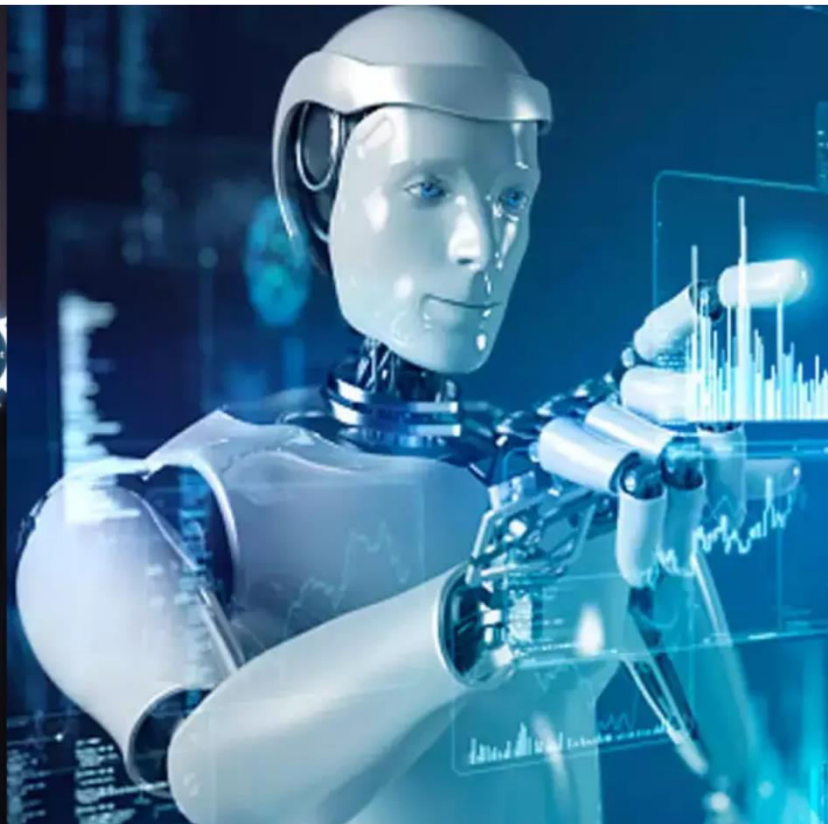




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# IOT based Building Water Tank Monitoring System

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**ABSTRACT:** Water is a fundamental necessity for all living beings, and managing its usage efficiently is vital, especially in areas facing water scarcity or irregular supply. In households, agricultural settings, and industrial applications, overhead tanks are commonly used to store water. However, monitoring the water level manually and switching the motor on or off can be inefficient, time-consuming, and prone to human error. To overcome these challenges, this project presents the design and development of a Water Level Indicator and Automatic Motor Switching System. This system is an electronic device that automatically detects the level of water in a tank and operates a water pump accordingly. The system primarily aims to automate the process of water level detection and motor control, thereby reducing water wastage, avoiding tank overflows, and conserving electricity. It also minimizes human involvement, ensuring that water management becomes a more effortless and error-free task. The system consists of water level sensors, an electronic control unit, and a motor switching mechanism. Conductive type sensors or float switches are placed at different levels in the tank to detect the water levels—typically labeled as Empty, Low, Medium, and Full. When the water level falls below the predefined minimum level, the system activates the water pump. Conversely, when the water reaches the maximum threshold, the system automatically turns the pump off. The control unit, built using basic electronic components or microcontrollers like Arduino, processes the input from the sensors and drives a relay that switches the pump.

**KEYWORDS:** Water Level Indicator, Automatic Motor Switching System, Conductive type sensors, float switches, Arduino.

## I. INTRODUCTION

Water management has been a persistent challenge throughout human history. Ancient civilizations like the Egyptians, Romans, and Mesopotamians developed sophisticated water distribution systems, including aqueducts, canals, and storage facilities. As societies evolved, so did water management techniques, culminating in our modern infrastructure with complex networks of pipes, pumps, treatment facilities, and storage tanks. In contemporary settings, overhead water tanks have become ubiquitous across residential, commercial, agricultural, and industrial sectors. These elevated structures utilize gravity to create water pressure for distribution, eliminating the need for continuous pumping. However, the traditional approach to managing these tanks has remained largely manual, requiring physical monitoring and human intervention to control water pumps. This manual system poses several challenges. First, it demands constant vigilance, with someone needing to check water levels regularly. Second, it's prone to human error, leading to issues like dry runs (pumps operating without water), tank overflows, or water shortages during critical times. Third, the inefficiency of manual operations often results in significant water and electricity wastage, contributing to resource depletion and higher utility costs. The integration of embedded systems and sensor technology into water management represents a growing trend toward smart infrastructure. This transition aligns with broader movements toward resource efficiency, sustainability, and reduced environmental impact. In regions experiencing water scarcity or irregular supply, such automated systems become not just a convenience but a necessity for effective water conservation and distribution.

## II. RELATED WORK

This chapter will provide a research of different paper, including author requirements, research perspective, and overview of project idea, general. Kumar et al. (2022) developed a low-cost IoT-based water level monitoring and control system using ultrasonic sensors and NodeMCU. Their research integrated cloud connectivity through ThingSpeak platform, allowing realtime water level monitoring and control via mobile applications. The system achieved 98% accuracy in water level detection with a response time under 2 seconds for motor switching operations. A notable feature was the implementation of predictive maintenance algorithms that could detect pump malfunctions



before critical failure. The authors concluded that their system reduced water wastage by approximately 30% compared to manual systems and decreased electricity consumption by 25% through optimized pump cycling. The study, however, noted challenges with power consumption of the monitoring system itself, suggesting the need for energy harvesting technologies in future implementations [1]. Sharma and Patel (2023) investigated the application of capacitive sensors for water level detection, addressing the limitations of conductive sensors in hard water regions. Their paper presented a comprehensive comparison between conductive, ultrasonic, capacitive, and float switch sensing technologies across various parameters including accuracy, durability, and cost-effectiveness. The authors implemented a multi-sensor approach that combined capacitive sensing with float switches as fail-safes. Their field tests across 50 household installations demonstrated improved durability with sensors functioning effectively for over 18 months without maintenance, compared to conductive sensors that required cleaning every 3-4 months. The system incorporated an Arduino Mega controller with a custom shield design that simplified installation. A key contribution was their detailed analysis of sensor degradation patterns in different water quality conditions. The research by Wang et al. (2021) focused on energy optimization in water pumping systems through intelligent motor control algorithms. Their system utilized machine learning to analyze water usage patterns and predict optimal pumping schedules. Through implementation of fuzzy logic controllers, the system could dynamically adjust motor speed rather than simply switching between on and off states. Field testing demonstrated energy savings of up to 40% compared to traditional systems. The authors introduced a novel approach to power factor correction that improved the overall electrical efficiency of the pumping system. Additionally, they developed pump acceleration and deceleration profiles that minimized water hammer effects, thereby extending infrastructure lifespan. The study highlighted the potential for further efficiency gains by integrating weather forecast data to anticipate rainfall and adjust storage levels accordingly [2]. Rodriguez and Kim (2024) presented a comprehensive evaluation of various wireless technologies for water level monitoring systems. This paper compared WiFi, LoRaWAN, ZigBee, and Bluetooth Low Energy in terms of power consumption, range, reliability, and implementation complexity. The researchers developed a modular system architecture that could accommodate multiple communication protocols based on deployment requirements. Their findings revealed that LoRaWAN was optimal for rural installations with limited power availability, while WiFi provided better performance in urban settings with stable power supply. The study included detailed power consumption profiles for each configuration and proposed an adaptive communication strategy that could switch between protocols based on power availability and transmission urgency. Their system architecture has since been adopted by several commercial water management solutions [3]. Gupta et al. (2023) explored the integration of solar power with automated water level monitoring systems for agricultural applications. Their design incorporated a 50W solar panel with battery storage that enabled completely off-grid operation. The system used float switches for reliability and low power consumption, with a custom-designed controller that entered ultra-lowpower sleep modes between measurements. Field testing in rural Indian farms demonstrated system autonomy of up to three months without maintenance. The authors developed an innovative water level prediction algorithm that correlated historical pumping patterns with crop water requirements and soil moisture readings. Their economic analysis showed that despite higher initial costs, the solar-powered system achieved return on investment within 14 months through savings on electricity bills and reduced crop losses from irregular irrigation [4]. The work by Oladapo et al. (2021) focused on improving reliability through redundant sensing mechanisms. Their system employed triple-redundant water level detection using different sensor technologies—conductive probes, ultrasonic sensors, and pressure transducers—with a voting algorithm to determine the actual water level. This approach achieved a remarkable 99.8% reliability rate over their 12-month testing period. The authors implemented a self-diagnostic subsystem that could detect sensor drift or failure and automatically recalibrate or notify maintenance personnel. They also developed a comprehensive fault tree analysis for water pumping systems that identified critical failure modes and implemented appropriate safeguards. The research concluded with a detailed MTBF (Mean Time Between Failures) analysis that demonstrated a threefold improvement over conventional single-sensor system [5]. Chen and Williams (2022) investigated the application of edge computing concepts to water management systems. Rather than transmitting raw sensor data for processing, their system performed local analytics and sent only action .

### **III. PROPOSED ALGORITHM**

This dissertation falls within the interdisciplinary domain of Internet of Things (IoT) applications for resource management, specifically focusing on smart water management systems. The research integrates multiple technical areas including:

**Embedded Systems Engineering** The dissertation incorporates principles of embedded systems design, focusing on the development of microcontroller based solutions that operate reliably in various environmental conditions. This includes sensor integration, signal conditioning, and real-time processing of environmental data. The work emphasizes low-power design techniques and reliable operation in challenging environments where water systems typically function.

**Internet of Things Architecture** The research embraces core IoT architectural principles, developing a comprehensive system that spans edge devices (sensors and controllers), gateway technologies, cloud infrastructure, and end-user interfaces. This encompasses the implementation of appropriate communication protocols, data management strategies, and system security measures essential for IoT deployments.

**Sensing Technologies** A significant focus area is the evaluation, selection, and implementation of appropriate sensing technologies for water level detection. The dissertation examines the relative merits of various sensing approaches including ultrasonic, capacitive, conductive, and mechanical methods, addressing factors such as accuracy, reliability, maintenance requirements, and cost effectiveness under different operating conditions.

**Control Systems** The dissertation applies control systems theory to develop efficient motor control algorithms that maintain desired water levels while minimizing energy consumption and mechanical wear. This includes the implementation of appropriate control loops, threshold management, and fail-safe mechanisms to ensure system reliability.

**Energy Efficiency** Energy conservation is a central theme, with research into optimizing power consumption of both the sensing/control system and the water pump itself. This may include investigation of solar power integration, battery management systems, and intelligent scheduling algorithms that leverage off-peak electricity rates.

**User Interface Design** The research addresses human-computer interaction aspects through the development of intuitive interfaces that provide meaningful visualizations of system status and water usage patterns. This includes mobile and web applications designed for various user profiles from homeowners to facility managers.

**Data Analytics** The dissertation incorporates data science principles to transform collected water usage data into actionable insights. This includes the development of algorithms for pattern recognition, anomaly detection, predictive maintenance, and consumption forecasting that enhance the system's value beyond basic automation. This multidisciplinary approach enables the dissertation to address water management challenges comprehensively, contributing to the growing body of knowledge around sustainable resource management through smart technology integration.

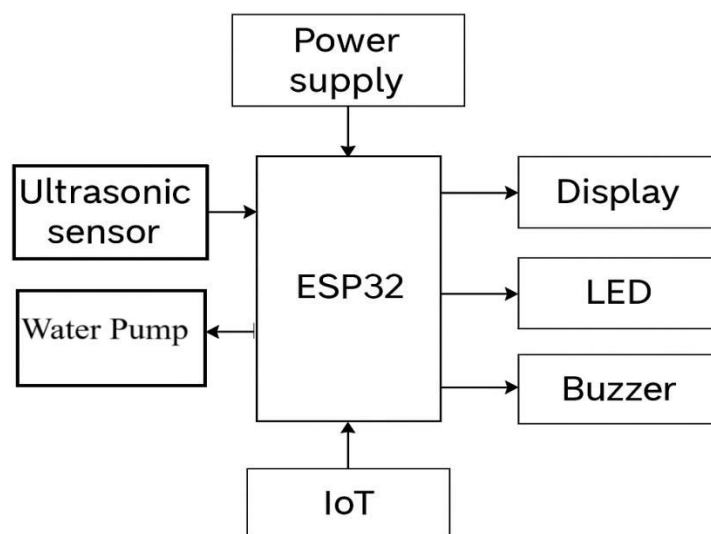


Fig: Block Diagram

The scope of this dissertation encompasses the complete development lifecycle of an IoT-based Water Level Indicator and Automatic Motor Switching System from conceptualization through implementation and validation. Specifically, the research will include:

- **Hardware Components**

Selection, integration, and calibration of appropriate water level sensing technologies (ultrasonic, capacitive, float switches, or combined approaches) Design of motor control circuitry including relay systems, power management, and protective mechanisms Implementation of microcontroller-based processing units for data acquisition and control logic Integration of wireless communication modules for Internet connectivity and device-to-device communication Development of power management solutions including potential solar integration for off-grid applications

- **Software Development** Embedded software for sensor data acquisition, processing, and motor control algorithms Cloud-based backend services for data storage, processing, and management Web and mobile application interfaces for user interaction and system management Implementation of data analytics algorithms for usage pattern recognition and prediction Security protocols and measures to protect system integrity and user data

- **System Integration** Creation of cohesive hardware-software architecture ensuring seamless operation Development of communication protocols between system components Integration with existing smart home/building ecosystems where applicable Implementation of over-the-air update mechanisms for future improvements

- **Testing and Validation** Laboratory testing of individual components and integrated system under controlled conditions Field testing in varied environments to evaluate real-world performance Assessment of system reliability, accuracy, and efficiency over extended operation periods Evaluation of user experience and system usability through structured feedback mechanisms.

#### **IV. PROPOSED METHODOLOGY**

This project automates the water level monitoring and motor control process using an ESP32 microcontroller integrated with ultrasonic sensors and IoT technology. It continuously checks the water level in an overhead tank and controls the water pump based on preset thresholds. The system enhances efficiency, reduces human intervention, and prevents water and power wastage.

1. **Power Supply Module**

- Provides regulated voltage (typically 5V or 3.3V) to all components including ESP32, sensors, display, and motor relay.
- Can include a battery backup or AC-DC adapter.

2. **Sensing Module**

- Ultrasonic Sensor (like HC-SR04) is used to detect water levels by measuring the distance between the sensor and the water surface.
- Replaces traditional float/conductive sensors for better accuracy and reliability.

3. **Control Unit (ESP32 Microcontroller)**

- Acts as the brain of the system.
- Reads sensor data, compares with threshold values, and takes decisions accordingly.
- Communicates with IoT module for remote updates.

4. **Display Module**

- LCD/LED display shows current water level status (Empty, Low, Medium, Full).
- May also display system status like pump ON/OFF.

5. **Alert Module**

- Buzzer alerts when tank is full or empty.
- LEDs provide visual indication for water levels or pump state.

6. **Motor Control Module**

- Uses a relay driver circuit to switch the water pump ON or OFF based on ESP32 output.

7. **IoT Module**

- Enables real-time remote monitoring using platforms like Blynk, Firebase, or MQTT.
- Sends water level updates and alerts to a smartphone or web dashboard



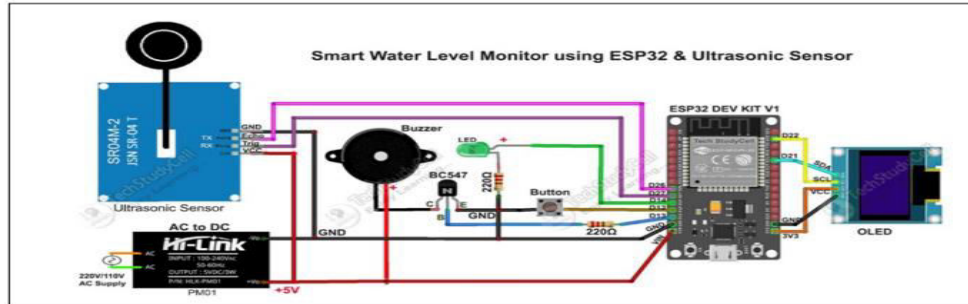


Fig: Circuit Diagram

## V. SIMULATION RESULTS

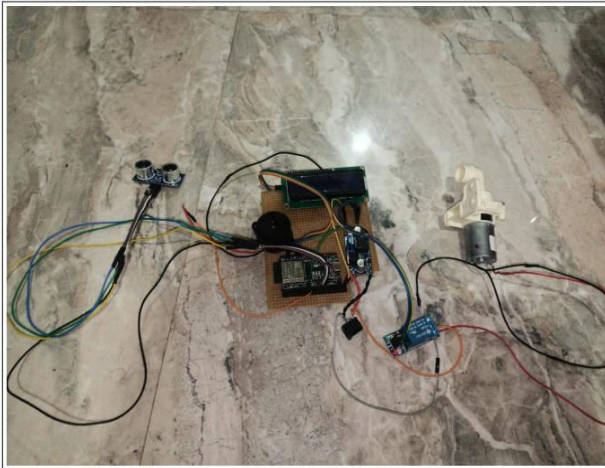


Fig 1: Experimental setup

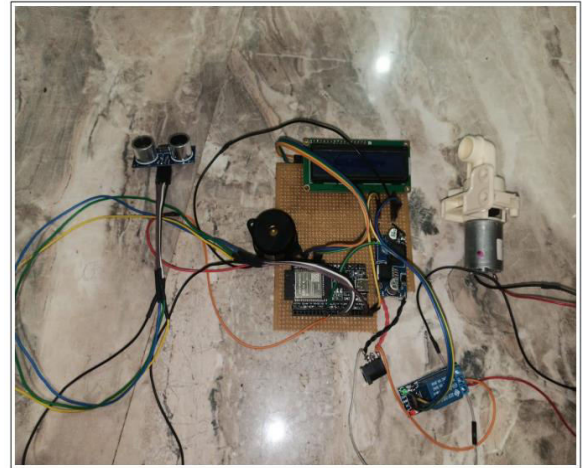


Fig 2: Experimental setup

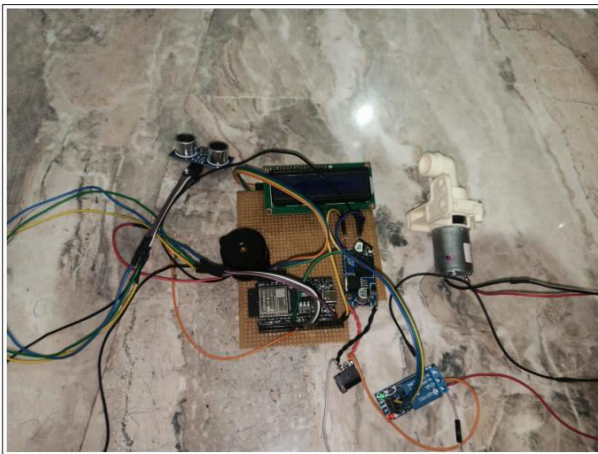


Fig 3: Experimental setup

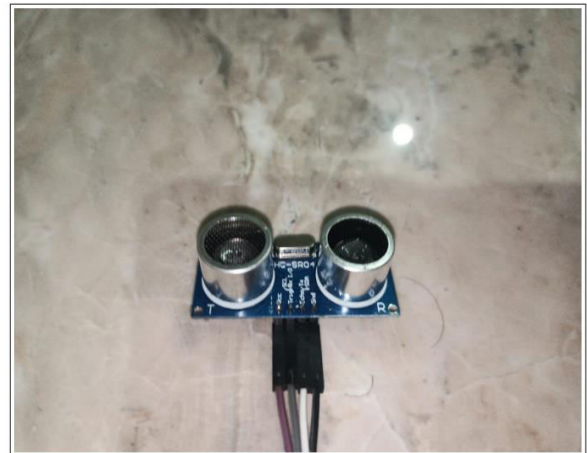


Fig 4: Experimental setup

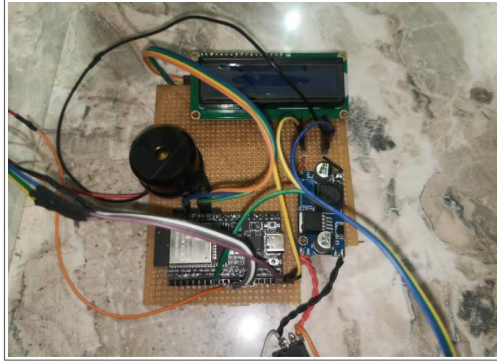


Fig 5: Experimental setup



Fig 6: Experimental setup

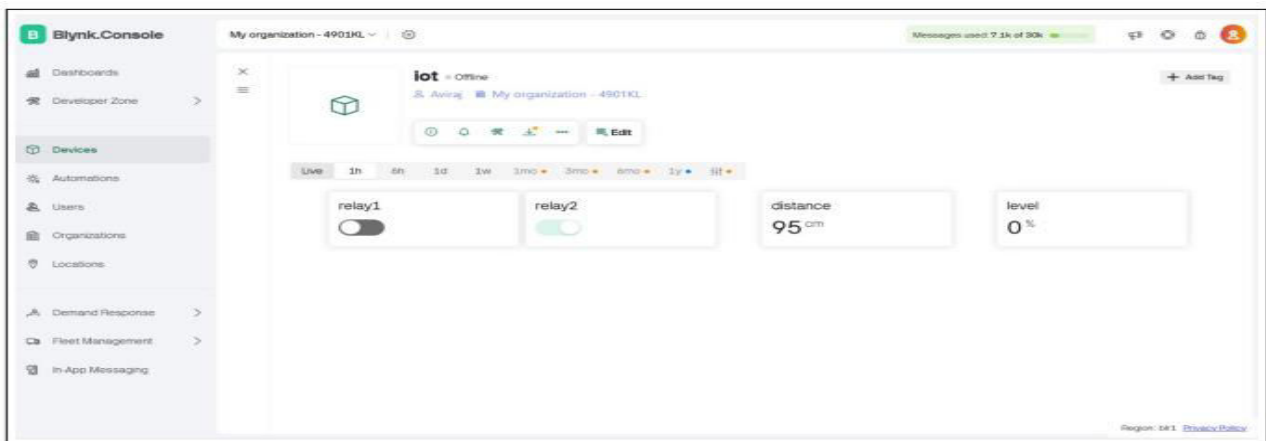


Fig 7: Website Interface

## VI. CONCLUSION AND FUTURE WORK

Develop a cross-platform mobile app to remotely monitor water levels, control motor operations, and receive notifications. Cloud Analytics: Store historical water level data in the cloud to analyse trends, optimize usage, and forecast water demand. Multiple Tank Monitoring: Extend the system to support monitoring and managing multiple water tanks simultaneously from a centralized dashboard. Solar Power Integration: Incorporate renewable energy sources like solar panels to make the system energy-efficient and suitable for remote locations. Leak Detection & Maintenance Alerts: Add sensors for leak detection and generate predictive maintenance alerts to prevent overflows and equipment damage. Voice Assistant Support: Enable voice control features (via Alexa, Google Assistant, etc.) for hands-free operation and status queries. AI-Based Decision Making: Integrate machine learning models to automatically adjust thresholds based on usage patterns or environmental conditions.

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