

# Study of smart water supply network using integrated IoT and sensor system

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**Abstract**—Water is one of the most essential resources for human life, yet conventional water distribution systems suffer from inefficiency, leakage, and unequal supply. This study presents a Smart Water Supply and Distribution System based on Internet of Things (IoT) technology for real-time monitoring and automated control. The system integrates ultrasonic sensors, flow sensors, microcontrollers, solenoid valves, and cloud platforms to monitor water levels, detect leakages, and optimize distribution. Automated pump and valve control ensures efficient utilization of water resources while reducing human intervention. The system also enables remote monitoring and predictive analysis through cloud integration. Experimental results demonstrate high accuracy (92–95%), leakage detection efficiency (~95%), and minimal latency (1–2 seconds). The proposed system is scalable and suitable for residential, industrial, agricultural, and municipal applications, contributing to sustainable water management and smart city development.

**Index Terms**—IoT, Smart Water System, Water Distribution, Leak Detection, Automation, Cloud Monitoring, Sustainable Water Management

## I. INTRODUCTION

Water scarcity and inefficient distribution systems are major global challenges. Traditional water supply systems rely on manual monitoring and control, leading to wastage, delayed fault detection, and uneven distribution. With increasing urbanization and population growth, there is a pressing need for intelligent water management systems.

The advancement of IoT technology enables real-time monitoring, automation, and data-driven decision-making. This research proposes a Smart Water Supply and Distribution System that integrates sensors, microcontrollers, and cloud platforms to improve

efficiency, reduce wastage, and ensure equitable distribution.

## II. METHODOLOGY

### 2.1 System Overview

The proposed Smart Water Supply and Distribution System is an IoT-based automated water management framework that enables real-time monitoring, intelligent decision-making, and efficient control of water resources. The system integrates sensing, processing, communication, and actuation components to form a closed-loop feedback system.

The methodology consists of four main stages:

1. Data Acquisition
2. Data Processing and Decision Making
3. Control and Actuation
4. Data Transmission and Cloud Integration

### 2.2 Data Acquisition (Sensing Layer)

The system uses sensors to continuously monitor water parameters.

Ultrasonic Sensor:

Measures water level using distance calculation:

$$\text{Water Level} = \text{Tank Height} - \text{Measured Distance}$$

Flow Sensor:

Measures flow rate using pulse output:

$$Q = K \times f \text{ Where } Q = \text{Flow rate (L/min)}, f = \text{pulse frequency}, K = \text{calibration constant.}$$

Optional Sensors: Pressure sensors and water quality sensors (pH, turbidity) can be added.

### 2.3 Data Processing (Control Unit)

The collected data is processed using a microcontroller (ESP32/Arduino). The controller performs filtering, threshold comparison, and decision-making. Control

Logic: - Tank level < Minimum → Pump ON- Tank level within limits → Monitoring  
- Tank level > Maximum → Pump OFF- Abnormal flow → Leak detection and valve closure

## 2.4 Control and Actuation

### Pump Automation:

The pump is activated when water level is low and turned off when the tank is full. Solenoid Valve Control:

Controls water distribution and close during leakage.

### Leakage Detection:

Leakage is identified when actual flow deviates from expected flow:

Leakage Condition:  $Q_{\text{actual}} \neq Q_{\text{expected}}$

## 2.5 Communication System

The system uses Wi-Fi (ESP32) for real-time data transmission. Alternatives include GSM and LoRa for remote locations.

Data transmitted includes water level, flow rate, pump status, valve status, and alerts.

## 2.6 Cloud Integration and Monitoring

Cloud platforms like ThingSpeak or Firebase are used for real-time monitoring, data storage, and analysis.

### Dashboard features:

- Graphical visualization
- System status display
- Alerts and notifications
- Historical data logging

## 2.7 Feedback Mechanism

The system operates on a closed-loop feedback mechanism where sensor data is continuously monitored, processed, and used for automatic control decisions.

## 2.8 Experimental Setup

The prototype includes ESP32 microcontroller, ultrasonic sensor, flow sensor, pump, solenoid valve, and cloud dashboard.

### Calibration:

Ultrasonic sensor error:  $\pm 1.6$  cm  
Flow sensor error:  $\pm 3-4\%$

## 2.9 Performance Evaluation Parameters

The system performance is evaluated based on sensor accuracy, leakage detection efficiency, response time, cloud latency, and overall reliability.

## 2.10 Methodology Flow Summary

1. Sensors collect data
2. Microcontroller processes data
3. Control logic applied
4. Pumps and valves operate
5. Data sent to cloud
6. Alerts generated

## III. OBSERVATIONS AND RESULT

### 1. Sensor Performance Observations

#### Ultrasonic Sensor:

- Accurately measured water levels across the range of 0–30 cm.
- Average error observed:  $\pm 1.6$  cm.
- Performance remained stable under repeated trials.

#### Flow Sensor:

- Measured flow rate with an accuracy of approximately 96–97%.
- Calibration constant improved measurement accuracy.
- Minor deviations observed due to turbulence.

### 2. Pump Automation Observations

- Pump activated correctly when water level dropped below 20%.
- Pump turned off automatically when tank level exceeded 90%.
- No overflow observed during testing.
- System responded instantly to level changes.

### 3. Valve Operation Observations

- Solenoid valve opened during normal conditions.
- Valve closed immediately upon leak detection.
- Average response time: 0.8–1 second.
- Reliable performance in all test cases.

### 4. Leakage Detection Observations

- Leakage detected within 2 seconds of occurrence.
- System generated alerts instantly.
- Valve shutoff prevented further water loss.
- Detection efficiency approximately 95%.

#### 5. Cloud System Observations

- Data transmission latency: 1–2 seconds.
- Real-time monitoring achieved successfully.
- No packet loss observed during continuous operation.
- Dashboard displayed stable and accurate readings.

#### 6. Overall System Observations

- System accuracy ranged between 92–95%.
- Fully automated operation reduced manual intervention.
- Efficient and uniform water distribution achieved.
- System proved reliable under multiple test conditions.

### IV. RESULT

The Smart Water Supply and Distribution System was experimentally tested under various operating conditions to evaluate its performance, accuracy, and reliability.

#### Sensor Performance:

- Ultrasonic sensor accuracy: 92–95% ( $\pm 1.6$  cm error)
- Flow sensor accuracy: 96–97%

#### Pump Automation:

- Pump ON below 20% level and OFF above 90%
- 100% success rate in automation

#### Valve Operation:

- Response time: 0.8–1 second
- Reliable in all test conditions

#### Leakage Detection:

- Detection within 2 seconds
- Efficiency: ~95%

#### Cloud Performance:

- Latency: 1–2 seconds
- Stable real-time monitoring

Overall, the system demonstrated high efficiency, reliability, and suitability for real-world applications.

### V. CONCLUSION

The developed Smart Water Supply and Distribution System provide an efficient and automated solution for modern water management. It ensures real-time monitoring, reduces water wastage, and improves operational efficiency. The system minimizes human

intervention and enables data-driven decision-making through cloud integration. It aligns with smart city initiatives and sustainable development goals. Future enhancements such as AI integration and renewable energy can further improve scalability and performance.

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