



A REVIEW OF SMART WATER LEVEL AND TEMPERATURE MONITORING SYSTEMS WITH TFT GRAPHICS

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Abstract:

This project presents the design and implementation of a Water Level and Temperature Monitoring System with TFT Graphics using ESP32. The system is developed to continuously monitor the water level and temperature in tanks or reservoirs and display the measured values in real time using a graphical TFT display. The main objective of the project is to provide an accurate, cost-effective, and user-friendly solution for water resource monitoring while reducing manual inspection and preventing water wastage.

The system uses an HC-SR04 ultrasonic sensor to measure the water level by calculating the distance between the sensor and the water surface. A DHT11 temperature sensor is used to measure the surrounding temperature. The ESP32 microcontroller collects data from both sensors, processes the readings, and displays the information on an TFT display in the form of graphical water level indicators, percentage values, and temperature readings. The graphical interface makes it easy for users to understand the current status of the water tank at a glance.

To improve safety and monitoring efficiency, the system also includes LED indicators and a buzzer. The LEDs indicate different water level conditions such as low, medium, and full, while the buzzer provides an audible alert whenever the water level falls below the minimum threshold or reaches a critical condition. In addition, the project integrates the Blynk IoT platform, allowing users to monitor water level and temperature remotely through a smartphone over Wi-Fi. This



enables real-time monitoring from any location with an internet connection.

The developed system is designed with a modular architecture, making it simple to install, operate, and maintain. The ESP32 microcontroller enables efficient data processing and wireless communication, allowing seamless integration with IoT platforms for future expansion. The graphical TFT display provides a clear and interactive user interface, enabling users to monitor system parameters quickly without requiring technical expertise. By combining sensor technology, embedded systems, and IoT connectivity, the proposed solution offers a reliable approach to smart water resource management while supporting sustainable water conservation practices. The system can also be upgraded with additional features such as automatic motor control, cloud data storage, water quality monitoring, and predictive analytics to meet future smart water management requirements.

The proposed system offers several advantages, including high measurement accuracy, real-time monitoring, low power consumption, reduced human effort, and easy installation. It helps prevent water overflow, avoids water shortages, and supports efficient water management. The prototype has been successfully tested under different water level conditions, demonstrating reliable performance, fast response, and stable operation. The system is suitable for applications such as residential water tanks, industrial water storage, agricultural irrigation systems, educational laboratories, and smart water management solutions.

Keywords: Esp32, Water level monitoring, Temperature monitoring, TFT display , Real-time monitoring, Blynk IOT.

1. INTRODUCTION

Water is one of the most valuable natural resources and is essential for human life, agriculture, industries, and environmental sustainability. Effective water management has become increasingly important due to rapid population growth, urbanization, industrial expansion, and climate change. The demand for clean and sufficient water is continuously increasing, making it necessary to monitor water storage systems accurately and efficiently. Improper management of water tanks often leads to problems such as water overflow, insufficient water supply, pump dry running, increased electricity consumption, and unnecessary water wastage. These issues not only increase operational costs but also affect the efficient utilization of available water resources.

In many homes, industries, and agricultural fields, water tank monitoring is still performed manually. This traditional method requires continuous human supervision and is often inaccurate, time-consuming, and inefficient. Manual monitoring can result in delayed actions, causing overflow or empty tanks that interrupt daily activities. Therefore, there is a growing need for an automated water monitoring system capable of providing accurate measurements, real-time information, and timely alerts to users.

Recent advancements in embedded systems, microcontrollers, sensors, and Internet of Things



(IoT) technologies have made smart monitoring systems more reliable, affordable, and easy to implement. Microcontroller-based systems can continuously collect sensor data, process it in real time, and control connected devices with high accuracy. The integration of wireless communication further enables remote monitoring and improves the accessibility of system information through smartphones and internet-enabled devices.

This project presents the design and implementation of a Water Level and Temperature Monitoring System with TFT Graphics using ESP32. The ESP32 microcontroller serves as the main processing unit due to its high processing capability, built-in Wi-Fi connectivity, and low power consumption. The system uses an HC-SR04 ultrasonic sensor to measure the water level by calculating the distance between the sensor and the water surface. Since the sensor works without direct contact with water, it provides accurate and reliable measurements while reducing maintenance requirements.

To monitor environmental conditions, a DHT11 temperature sensor is integrated into the system. The sensor continuously measures the surrounding temperature, enabling users to observe environmental variations that may affect water storage conditions. The temperature readings are processed by the ESP32 along with the water level data to provide complete monitoring information.

A significant feature of the proposed system is the use of TFT graphical display. Unlike conventional LED indicators or seven-segment displays, the TFT display presents information in an attractive and user-friendly graphical format. It displays the water level using graphical bars, percentage values, and numerical readings, along with the current temperature. The graphical interface allows users to quickly understand the system status without interpreting complex numerical values, thereby improving usability and monitoring efficiency.

The system also incorporates LED indicators and a buzzer to provide visual and audible alerts. Different LEDs indicate various water level conditions such as low, medium, and full levels. Whenever the water level reaches a critical condition, the buzzer generates an alarm to notify the user immediately. These alert mechanisms improve system safety by preventing water shortages and reducing the possibility of overflow.

To enhance accessibility and support smart monitoring, the project is integrated with the Blynk IoT platform. Through the built-in Wi-Fi capability of the ESP32, sensor data is transmitted to the Blynk application, allowing users to monitor the water level and temperature remotely using a smartphone. Real-time monitoring enables users to access important information from any location with an internet connection, making the system more flexible and convenient.

The proposed monitoring system offers several advantages, including real-time operation, accurate sensing, low maintenance, low power consumption, simple installation, and cost-effective implementation. It minimizes human intervention, conserves water, reduces electricity consumption, and improves the overall efficiency of water management. The modular design also



allows future enhancements such as automatic motor control, cloud-based data storage, historical data analysis, water quality monitoring, SMS notifications, and predictive maintenance using artificial intelligence.

The developed prototype has been tested under different operating conditions and has demonstrated reliable performance in measuring water level and temperature. The graphical TFT interface, IoT-based remote monitoring, LED indicators, and buzzer alerts together provide an efficient and user-friendly solution for water management. The system is suitable for residential water tanks, industrial storage tanks, agricultural irrigation systems, educational laboratories, commercial buildings, and smart city applications.

2. LITERATURE SURVEY

Gupta et al. (2025)[1] proposed an IoT-enabled smart water monitoring system featuring a graphical TFT display and cloud connectivity. The system collected sensor data in real time, supported remote monitoring, and enabled predictive analysis for efficient water resource management.

Mahajan et al. (2024)[2] designed an intelligent embedded water management system incorporating water level detection, temperature monitoring, automatic motor control, and a TFT graphical interface. Their solution minimized water wastage while improving automation in domestic water supply systems.

Roy et al. (2024)[3] developed a multi-parameter water monitoring system capable of measuring water level, temperature, and turbidity. A TFT graphical display presented the information using dynamic charts, making data visualization and interpretation more effective.

Verma and Gupta (2023)[4] introduced a water tank monitoring system equipped with GSM-based notifications and a TFT display. The system provided remote status updates through automated alerts, improving accessibility and user convenience.

Joshi and Kulkarni (2023)[5] implemented an Arduino-based automatic water level and temperature monitoring system with a TFT LCD. The graphical display presented numerical values and waveform plots for improved accuracy and easier analysis.

Reddy and Kumar (2022)[6] presented a microcontroller-based water monitoring solution that displayed real-time measurements on a TFT graphical interface. The system enhanced measurement accuracy and improved the readability of monitoring data.

Nair et al. (2022)[7] proposed a smart irrigation system that integrated water level and temperature sensing with a TFT display. The graphical interface offered clear visual information, assisting farmers in making informed irrigation decisions.

Bhosale and Patankar (2022)[8] developed an affordable embedded water tank monitoring system featuring a real-time TFT display. The design focused on cost-effectiveness and practical



implementation for household applications.

Patil and Deshmukh (2021)[9] designed a smart water tank monitoring system that combined temperature sensing with a TFT graphical display. The system improved the presentation and interpretation of monitoring information.

Mehta and Joshi (2021)[10] proposed a smart water management system using ultrasonic and temperature sensors. The TFT display illustrated graphical trends, enabling efficient monitoring and quick decision-making.

Khan and Ahmed (2021)[11] developed an IoT-based water level monitoring system with cloud connectivity and a TFT graphical interface. Their approach enhanced remote access, real-time monitoring, and data management.

Kumar et al. (2020)[12] introduced an Arduino-based water level monitoring system utilizing ultrasonic sensing and automatic motor control. The system reduced manual intervention while improving water management efficiency.

Singh et al. (2020)[13] presented an automated water pump control system with temperature monitoring to protect motors from overheating. Their design contributed to energy conservation and reliable system operation.

Chaudhary et al. (2020)[14] developed a digital water monitoring system based on Arduino and temperature sensors with a TFT display. The graphical interface improved usability and simplified system monitoring.

Sharma et al. (2019)[15] proposed an IoT-based solution for real-time monitoring of water level and temperature using Node MCU and cloud technology.

Desai et al. (2019)[16] designed an automatic water tank filling system incorporating a graphical display and buzzer alerts. The solution effectively prevented tank overflow and dry-run conditions.

Ali et al. (2018)[17] introduced an economical real-time water level monitoring system using capacitive sensing technology and a graphical display interface. The system emphasized affordability while maintaining reliable performance.

Thomas and Kumar (2017)[18] developed a household water monitoring system using float sensors, temperature sensors, a microcontroller, and an LCD display. Automatic motor control improved reliability and prevented water overflow.

Rao et al. (2016)[19] presented an embedded water monitoring system integrating ultrasonic sensing with GSM communication. SMS notifications informed users about water level changes, enabling remote supervision and automation.

Patel and Shah (2015)[20] proposed a low-cost Arduino-based system for monitoring water level and temperature in real time. The system displayed readings digitally and supported efficient motor control.

Karthik et al. (2014)[21] designed a real-time monitoring system that incorporated temperature sensing with a microcontroller. Digital data presentation reduced manual effort and provided an affordable solution for residential applications.

3. PROPOSED METHODOLOGY

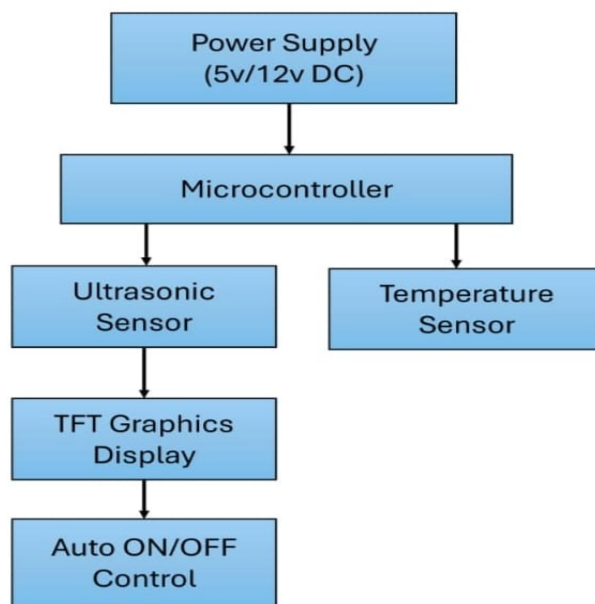


Figure 1 Block diagram of Water Level & Temperature Monitor with TFT Graphics

The Water Level and Temperature Monitoring System with TFT Graphics using ESP32 is designed to continuously monitor the water level in a tank and the surrounding temperature in real time using sensor-based technology. The system mainly consists of an ESP32 microcontroller, an HC-SR04 ultrasonic sensor for water level measurement, a DHT11 temperature sensor, TFT graphical display, LED indicators, a buzzer, and the Blynk IoT platform for remote monitoring.

When the system is powered ON, the ESP32 microcontroller initializes all connected devices, including the ultrasonic sensor, DHT11 sensor, TFT display, LEDs, buzzer, and Wi-Fi connection. The ESP32 continuously collects data from the sensors and processes it in real time.

The HC-SR04 ultrasonic sensor is mounted at the top of the water tank. It transmits ultrasonic sound waves toward the water surface and measures the time taken for the reflected echo to return. Using this time, the ESP32 calculates the distance between the sensor and the water surface and converts it into the water level percentage. Based on the measured value, the system determines whether the tank is Empty, Low, Medium, or Full.

At the same time, the DHT11 sensor continuously measures the surrounding temperature and sends digital data to the ESP32. The controller processes this information and converts it into temperature



values expressed in degrees Celsius (°C).

The processed sensor readings are displayed on the TFT graphical display. The display presents the current water level using graphical bars, percentage values, and text indicators along with the real-time temperature reading. This graphical representation allows users to understand the status of the tank quickly and accurately.

To provide immediate visual indications, the system uses LED indicators. Different LEDs glow according to the water level conditions, allowing users to identify the tank status easily. A buzzer is activated whenever the water level reaches a critical low level, providing an audible warning so that corrective action can be taken promptly.

The ESP32 also connects to the Blynk IoT platform through its built-in Wi-Fi module. The measured water level and temperature data are transmitted to the Blynk mobile application, allowing users to monitor the system remotely in real time from anywhere with an internet connection.

The entire monitoring process is repeated continuously at regular intervals. This ensures accurate, real-time monitoring of water level and temperature while reducing manual effort, preventing water-related problems, and improving overall water management efficiency. The developed system is suitable for residential water tanks, agricultural applications, industrial storage tanks, and other smart water monitoring applications.

4. CONCLUSION

The Water Level and Temperature Monitoring System with TFT Graphics using ESP32 has been successfully designed and implemented to provide an efficient, accurate, and real-time solution for monitoring water level and temperature. The system utilizes an HC-SR04 ultrasonic sensor to measure the water level, a DHT11 sensor to monitor temperature, and TFT display to present the information in a clear graphical format. The integration of LED indicators, a buzzer, and the Blynk IoT platform further improves the functionality by providing visual alerts, audible warnings, and remote monitoring capabilities.

The developed system minimizes manual intervention, improves monitoring accuracy, and helps users detect low or full water levels quickly. Real-time graphical visualization and IoT connectivity make the system easy to use and suitable for modern smart monitoring applications. The prototype demonstrated reliable performance, fast response, and stable operation under different testing conditions.

Overall, the proposed system provides a low-cost, user-friendly, and energy-efficient solution for water management. It can be effectively used in residential water tanks, agricultural irrigation systems, commercial buildings, and industrial water storage applications. In the future, the system can be further enhanced by integrating automatic motor control, cloud-based data logging, water quality sensors, SMS or email notifications, and AI-based predictive monitoring for smarter and



more efficient water resource management.

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