SYNOPSIS

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Project Title: Optimizing Water Management Using LoRaWan -Enabled IoT Framework and Behavioural Analysis

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Abstract

Sustainable water usage is an important factor in efficient resource management within extensive water supply networks. In this regard, the current study attempts to investigate water consumption behavior in the context of a university campus via the implementation of a cutting-edge IoT system driven by LoRaWAN technology for high-accuracy data collection. The system takes advantage of LoRaWAN-capable smart meters that are strategically placed throughout the water distribution network on campus, enabling secure real-time data transmission over long distances at low power. The low-power wide-area network architecture guarantees efficient and scalable data collection from points such as student hostels and faculty/staff quarters. The accumulated data from weekly and monthly usage is fed into deep learning algorithms that reveal important patterns of water use driven by events like the academic calendar, holidays, and occupancy variability. These data allow for nuanced insights into campus-wide water consumption patterns. Compared with conventional monitoring strategies, the addition of LoRaWAN further strengthens the system's scalability, cost-effectiveness, and robustness, especially for environments working under intermittent water supply systems (IWS). Furthermore, the study identifies the various campus areas have different patterns of usage, and this gives effective insights which can be utilized for water management plans and ensuring sustainable consumption patterns by the inhabitants in the campus.

Specific Contribution:

- Implemented a Statistical Forecasting Model and Hardware setup using ARIMA-Based water Flow predction Model.
- Involved in active Learning methods in hardware setup design of during implementation.
- Executed retraining of the model using newly acquired example data for better learning effectiveness.
- Tested and validated the logic flow between IoT devices.

Specific Learning:

- Acquired in-depth knowledge of ARIMA and its application in real-world forecasting
- Learned how to handle and prepare time-series data for statistical modeling.
- Gained experience with MQTT, TCP Sockets, and UART in an integrated pipeline.
- Implemented secure MQTT communication with real-time sensor data using ESP32 and Adafruit IO.

Technical Limitations & Ethical Challenges Faced:

- At low speeds, pulse outputs were less sensitive, resulting in flow rate errors.
- The Raspberry Pi was limited on GPIO pins with which to operate multiple relays or peripherals at once. Runs both the model and GPIO operations placed on the board.
- MQTT messages were sometimes lost or were delayed under poor Wi-Fi conditions. Caused inconsistent data flow between ESP32 and Raspberry Pi. Required retries and some tuning of QoS to improve reliability.

Name & Signature of the Student   Signature of Guide

Nishanth M V