pipe
- Water tap connector
- Jumper wires/Connecting wires

3.4.2 Software Specification

- **Arduino IDE :** The Arduino IDE is the software used to write the program for the project and upload the code. By leveraging Arduino microcontrollers and sensors, the IDE enables seamless communication between the smart water meters and the web-based dashboard.
- **Thinger.io :** Thinger.io is a robust IoT platform designed to facilitate the seamless integration and management of connected devices and data streams. In the context of the proposed smart water meter project, Thinger.io serves as a powerful integration tool for monitoring water usage within households.

3.4.3 Standards and Policies

Accuracy Standards

The smart water meters will adhere to industry standards for accuracy in measuring water consumption, ensuring reliable data collection and billing accuracy for users.

Data Privacy Policy

The project will implement stringent data privacy policies to safeguard users personal information collected by the smart meters and mobile application, adhering to relevant data protection regulations such as GDPR or CCPA.

Water Conservation Regulations

The project will align with local water conservation regulations and policies, ensuring that offsetting contributions to conservation projects comply with governmental guidelines and requirements.

Environmental Policy

The project will incorporate environmental sustainability principles into its operations, such as minimizing carbon footprint during manufacturing and promoting eco-friendly practices in water management.

Accessibility Guidelines

The mobile application will follow accessibility guidelines to ensure that users with disabilities can effectively use the application to monitor their water usage and engage in conservation efforts.

Chapter 4

METHODOLOGY

4.1 Smart water meter Architecture

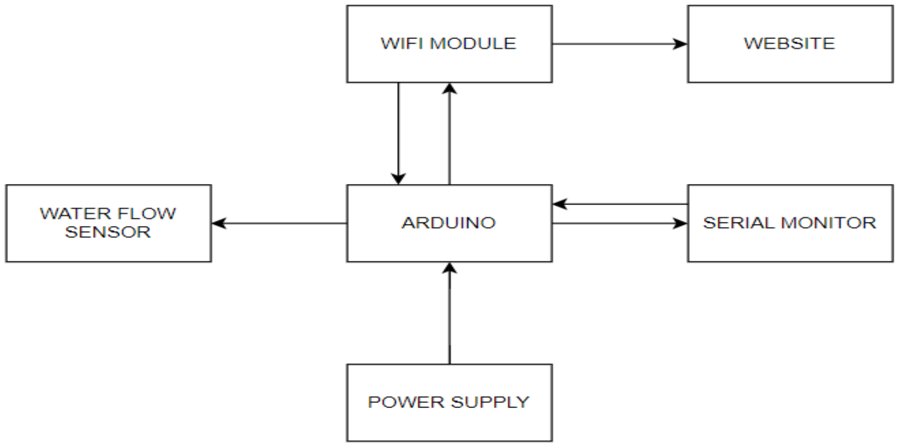

Figure 4.1: **Architecture Diagram of smart water meter**

From the fig 4.1 depicts a schematic diagram illustrating the connectivity and interaction between various components of a water flow monitoring system. The central component is an Arduino microcontroller, depicted as the hub connecting all other elements. A Water Flow Sensor is directly connected to the Arduino, serving as the primary data input source that measures the flow of water. The Arduino is also linked to a Power Supply ensuring it receives adequate energy to function efficiently.Additionally, a WiFi Module interfaces with the Arduino, facilitating wireless communication and data transfer capabilities. This module plays a pivotal role in transmitting data from the Arduino to an external Website where information can be monitored and analyzed remotely. Furthermore, there's a connection from the Arduino to a Serial Monitor which likely serves as another medium for observing data readings directly.The diagram employs rectangular shapes labeled with capital letters to represent each component, while arrows indicate directional flow of information or energy between these components.

4.2 Design Phase

4.2.1 Data Flow Diagram

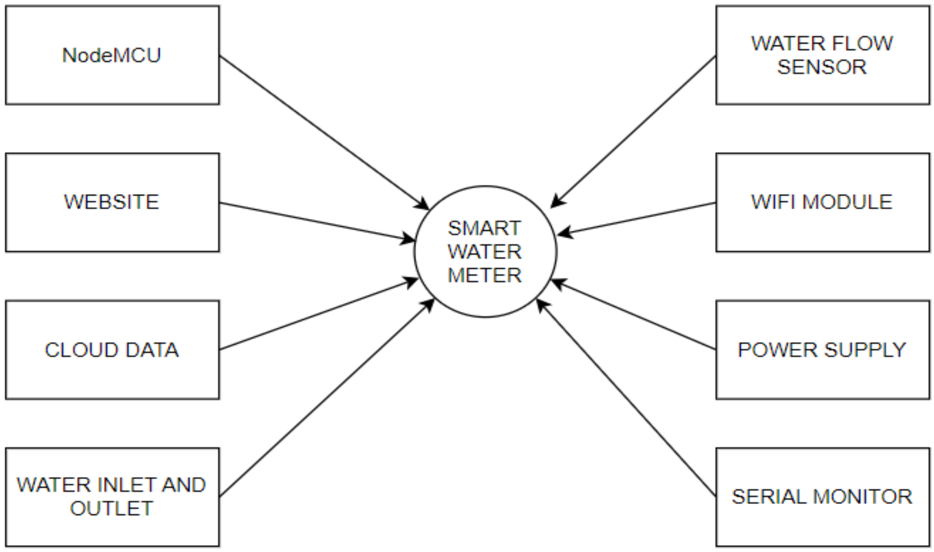

Figure 4.2: **Data Flow Diagram**

From the fig 4.2 states that the Smart Water Meter system, with the Smart Water Meter at its core, responsible for accurately measuring water flow within households. Connected components include the NodeMCU, serving as the central hub, the Water Flow Sensor for measuring water flow, a Power Supply ensuring continuous operation, a WiFi Module enabling wireless communication, and a Serial Monitor for direct data observation.Data flow and remote access are facilitated through connections to a Website and Cloud Data, enabling users to monitor water usage remotely, access real-time insights, and manage consumption efficiently. Overall, the system aims to empower users by promoting water conservation and contributing to sustainable resource management. By combining hardware components, connectivity features, and real-time monitoring capabilities, the Smart Water Meter system revolutionizes household water management, providing a comprehensive solution to address water scarcity and promote responsible usage.

4.2.2 Use Case Diagram

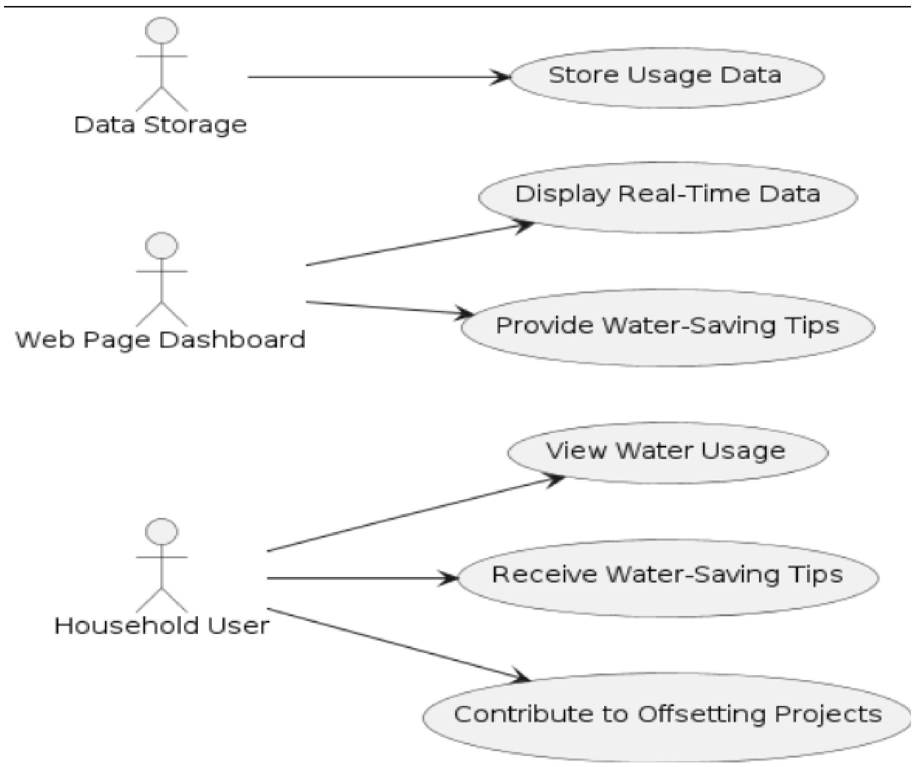

Figure 4.3: **Use Case Diagram**

From the fig 4.3 states that the provided flowchart illustrates the workflow of the proposed Smart Water Meter with Offsetting Integration system, designed to revolutionize water management and conservation efforts. The system comprises essential components such as Data Storage, Web Page Dashboard, and Household User.The workflow begins with the SmartMeter reading water flow data from the WaterFlowSensor and storing usage records in the Database. Simultaneously, the Web Page Dashboard updates with real-time information, providing users with access to personalized tips and opportunities to contribute to offsetting projects.By leveraging IoT technology, the system seamlessly integrates with a web page, offering users convenient monitoring capabilities. Its primary purpose is to empower users to manage water usage responsibly while contributing to water resource preservation efforts.Overall, the system aims to foster a culture of responsible water usage and environmental stewardship. By providing users with real-time data insights, personalized tips, and opportunities for direct engagement in conservation projects, it seeks to instill a sense of ownership and responsibility towards water resources.

4.2.3 Class Diagram

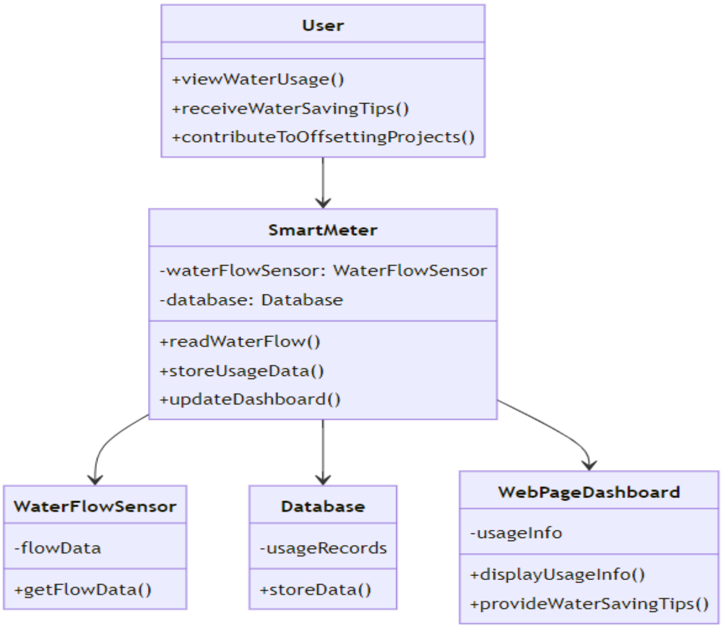

Figure 4.4: **Class Diagram**

From the fig 4.4 states that the provided flowchart outlines the intricate interaction among components within a water usage monitoring system, aimed at revolutionizing household water management and promoting responsible usage practices. At its core, the system involves the User, SmartMeter, WaterFlowSensor, Database, and WebPageDashboard.The SmartMeter serves as the central component, tasked with managing water flow data obtained from the WaterFlowSensor. This real-time data is stored in the Database for future analysis and reference. Concurrently, the WebPageDashboard updates with current usage information, providing users with insights into their consumption patterns and offering personalized water-saving tips.By empowering users to monitor their water usage in real-time and providing actionable insights for reducing wastage, the system fosters a culture of responsible water usage. Users are encouraged to participate in initiatives that offset excessive use, contributing to the preservation of water resources for future generations.Overall, the system aims to revolutionize household water management by leveraging automation and IoT technology to facilitate informed decision-making and promote sustainable practices.

4.2.4 Sequence Diagram

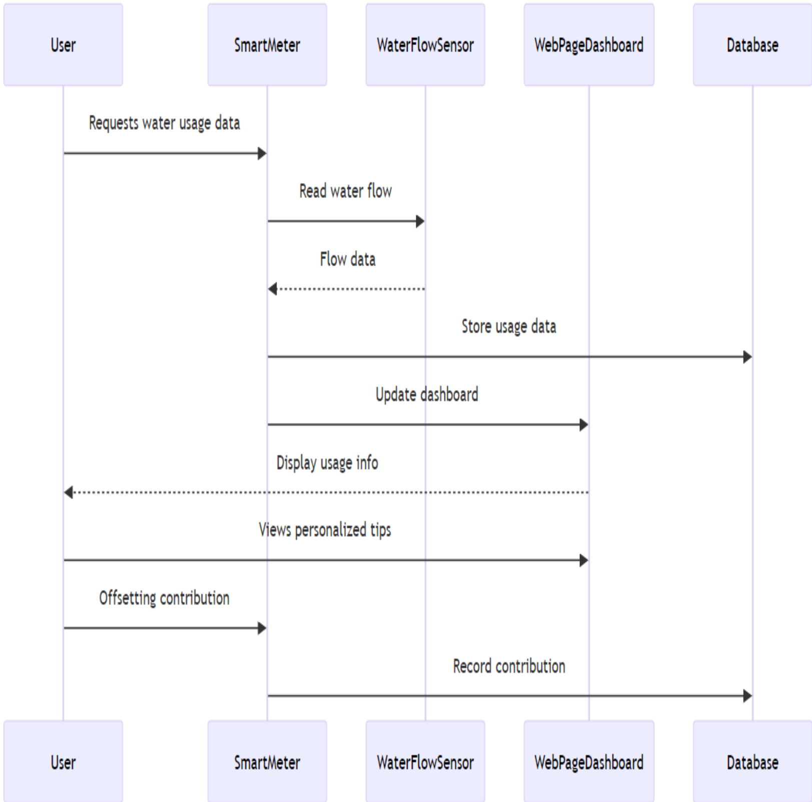

Figure 4.5: **Sequence Diagram**

From the fig 4.5 describes that the Smart Water Meter system is a sophisticated platform designed to enhance water management and promote environmental conservation. At its core lies the Smart Water Meter class, which serves as the backbone of the system by measuring water flow, tracking usage, and providing real-time data. Users are represented by the User class, enabling personalized interaction with the system through attributes such as username and email. Additionally, allowing users to contribute to sustainability efforts. The web page class acts as a vital interface between users and the system, offering functionalities such as displaying water usage insights, providing water-saving tips, and facilitating contributions to offset projects.Water-saving tips are stored within the WaterSavingTip class, providing users with valuable information on conservation practices.

4.2.5 Collaboration diagram

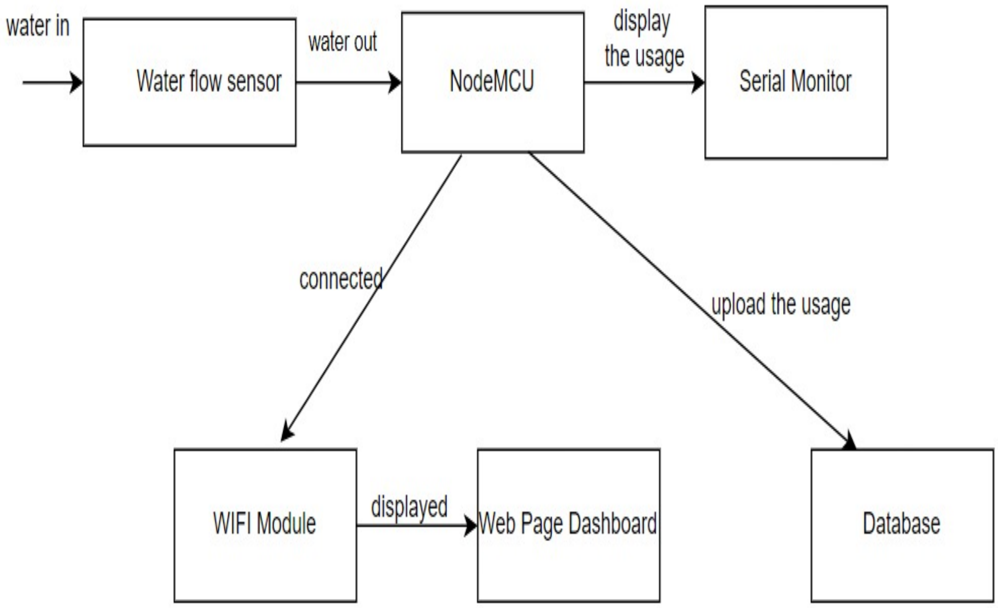

Figure 4.6: **Collaboration diagram**

From the fig 4.6 describes that the provided image depicts a water usage monitoring system designed to efficiently track and manage water consumption. It comprises key components such as the Water Flow Sensor, NodeMCU, Serial Monitor, WIFI Module, and Database. The Water Flow Sensor measures both incoming and outgoing water, with the NodeMCU processing this data for display on the Serial Monitor and transmission via the WIFI Module to a Web Page Dashboard. Users can access real-time water usage statistics remotely through the dashboard and further analyze the data stored in the database.Overall, this system serves to inform users about their water usage patterns, empowering them to make informed decisions for conservation. By providing real-time monitoring and remote access capabilities, it enhances water management efficiency and encourages responsible consumption practices.

4.2.6 Activity Diagram

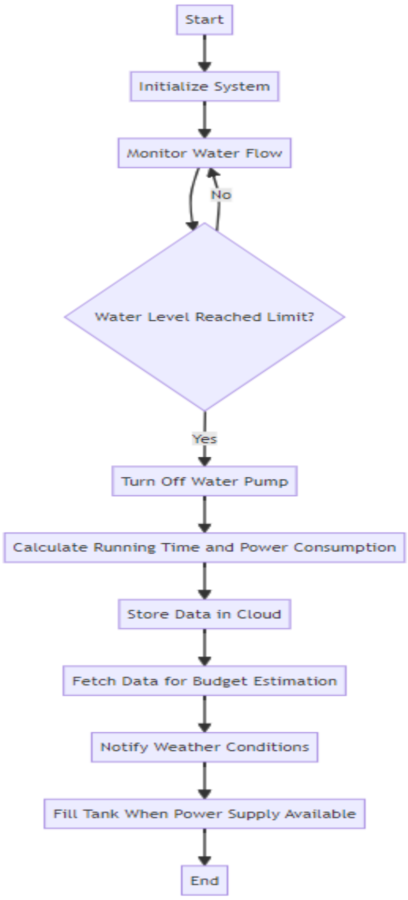

Figure 4.7: **Activity Diagram**

From the fig 4.7 states that the flowchart presents the operational workflow and interplay among key components within a Smart Water Meter system, aiming to enhance water management efficiency and promote sustainable usage practices. At its core, the system comprises Data Storage, a Web Page Dashboard, and Household Users.The process initiates with the SmartMeter reading water flow data from the WaterFlowSensor, which is then stored in the Database for future reference and analysis. Concurrently, the Web Page Dashboard dynamically updates with real-time usage information, providing users with insights into their consumption patterns and offering personalized water-saving tips. Additionally, users have the opportunity to contribute to offsetting projects directly through the system.Through the seamless integration of IoT technology, the system ensures convenient monitoring and interaction via a web-based platform, enhancing user engagement and facilitating proactive water management.

4.3 Algorithm & Pseudo Code

4.3.1 Smart Water Meter with Offsetting Integration

1. Define the Problem:
   - Identify the growing concern over water scarcity and the need for sustainable water management practices.
2. Identify Objectives:
   - Aim to develop a Smart Water Meter with Offsetting Integration.
   - Revolutionize household water usage monitoring.
   - Provide real-time data insights to users.
   - Facilitate user engagement in water conservation efforts.
3. Core Components:
   - Develop a smart water meter to accurately track and record real-time water consumption within households.
   - Implement Offsetting Integration, allowing users to contribute directly to water conservation projects.
   - Leverage IoT technology for seamless integration with a web page.
4. System Functionality:
   - Enable real-time tracking of household water usage.
   - Provide users with valuable insights into their consumption patterns.
   - Allow users to contribute to water conservation projects to offset their water footprint.
   - Empower users to take proactive measures towards water conservation.
5. Implementation Steps:
   - Design and build a smart water meter hardware with accurate sensors.
   - Implement IoT connectivity for real-time data transmission.
   - Integrate Offsetting Functionality:
   - Develop a mechanism for users to contribute to water conservation projects.

- Integrate this functionality with the smart water meter system.
- Web Page Integration:
- Develop a user-friendly web page interface for monitoring water usage.
- Create a dashboard displaying comprehensive water consumption data.
- Offer personalized water-saving tips based on individual usage patterns.

6. Impact Evaluation:

- Assess the effectiveness of the system in promoting water conservation.
- Measure user engagement and participation in offsetting initiatives.
- Evaluate the system's contribution to the preservation of water resources

4.3.2 Pseudo Code

```
Include ThingerESP8266 library
Include ESP8266WiFi library

Define Thinger.io account credentials
Define Wi-Fi credentials
Define pin connected to the flow sensor

Initialize ThingerESP8266 object with credentials

Initialize variables for managing timing and water flow data

Define Interrupt Service Routine (ISR) to count pulses from the flow sensor

Setup function:
  - Begin serial communication for debugging
  - Connect to Wi-Fi network using defined credentials
  - Set pin mode for the flow sensor as INPUT_PULLUP
  - Initialize variables
  - Attach interrupt to count pulses from the flow sensor

Loop function:
  - Get current time in milliseconds
  - Check if it's time to send data based on defined interval
    - Calculate flow rate based on pulse count and calibration factor
    - Update total flow
    - Print flow rate and total flow to serial monitor
    - Send flow rate and total flow data to Thinger.io
```

4.4 Module Description

4.4.1 Smart Water Meter Module

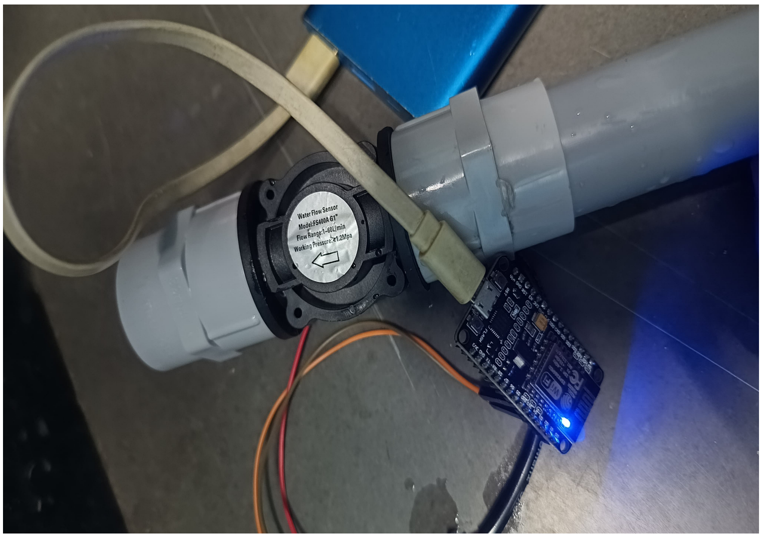

Figure 4.8: **Smart Water Meter Module**

From the fig 4.8 states that the Water Flow Monitoring Module is an essential component designed to provide accurate and real-time tracking of water consumption within households. Its primary purpose is to empower users with detailed insights into their water usage patterns, enabling informed decision-making and proactive water management practices.

At the core of the module is the SmartMeter, which acts as the central processing unit responsible for reading water flow data from the WaterFlowSensor. The WaterFlowSensor, another critical component, measures the flow of water and provides continuous real-time data to the SmartMeter. This enables the module to calculate both flow rate and total volume consumed accurately.

The module's functionality includes continuous monitoring of water flow, updating usage records in the database in real-time. This ensures that users have access to accurate and up-to-date information about their water consumption habits. The database component plays a crucial role in storing usage records, facilitating analysis, and record-keeping for future reference.

Overall, the Water Flow Monitoring Module offers households the ability to actively monitor and manage their water usage, contributing to water conservation efforts and promoting sustainable water management practices.

4.4.2 User Engagement Module

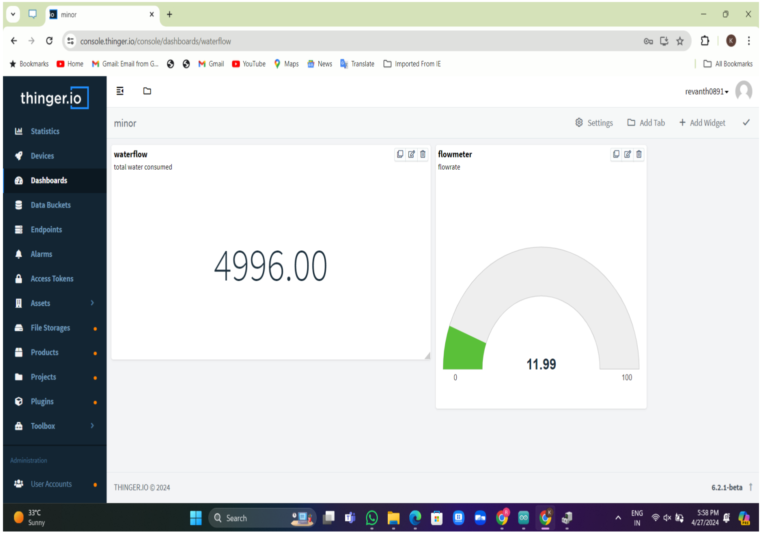

Figure 4.9: **User Engagement Module**

From the fig 4.9 states that the User Engagement Module plays a pivotal role in promoting proactive water conservation efforts among users by fostering personalized guidance and facilitating behavioral changes.

At its core, the WebPageDashboard serves as a user-friendly interface, offering personalized water-saving tips and insights into consumption patterns. Through this dashboard, users can conveniently access their usage data and interact with various features to receive guidance on responsible water usage practices.

The module's functionality revolves around educating users on sustainable water management practices and encouraging behavioral changes. By providing tailored tips and insights based on individual consumption patterns, the module empowers users to make informed decisions about their water usage habits. This proactive approach not only enhances user awareness but also fosters a sense of responsibility towards water conservation.

Overall, the User Engagement Module serves as a catalyst for encouraging users to adopt sustainable behaviors and contribute to the preservation of water resources. Through personalized guidance and interactive features, it empowers users to play an active role in mitigating water scarcity and promoting environmental sustainability.

4.4.3 Offsetting Integration Module

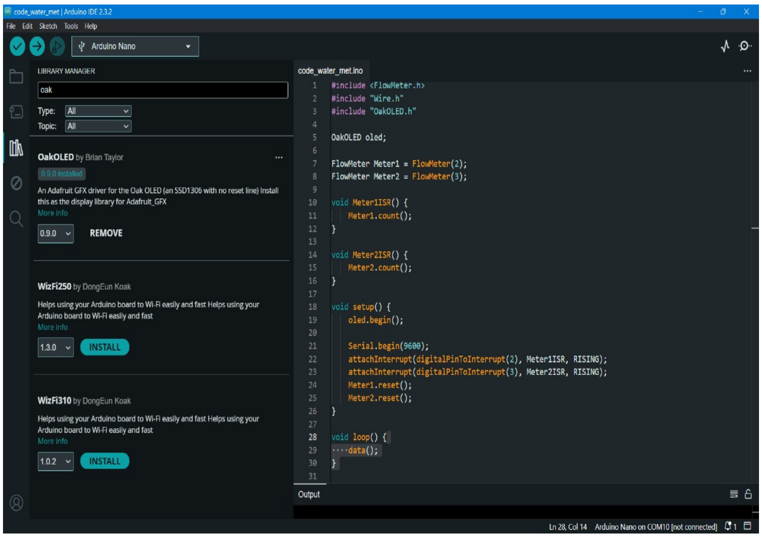

Figure 4.10: **Offsetting Integration Module**

From the fig 4.10 describes that the Offsetting Integration Module is designed to empower users to actively contribute to water conservation projects, thereby mitigating their water footprint and promoting environmental sustainability.

Central to this module is the WebPageDashboard, which serves as the primary interface for users to access real-time usage information and engage in offsetting efforts. Through this dashboard, users can conveniently view personalized water-saving tips and participate in offsetting projects by making contributions.

The module's functionality revolves around providing users with an intuitive platform to engage in offsetting efforts effectively. It showcases various opportunities for users to contribute to conservation initiatives and illustrates the impact of their contributions. By actively participating in these projects, users can play a significant role in preserving water resources and promoting sustainability.

Overall, the Offsetting Integration Module facilitates user engagement in offsetting efforts, empowering individuals to take meaningful actions towards water conservation. Through the seamless integration of offsetting opportunities within the WebPageDashboard, users are encouraged to contribute actively to environmental preservation efforts, ultimately fostering a culture of responsibility and stewardship towards water resources.

4.5 Steps to execute/run/implement the project

4.5.1 Project Planning

- Define the project scope, objectives, and target audience.
- Design the architecture of the smart water meter system, including hardware specifications, IoT connectivity, and data management infrastructure.
- Identify suitable water conservation projects for offsetting integration.

4.5.2 Software Development

- Develop the web platform with a user-friendly interface for monitoring water usage.
- Implement real-time data visualization features on the dashboard.
- Incorporate personalized water-saving tips based on consumption patterns.

4.5.3 Testing and Quality Assurance

- Conduct rigorous testing of the smart water meter hardware and software to ensure accuracy, reliability, and security.
- Perform usability testing to validate the user experience and interface effectiveness.
- Address any bugs or issues identified during testing and refine the system accordingly.

4.5.4 Hardware Development and Integration

- Develop the smart water meter hardware with sensors for accurate water consumption measurement.
- Integrate IoT technology for real-time data transmission to the web platform.
- Ensure compatibility and reliability of the hardware components.

4.5.5 Full-Scale Deployment

- Roll out the smart water meter system to a wider audience, potentially partnering with utility companies or municipalities for broader adoption.
- Scale up infrastructure and support systems to handle increased user load.
- Continuously monitor system performance and user feedback for ongoing improvement.

4.5.6 Continuous Improvement and Maintenance

- Regularly update the system with new features, optimizations, and security patches.
- Monitor data trends and user behavior to identify opportunities for further enhancements.
- Provide ongoing customer support and troubleshooting assistance to ensure user satisfaction.

Chapter 5

IMPLEMENTATION AND TESTING

5.1 Input and Output

5.1.1 Input Design

The Smart Water Meter with Offsetting Integration features an intuitive user interface for real-time water consumption monitoring and participation in conservation projects. It displays consumption data with interactive graphs, alerts for anomalies, and historical comparisons. A dedicated section enables users to contribute to offsetting initiatives, providing project details and a streamlined donation process. Personalized water-saving tips, based on usage patterns, foster conservation efforts. Customization options include unit preferences and goal setting for consumption reduction. Accessibility features ensure inclusivity, while stringent security measures safeguard user data and transactions. A feedback mechanism encourages user input for continual improvement. This design balances user convenience, data security, and environmental impact awareness within a comprehensive platform.

5.1.2 Output Design

The Smart Water Meter's Output Design focuses on presenting real-time consumption data, offsetting integration details, personalized water-saving tips, and usage history. It prominently displays consumption data with intuitive charts and alerts for abnormal usage. Users can explore water conservation projects and track their contributions' impact. Personalized tips based on individual usage patterns are provided to encourage sustainable habits. Historical data analysis aids in identifying usage trends and optimizing consumption. Customization options include setting goals and preferences. Mobile accessibility ensures users can conveniently monitor usage from smartphones. A feedback mechanism allows users to provide suggestions and report issues, fostering continuous improvement. Overall, the design aims to empower users with actionable insights and engagement opportunities to promote responsible water management.

5.2 Testing

Testing for the Smart Water Meter involves functional validation of real-time tracking, offsetting integration, and dashboard accuracy. Accuracy testing ensures precise measurement and contribution alignment with conservation projects. Security assessments validate data protection measures and authentication protocols. User experience testing evaluates interface intuitiveness, responsiveness, and personalized tips' effectiveness. Integration testing confirms seamless interaction between the meter, dashboard, and offsetting platform. Performance tests assess system response and load handling, ensuring optimal functionality under varying conditions. Compatibility checks ensure consistent performance across browsers, operating systems, and devices. Thorough testing across these domains ensures the Smart Water Meter's reliability, accuracy, security, and user satisfaction, enhancing its effectiveness in promoting sustainable water management practices.

5.3 Types of Testing

5.3.1 Unit testing

Unit testing for smart water meter involves validating the NodeMCU's ability to accurately collect and transmit real-time water consumption data from sensors to the web page. This includes verifying the reliability of sensor readings under various environmental conditions and flow rates. Additionally, unit testing ensures that the NodeMCU effectively communicates with other components, such as the web page dashboard and offsetting platform, through Wi-Fi connectivity. Security measures, such as encryption protocols and access controls, are also tested to safeguard data transmitted by the NodeMCU. By conducting thorough unit testing of the NodeMCU, developers can ensure its reliability, accuracy, and seamless integration within the Smart Water Meter system, enhancing its effectiveness in promoting sustainable water management practices.

Test result

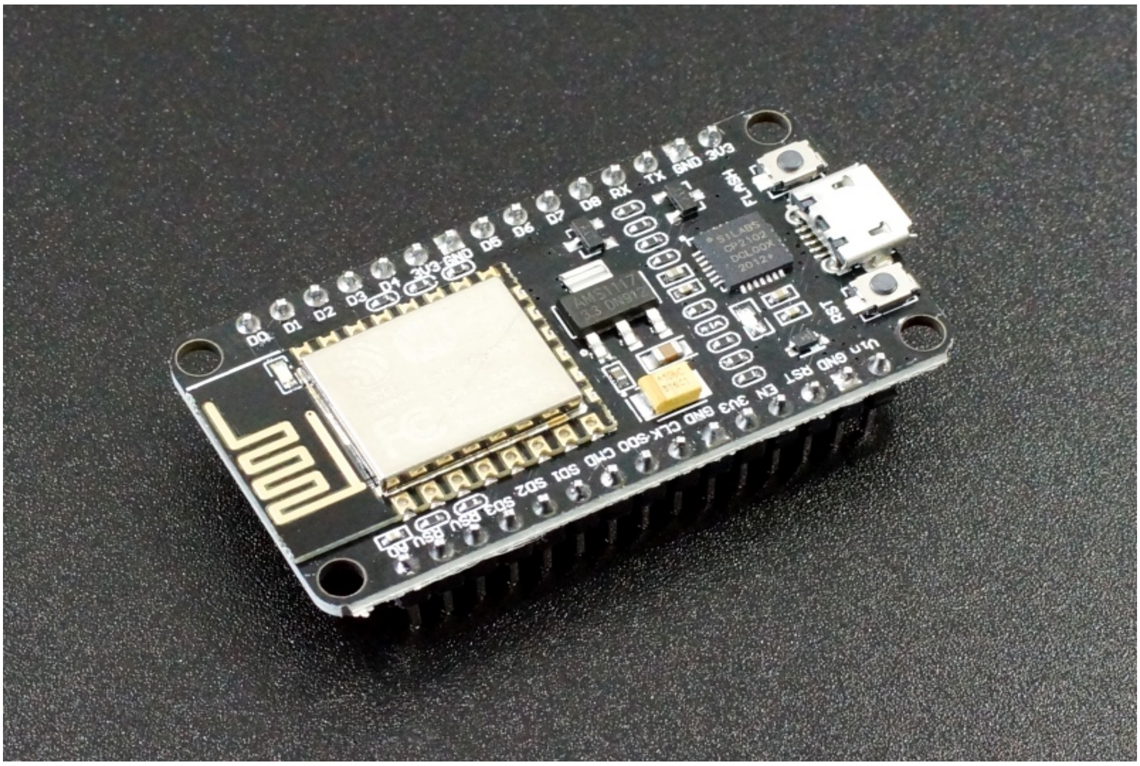

Figure 5.1: **Unit testing**

5.3.2 Integration testing

Integration testing for the Smart Water Meter's NodeMCU involves validating its seamless interaction with the system components while utilizing the user's hotspot for connectivity. This testing ensures that the NodeMCU effectively communicates with sensors to collect real-time water consumption data and securely transmits it to the web page dashboard through the user's hotspot connection. Integration testing verifies that the NodeMCU properly integrates with the web page dashboard to display accurate consumption metrics and enable user engagement features such as personalized tips and offsetting contributions. Additionally, testing includes assessing the reliability of the NodeMCU's connection to the user's hotspot under various network conditions. By thoroughly evaluating the integration of the NodeMCU with the system components and the user's hotspot, developers can ensure the Smart Water Meter functions seamlessly and provides users with reliable data and engagement opportunities.

Test result

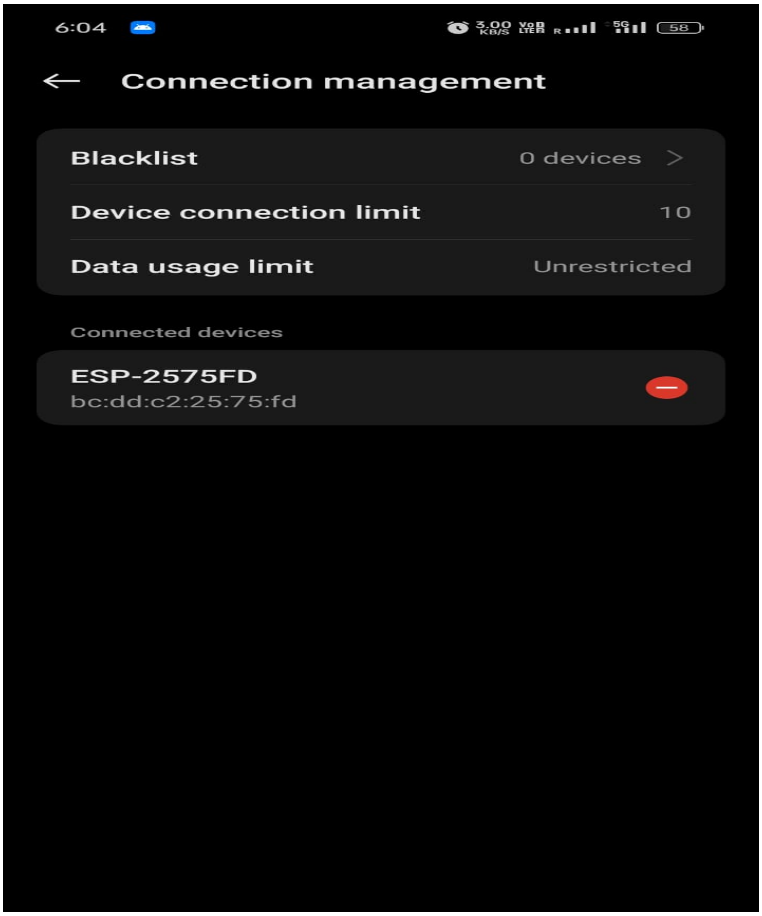

Figure 5.2: **Integration testing**

5.3.3 System testing

The provided firmware configures the NodeMCU for WiFi connectivity, pivotal for its integration into the Smart Water Meter system. It initiates WiFi connection using specified credentials, ensuring reliable network communication. System testing verifies its robust network connection and seamless collaboration with other components like sensors and the web server. Performance under varied network conditions and implementation of security measures are also evaluated. This firmware plays a pivotal role in facilitating the NodeMCU's function within the Smart Water Meter ecosystem.

Test result

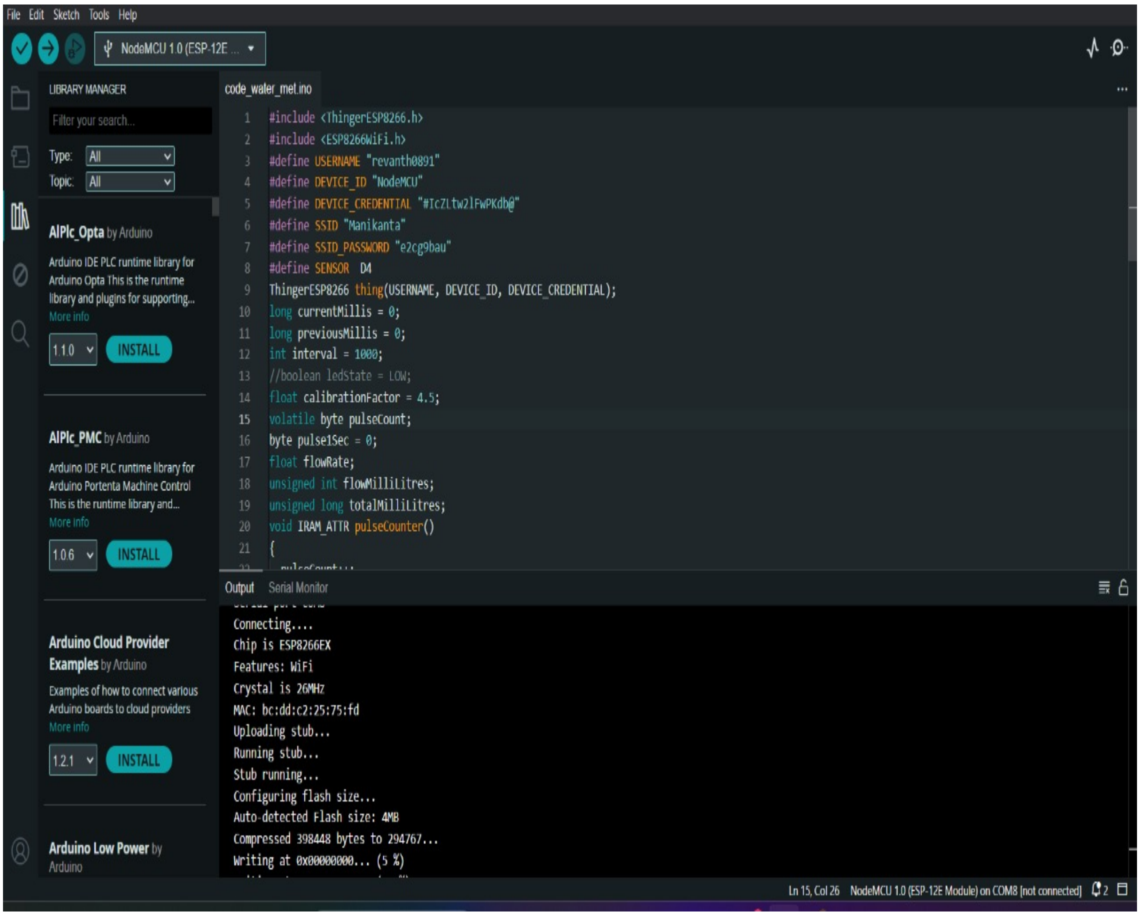

Figure 5.3: **System testing**

5.3.4 Test Result

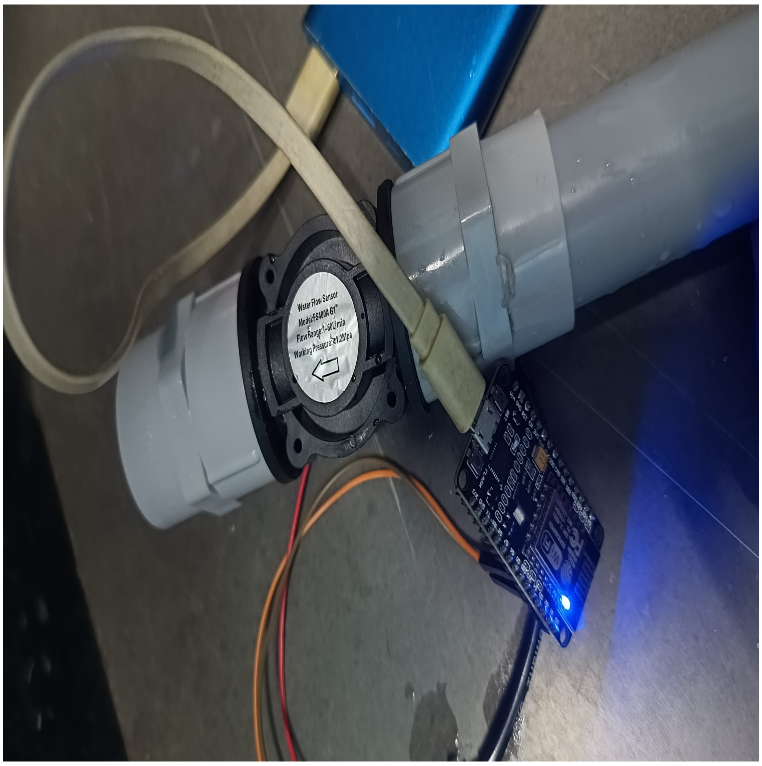

Figure 5.4: **Execution result**

From the fig 5.4 describes that the Water flow sensor is connected to the NodeMCU and measures the rate of water flow. When water flows through the sensor, it triggers the code inside the NodeMCU. The NodeMCU then processes this signal and calculates the water flow rate. This data can be used for various applications, such as monitoring water usage in real-time, detecting leaks, or automating irrigation systems. The power supply ensures the continuous operation of the system. This setup demonstrates an effective use of IoT technology for environmental monitoring and resource management. It's a great example of how simple components can be used to create a sophisticated and useful system.

Chapter 6

RESULTS AND DISCUSSIONS

6.1 Efficiency of the Proposed System

The proposed system offers significant efficiency improvements in water management through its real-time tracking capabilities and personalized conservation features. By utilizing smart water meters and a user-friendly website, the system enables households to monitor their water usage instantly and receive tailored tips for reducing consumption. This proactive approach empowers individuals to make informed decisions about their water usage, leading to more efficient resource allocation and reduced wastage.

Furthermore, the integration of offsetting contributions to water conservation projects enhances efficiency by channeling resources directly into initiatives aimed at mitigating water scarcity. This not only offsets individual water footprints but also contributes to broader conservation efforts. Additionally, the system's data analytics capabilities provide valuable insights into usage patterns across communities, allowing for targeted interventions and infrastructure improvements. Overall, the proposed system offers an efficient and sustainable approach to water management, promoting responsible consumption and maximizing the effectiveness of conservation efforts.

6.2 Comparison of Existing and Proposed System

Existing system

Two previous existing systems for monitoring water usage are mechanical water meters and manual tracking methods. Mechanical water meters, common in many households, use internal mechanisms like turbines to measure water flow. Meter readers manually record these measurements periodically for billing. However, this system is labor-intensive and prone to human error. Manual tracking methods involve individuals recording their water usage manually using pen and paper or basic spreadsheets. While simple, these methods lack real-time monitoring and are reliant on users' consistency and accuracy. Both systems have limitations in efficiency and accuracy compared to modern smart water metering technologies. Smart meters offer real-time tracking, accurate data collection, and automated billing, reducing labor costs and errors. They also provide insights into usage patterns, aiding in conservation efforts and promoting efficient water management.

Proposed system

The proposed system is a Smart Water Meter with Offsetting Integration, designed to address water scarcity concerns and promote sustainable water management. It comprises a smart meter accurately tracking real-time household water consumption, with data accessible via a web-based dashboard. Users can conveniently monitor usage patterns and receive personalized water-saving tips. The system features Offsetting Integration, allowing users to contribute directly to water conservation projects to offset their water footprint. With mobile integration, users can access consumption data from smartphones. This comprehensive solution aims to revolutionize household water management, empower users to proactively conserve water, and contribute to preserving water resources for future generations.

6.3 Sample Code

```
#include <ThingerESP8266.h>
#include <ESP8266WiFi.h>
#define USERNAME "Your Account Username"
#define DEVICE_ID "Device-ID"
#define DEVICE_CREDENTIAL "Your Private Key"
#define SSID "Wi-Fi Name"
#define SSID_PASSWORD "Password"
#define SENSOR  D3
ThingerESP8266 thing(USERNAME, DEVICE_ID, DEVICE_CREDENTIAL);
long currentMillis = 0;
long previousMillis = 0;
int interval = 1000;
//boolean ledState = LOW;
float calibrationFactor = 4.5;
volatile byte pulseCount;
byte pulse1Sec = 0;
float flowRate;
unsigned int flowMilliLitres;
unsigned long totalMilliLitres;
void IRAM_ATTR pulseCounter()
{
```

```
  pulseCount++;
}
void setup()
{
  Serial.begin(115200);
  thing.add_wifi(SSID, SSID_PASSWORD);
  pinMode(SENSOR, INPUT_PULLUP);
  pulseCount = 0;
  flowRate = 0.0;
  flowMilliLitres = 0;
  totalMilliLitres = 0;
  previousMillis = 0;
  attachInterrupt(digitalPinToInterrupt(SENSOR), pulseCounter, FALLING);
}
void loop()
{
  currentMillis = millis();
  if (currentMillis - previousMillis > interval) {
    pulse1Sec = pulseCount;
    pulseCount = 0;
    flowRate = ((1000.0 / (millis() - previousMillis)) * pulse1Sec) / calibrationFactor;
    previousMillis = millis();
    flowMilliLitres = (flowRate / 60) * 1000;
    totalMilliLitres += flowMilliLitres;
    // Print the flow rate for this second in litres / minute
    Serial.print("Flow rate: ");
    Serial.print(int(flowRate));  // Print the integer part of the variable
    Serial.print("L/min");
    Serial.print("\t");       // Print tab space
    // Print the cumulative total of litres flowed since starting
    Serial.print("Output Liquid Quantity: ");
    Serial.print(totalMilliLitres);
    Serial.print("mL / ");
    Serial.print(totalMilliLitres / 1000);
    Serial.println("L");
    thing["data"] >> [](pson& out){
    out["Flow Rate"] = flowRate;
    out["Total"]= totalMilliLitres;
     };
    thing.handle();
    thing.stream(thing["data"]);
  }
}
```

Output

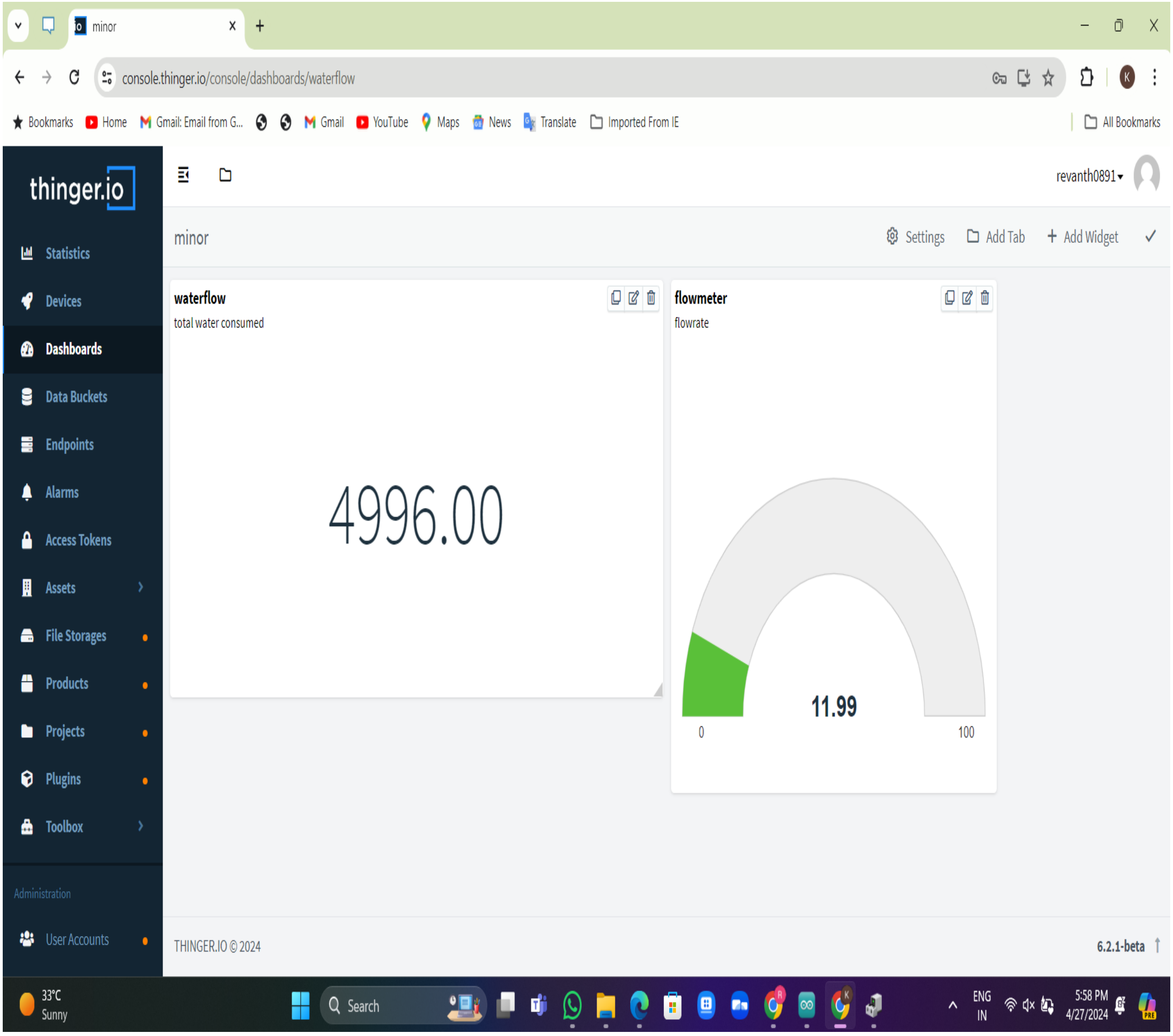

Figure 6.1: **Final Output of water usage**

From the fig 6.1 states that the image showcases a user interface within the thinger.io platform, focusing on a water flow sensor's data. The sensor calculates both flow rate and total water volume consumed, displayed on the interface. Real-time data allows users to monitor consumption patterns. Integrated with thinger.io, the platform offers convenient access to usage information. By empowering users with accurate data, the system promotes proactive water conservation, fostering responsible usage practices and contributing to water resource preservation for future generations.

Chapter 7

CONCLUSION AND FUTURE ENHANCEMENTS

7.1 Conclusion

In conclusion, the development of the Smart Water Meter with Offsetting Integration not only addresses the pressing concerns surrounding water scarcity but also represents a proactive step towards fostering a more sustainable future. By offering households real-time data insights and opportunities for direct engagement in conservation efforts, this project embodies a multifaceted approach to water management. Through the integration of cutting-edge smart meter technology with offsetting initiatives, users are empowered to not only monitor their water consumption but also actively contribute to conservation projects aimed at mitigating their environmental impact.

Moreover, the seamless integration of the smart water meter with a user-friendly mobile application amplifies the accessibility and effectiveness of the system. By providing users with personalized conservation tips based on their individual usage patterns, the application serves as a catalyst for behavioral change, encouraging more conscious and responsible water consumption practices. Ultimately, this innovative system not only revolutionizes household water management but also cultivates a culture of environmental stewardship and resilience. By harnessing the potential of Internet of Things (IoT) technology and fostering community engagement, the project paves the way for a more sustainable and equitable distribution of water resources, safeguarding the well-being of both present and future generations.

7.2 Future Enhancements

Looking ahead, several enhancements could further augment the capabilities and impact of the Smart Water Meter with Offsetting Integration. Firstly, incorporating advanced machine learning algorithms into the system could enable predictive analytics, allowing users to anticipate and mitigate potential water usage inefficiencies before they occur. By analyzing historical data and user behavior patterns, the system could provide proactive suggestions for optimizing water usage and reducing waste, thus enhancing overall efficiency and conservation efforts.

Additionally, expanding the scope of the Offsetting Integration feature to include partnerships with a wider range of water conservation projects and initiatives could amplify its effectiveness. By offering users a diverse selection of projects to support, ranging from local watershed restoration efforts to international clean water access programs, the system could cater to a broader range of interests and priorities. This expansion would not only increase user engagement but also foster greater collective impact in addressing global water challenges. Overall, these future enhancements have the potential to further elevate the Smart Water Meter with Offsetting Integration as a leading solution for sustainable water management in the years to come.

Chapter 8

PLAGIARISM REPORT

Dupli Checker

PLAGIARISM SCAN REPORT

8% Plagiarised	92% Unique	**Date**	2024-04-24
		Words	512
		Characters	4052

Content Checked For Plagiarism

Chapter 7
CONCLUSION AND FUTURE
ENHANCEMENTS
7.1 Conclusion
Why Wateron — Our Digital Water Meters Ensure 100% Fairness In Your Apartment's Water Billing System.
SmarterHomes provides smart water metering solution for multi inlet apartment buildings. Ultrasonic Technology. Monitor Water Consumption. Insightful Analytics.

In conclusion, the development of the Smart Water Meter with Offsetting Inte-
gration not only addresses the pressing concerns surrounding water scarcity but also
represents a proactive step towards fostering a more sustainable future. By offering
households real-time data insights and opportunities for direct engagement in conser-
vation efforts, this project embodies a multifaceted approach to water management.
Through the integration of cutting-edge smart meter technology with offsetting ini-

Figure 8.1: **Plagiarism Report**

Chapter 9

SOURCE CODE & POSTER PRESENTATION

9.1 Source Code

```
#include <ThingerESP8266.h>
#include <ESP8266WiFi.h>
#define USERNAME "revanth0891"
#define DEVICE_ID "NodeMCU"
#define DEVICE_CREDENTIAL "#IcZLtw2lFwPKdb@"
#define SSID "Manikanta"
#define SSID_PASSWORD "e2cg9bau"
#define SENSOR  D4
ThingerESP8266 thing(USERNAME, DEVICE_ID, DEVICE_CREDENTIAL);
long currentMillis = 0;
long previousMillis = 0;
int interval = 1000;
//boolean ledState = LOW;
float calibrationFactor = 4.5;
volatile byte pulseCount;
byte pulse1Sec = 0;
float flowRate;
unsigned int flowMilliLitres;
unsigned long totalMilliLitres;
void IRAM_ATTR pulseCounter()
{
  pulseCount++;
}
void setup()
{
  Serial.begin(115200);
  thing.add_wifi(SSID, SSID_PASSWORD);
  pinMode(SENSOR, INPUT_PULLUP);
  pulseCount = 0;
  flowRate = 0.0;
  flowMilliLitres = 0;
  totalMilliLitres = 0;
  previousMillis = 0;
  attachInterrupt(digitalPinToInterrupt(SENSOR), pulseCounter, FALLING);
}
```

```
void loop()
{
  currentMillis = millis();
  if (currentMillis - previousMillis > interval) {
    pulse1Sec = pulseCount;
    pulseCount = 0;
    flowRate = ((1000.0 / (millis() - previousMillis)) * pulse1Sec) / calibrationFactor;
    previousMillis = millis();
    flowMilliLitres = (flowRate / 60) * 1000;
    totalMilliLitres += flowMilliLitres;
    // Print the flow rate for this second in litres / minute
    Serial.print("Flow rate: ");
    Serial.print(int(flowRate));  // Print the integer part of the variable
    Serial.print("L/min");
    Serial.print("\t");        // Print tab space
    // Print the cumulative total of litres flowed since starting
    Serial.print("Output Liquid Quantity: ");
    Serial.print(totalMilliLitres);
    Serial.print("mL / ");
    Serial.print(totalMilliLitres / 1000);
    Serial.println("L");
    thing["data"] >> [](pson& out){
    out["Flow Rate"] = flowRate;
    out["Total"]= totalMilliLitres;
     };
    thing.handle();
    thing.stream(thing["data"]);
  }
}
```

9.2 Poster Presentation

Figure 9.1: **Poster Presentation**

References

[1] Manmeet Singh and Suhaib Ahmed, IoT based smart water management systems: A systematic review, vol. 46, pp. 5211-5218, 2021.

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