

SMART WATER METER AND WATER QUALITY MONITORING USING IOT

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Abstract -The management of water quality and scarcity are major worldwide issues that call for effective, real-time monitoring systems. The design and implementation of an IoT-based Smart Water Meter and Water Quality Monitoring System that integrates sensors, GSM communication, and microcontroller-based data processing is reviewed in this paper. Key water quality parameters are measured by the system using Arduino Uno R3 as the central controller, which interfaces with water flow sensors (YF-S201), TDS (Total Dissolved Solids), turbidity, and pH sensors. A GSM module (SIM800L) wirelessly transmits the gathered data to a cloud server or mobile application, allowing for remote monitoring and the sending of alerts for contamination or excessive water use. For on-site observation, real-time readings are provided by a local LCD display.

The system ensures safe water quality by continuously monitoring contamination levels and improves water conservation by identifying leaks and unauthorized usage. Real-time analytics, automated reporting, and low deployment costs are some of its main benefits, which make it appropriate for use in industrial, residential, and agricultural settings. Future advancements like machine learning-based anomaly detection and solar-powered operation are discussed, along with issues like sensor calibration, power consumption, and network reliability. This review emphasizes how IoT-based smart water systems can support public health and sustainable water management.

Keywords: IoT, Arduino Uno, GSM, TDS, Turbidity, pH Sensor, Smart Water Meter, Water Quality Monitoring, and Real-time Monitoring.

1.INTRODUCTION

Access to safe and clean water is essential for both environmental sustainability and human health. Manual sampling and laboratory analysis are common components of traditional water monitoring techniques, which can be labor-intensive, time-consuming, and inaccurate. Water resource management has been completely transformed by the Internet of Things (IoT), which allows for real-time monitoring and data collection via networked sensors and devices. Continuous monitoring of variables like pH, turbidity,

temperature, and flow rates is made possible by smart water meters and Internet of Things-based water quality monitoring systems. These systems improve the capacity to identify irregularities, control usage, and effectively guarantee water safety. For example, automated data transmission and analysis made possible by the integration of wireless sensor networks with IoT platforms enables better water quality management and prompt decision-making.

2. BODY OF PAPER

PROPOSED STATEMENT

Conventional water monitoring techniques are frequently labor-intensive, manual, and devoid of real-time feedback, which causes inefficient water use and delayed identification of problems with water quality. Water waste and undetected contamination events may arise from a lack of ongoing monitoring. IoT-based solutions provide real-time data collection and analysis, but their widespread adoption is hampered by issues like data security flaws, poor communication coverage, and energy consumption control. Effective, safe, and affordable Internet of Things (IoT)-based smart water meters and water quality monitoring systems are therefore required in order to guarantee water safety, offer real-time insights, and support sustainable water resource management.

OBJECTIVE OF THE PROPOSED SYSTEM

To examine the planning and execution of a smart water monitoring system that uses Internet of Things technology to integrate water quality evaluation and water consumption tracking.

To examine how the GSM module facilitates remote, real-time data communication and alerts for abnormalities in water quality and usage.

To assess how well sensors (TDS, turbidity, pH) detect vital water quality indicators that are important for both environmental and human safety.

To evaluate the water flow meter's ability to measure water usage accurately and in real time for industrial or residential applications.

METHODOLOGY

Sensor Integration: Attach sensors to the Arduino Uno R3, making sure that the right analog or digital pins are assigned. For example, analog pin A0 may be used for pH sensors, A1 for TDS, and A2 for turbidity.

Data Acquisition: Using its integrated Analog-to-Digital Converter (ADC), the Arduino transforms analog signals from the sensors into digital values.

Data processing: Put calibration algorithms into practice to convert unprocessed sensor data into useful units (such as pH units, ppm for TDS, and NTU for turbidity). Accuracy is guaranteed by calibration, which also corrects for sensor drift over time.

Data Transmission: The GSM module transmits processed data to a distant server or cloud platform. This makes it possible to monitor and issue alerts in real time.

Data Visualization and Analysis: Dashboards on the server side allow users to see data and track water quality metrics over time. When parameters surpass safe thresholds, alerts can be set up to notify relevant parties.

MATHEMATICAL MODEL

1. Sensor Data Collection Input Parameters

An Arduino Uno's sensors gather data in real time:

Q: The rate of water flow (liters per minute)

pH: The degree of acidity or alkalinity

Total Dissolved Solids, or TDS (ppm)

TU: Turbidity (NTU)

2. Computation and Processing

a. Calculating Water Use:

By integrating the flow rate, the total volume of water consumed up to time t is determined:

$$V(t) = \int_0^t Q(t) dt$$

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b. Calculating the Water Quality Index (WQI):

Weighted normalized functions are used to calculate the Water Quality Index:

$$WQI = w_1 \cdot f_{pH}(pH) + w_2 \cdot f_{TDS}(TDS) + w_3 \cdot f_{TU}(TU) + w_4$$

WQI is equal to $w_1 \cdot f_{pH}(pH) + w_2 \cdot f_{TDS}(TDS) + w_3 \cdot f_{TU}(TU)$.

Where:

$$f_{pH}(pH) = 100 - 10 \cdot |pH - 7| \quad f_{pH}(pH) = 100 - 10 \cdot |pH - 7|$$

$$f_{TDS}(TDS) = 100 - TDS$$

$$f_{TDS}(TDS) = 100 - 5 \cdot TDS$$

$$f_{TU}(TU) = 100 - 2 \cdot TU = f_{TU}(TU) = 100 - 2 \cdot TU$$

Weights w_1, w_2, w_3 are assigned according to parameter significance, guaranteeing that $w_1 + w_2 + w_3 = 1$.

3. Transmission of Data

A data packet $D(t)$ is sent to a distant server via a GSM module at regular intervals T :

$$D(t) = \{Q, pH, TDS, TU, V(t), WQI\}$$

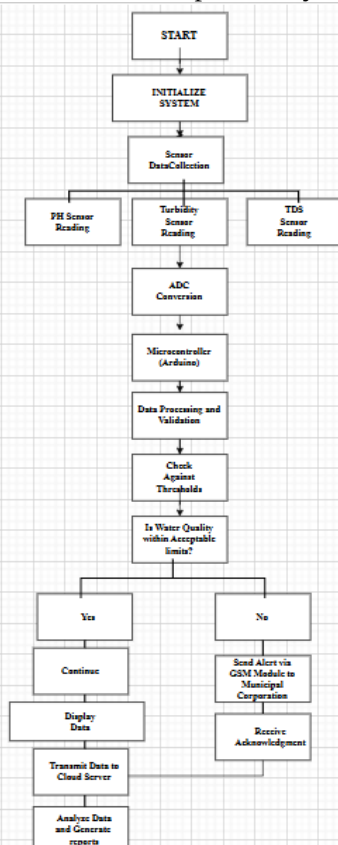
4. Monitoring of Thresholds and Alerts

To alert users when any parameter surpasses safe bounds, an alert function $A(t)$ is defined:

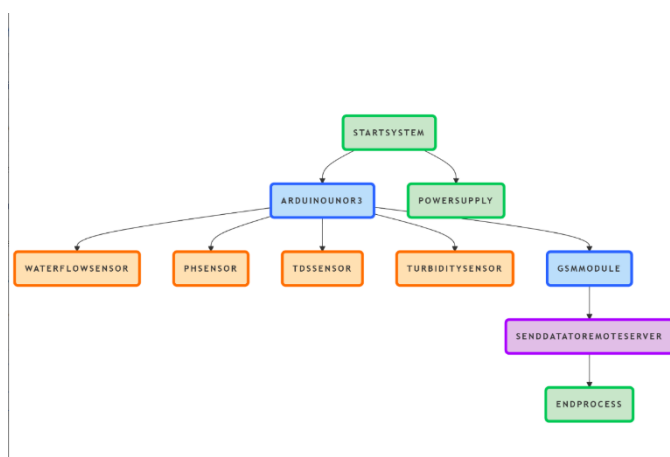
$$A(t) = \begin{cases} 1, & \text{if } pH < 6.5, \text{ or } pH > 8.5, \text{ or if } TDS > 500, \text{ or if } TU > 50, \\ 0, & \text{otherwise} \end{cases}$$

1, 0, if $TU > 5, TDS > 500, pH < 6.5, \text{ or } pH > 8.5$; otherwise,

The system sends out alerts via dashboard notifications or SMS when $A(t) = 1$.



BASIC MODEL



SYSTEM FEATURE 2

Reliability

One essential component that guarantees steady and precise readings over time is the Smart Water Meter and Water Quality Monitoring System's dependability. High-precision sensors like these are used in the system's design:

- To measure total dissolved solids, use a TDS sensor.
- pH indicator for alkalinity and acidity,
- water clarity using a turbidity sensor,
- Water flow meter to monitor usage.

Multiple sensor input integration and real-time processing are guaranteed by the Arduino Uno R3 microcontroller without sacrificing data. For remote data transmission, the GSM module offers reliable wireless communication, doing away with the need for manual reading and reducing human error. Long-term accuracy and dependability are ensured by the system's ability to function in a variety of water conditions thanks to proper calibration and the use of industrial-grade components.

Availability

Data on water quality and consumption is continuously available thanks to the system's design. It is perfect for round-the-clock monitoring in residential, commercial, or governmental settings because it runs independently with little assistance from humans. Availability-supporting features include:

- GSM module-based real-time data transfer.
- LCD/LED display for alerts and local feedback.

power efficiency that enables remote locations to use solar or battery power.

Partial operation is possible even in the event of a sensor failure thanks to modular sensor integration.

High availability is also facilitated by regular cloud/data server backups and redundancy in data transmission, guaranteeing that users always have access to the most recent water quality metrics.

Maintability

The system's open-source software and modular hardware address maintainability. The following elements make maintenance easier:

- The Arduino Uno R3 facilitates simple reprogramming and firmware updates.
- Sensor modules that are plug-and-play can be readily upgraded or replaced without affecting the system as a whole.
- It is possible to program self-diagnostic features (optional) to identify irregularities in sensor readings.
- On-site technical visits are less necessary when troubleshooting remotely using GSM connectivity.

Even semi-skilled workers can perform routine maintenance procedures with little training because they are simple and well-documented, such as hardware inspections and sensor calibration.

3. CONCLUSIONS

The IoT's contribution to smart water metering and water quality monitoring is highlighted in this review. The system integrates turbidity, pH, TDS, and a water flow meter with an Arduino Uno R3 controller to track water quality and usage in real time. Effective water management is made possible by the remote transmission of data via a GSM module. Both urban and rural applications can benefit from the system's affordability and scalability..

4.FUTURE SCOPE

Future improvements may include:

- Upgrading Communication Modules: Data transmission speed, range, and dependability can be improved by switching from GSM to Wi-Fi, LoRa, or NB-IoT.
- Better Microcontroller: More powerful processing power and integrated wireless connectivity can be obtained by switching from Arduino Uno to more sophisticated boards like ESP32.
- Automation and Smart Alerts: Upcoming systems may be able to control features like valve shutoff and provide automated alerts for anomalous parameters.
- AI-Based Analysis: Preventive maintenance and more intelligent resource management are made possible by machine learning algorithms that can forecast contamination events or usage trends.Admin

dashboard for viewing attendance reports and analytics.

- Addition of voice or RFID features as multi-modal authentication.
- Sending automated emails alongside SMS.
- Detection of multiple faces simultaneously in group scenarios.

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6.REFERENCES

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