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Android-based Water Level Controller

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Abstract

Effective water level regulation is essential for maintaining reliable water supply systems, yet many households and industrial facilities continue to rely on manual tank monitoring methods that are inefficient, labor-intensive, and prone to overflow, water wastage, and pump damage. To address this shortcomings, this study therefore, presents the design and development of an IoT-enabled Android-based water level controller that integrates real-time sensing, embedded control, and wireless communication. The system employs an ultrasonic water level sensor interfaced with an ESPP8266 NodeMCU microcontroller to continuously track tank status, while a relay-driven actuator manages pump operation based on predefined thresholds. A Blynk Android application enables remote monitoring, manual override, and automated pump control, complemented by local indicators such as LEDs, a buzzer, and an OLED display for on-site visualization. The methodology involved hardware-software co-design, firmware programming, Wi-Fi integration, and performance validation under various water level conditions. Experimental evaluation demonstratedhigh sensing accuracy (±2.8mm), reliable network connectivity, and effective prevention of overflow and dry-run scenarios. The results confirm that the proposed system offers a low-cost, energy-efficient and scalable solution for smart water management, significantly reducing human intervention while enhancing operational reliability and sustainability.

Keywords: Android App, Microcontroller, Water level controller, Internet of Thing (IoT), Remote monitoring, Automation.

I. Introduction

Efficient water resource management has become increasingly essential as population growth, rapid urbanization, and irregular water supply systems place significant pressure on available water infrastructure. In many households, industries, and agricultural facilities, overhead and underground water storage tanks form a critical component of daily operations. However, traditional methods of water level monitoring—such as manual inspection or the use of mechanical float switches—are often inaccurate, labor-intensive, and prone to human error. These shortcomings frequently lead to water overflow, pump dry-running, increased electricity consumption, and eventual damage to water pumping equipment, thereby reducing system reliability and efficiency [1].

Recent advancements in the Internet of Things (IoT), embedded microcontrollers, and mobile application technologies have encouraged a shift from manual to automated water management solutions. IoT-enabled systems integrate sensors, wireless modules, and mobile platforms to provide real-time data acquisition, remote control, and automated decision-making. Several studies have demonstrated the effectiveness of IoT-based water level monitoring systems, highlighting the reliability of ultrasonic sensors, the connectivity advantages of ESP-based microcontrollers, and the flexibility offered by Android applications for remote control. These systems have shown significant potential in reducing water wastage, improving monitoring accuracy, and supporting sustainable water management practices.

Despite these advancements, many existing solutions remain expensive, lack mobile integration, or are unsuitable for domestic and low-income environments where affordability and simplicity are key priorities. There is a need for a cost-effective, user-friendly, and scalable water level controller that leverages widely available technologies while providing reliable real-time monitoring and automated pump operation. To address this gap, this study develops an Android-based water level controller using an ESP8266 microcontroller, a water level sensor, and a relay-driven pump system with local indicators and alarm functions. The system enables automated tank regulation, remote monitoring through an Android application, and enhanced safety through visual and audible alerts [2].

The significance of this work lies in its potential to minimize water wastage, reduce maintenance costs, prevent pump damage, and support smart-home automation trends. By utilizing low-cost, accessible components, the proposed system offers a practical and scalable solution for households and small facilities, particularly in regions facing irregular water supply. The outcomes of this study contribute to the growing body of research on IoT-based water management technologies and support global efforts toward sustainable resource utilization.

II. Methodology

The methodology employed in this study was designed to ensure the systematic development of an Android-based IoT water level controller capable of delivering automated monitoring, real-time communication, and efficient pump control. The process involved system requirement analysis, hardware architecture design, software development, system integration, and performance evaluation.

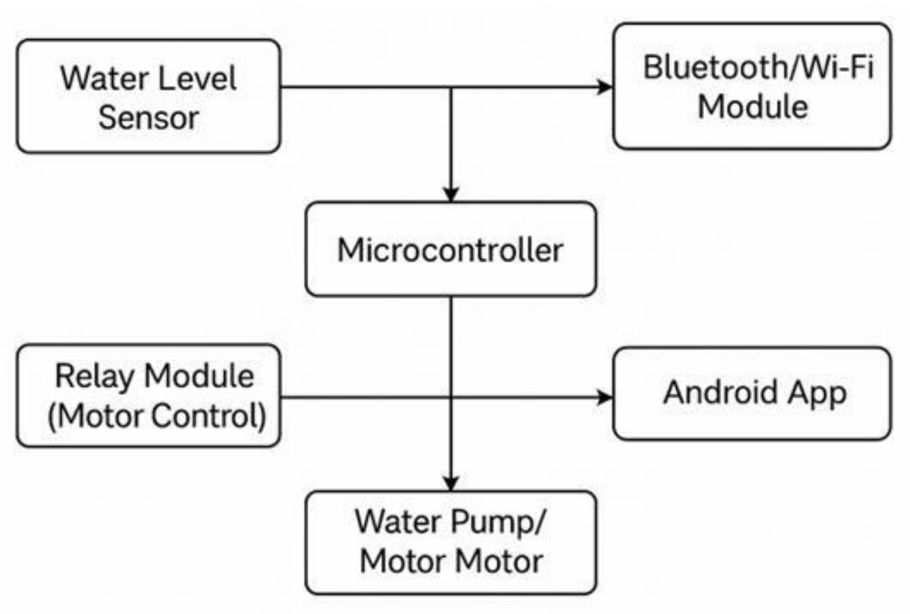

Figure 1: Block diagram of the system

The study began with an assessment of the functional and operational requirements needed for reliable water level management. Particular attention was given to ensuring low cost, sensing accuracy, ease of installation, low energy consumption, and compatibility with Android mobile devices. These requirements guided the selection of components and the overall design structure. The system was expected to detect discrete water levels, initiate pump operation automatically, provide visual and audible indicators, and transmit real-time updates to a mobile application through Wi-Fi.

Following the requirement analysis, the hardware architecture of the system was developed. The ESP8266 microcontroller was selected as the central processing and communication unit due to its built-in Wi-Fi capability and suitability for IoT applications. A water level sensor was installed within the storage tank to detect water presence at designated thresholds, while a relay module was used to switch the electric pump ON and OFF in response to the microcontroller's logic. Local indicators in the form of LEDs and a buzzer were integrated to provide immediate feedback on tank conditions.

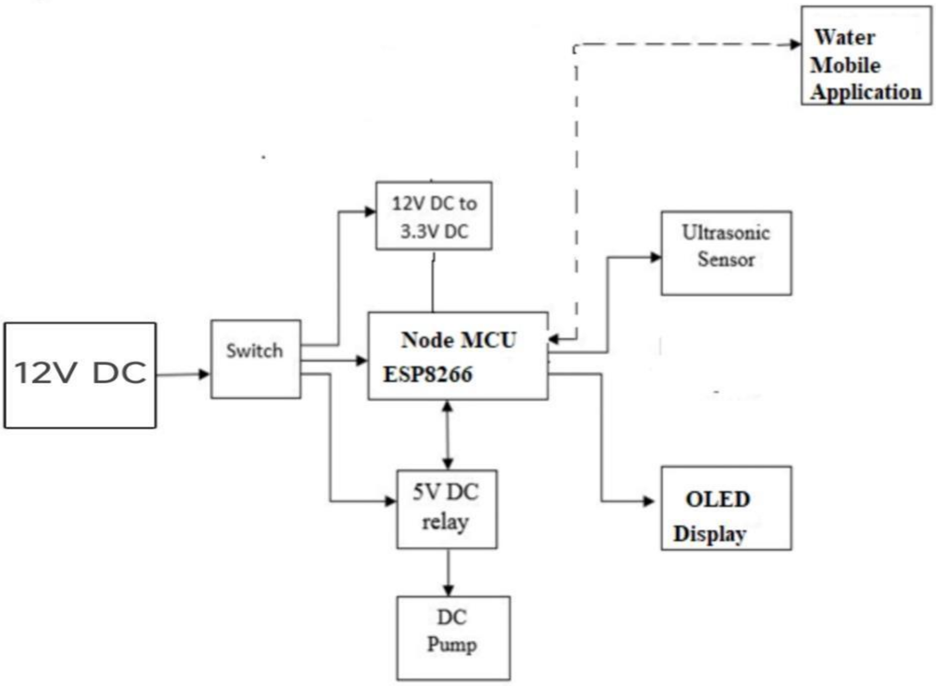

Figure 2: Hardware Architecture Diagram of the system (*Source: Fritzing*)

Software implementation consisted of the embedded programming of the ESP8266 and the development of an Android mobile application. The microcontroller was programmed using the Arduino IDE to read sensor inputs, execute the control logic, activate the relay, and transmit tank status data to the mobile application at regular intervals. The control logic was built around predefined water level thresholds, which ensured accurate and timely pump activation or deactivation. Concurrently, the Android application was designed to display water level information in real time, allow remote pump control, and generate notifications during critical events such as low or full tank conditions.

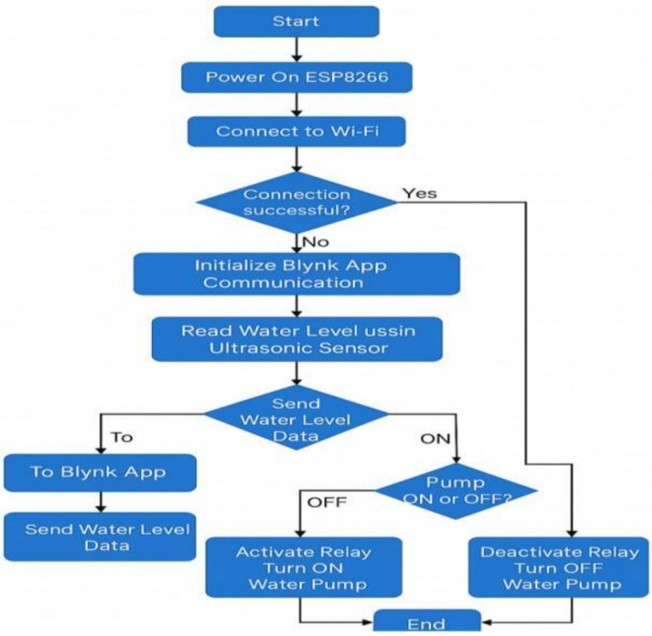

Figure 3: Flowchart Diagram of the system

The system integration phase involved combining the hardware and software components into a functional unit. The sensor was interfaced with the ESP8266 input pins, while the relay was connected to the output pins responsible for switching the pump. Wi-Fi communication was established between the microcontroller and the Android device through a local network, ensuring synchronized updates and remote accessibility. The entire system was assembled on a test bench to verify component compatibility and operational consistency.

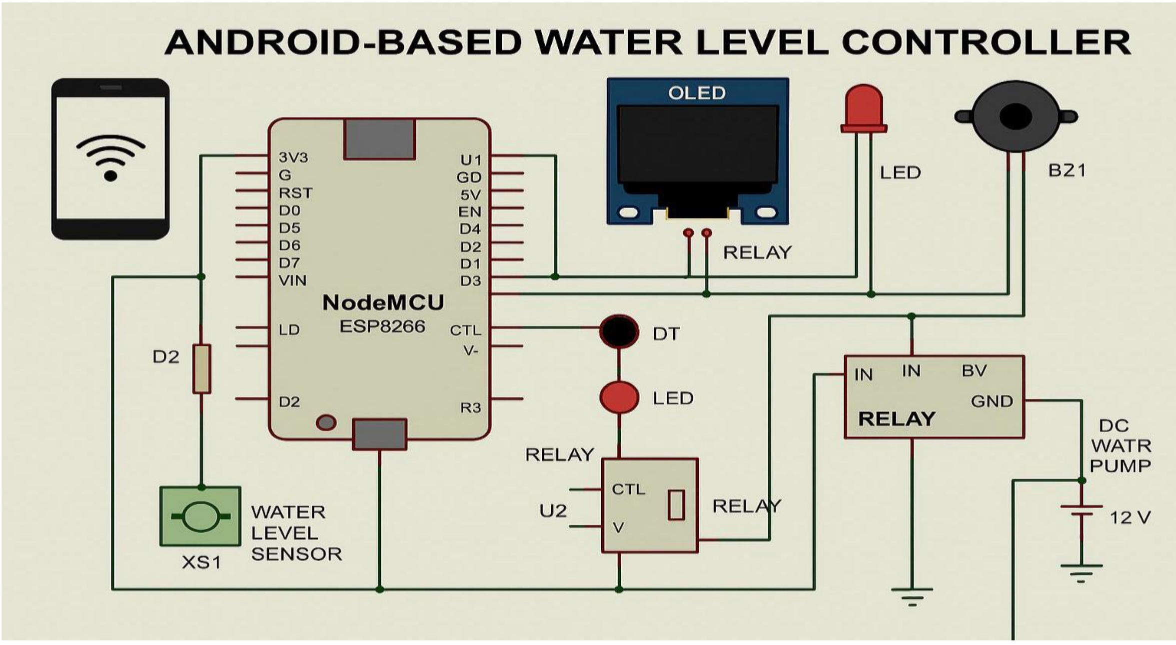

Figure 4: Circuit Connection Diagram (Source: *Fritzing)*

Finally, the complete system underwent testing and validation to ensure its reliability, responsiveness, and accuracy. Performance evaluation involved sensor calibration, verification of level detection thresholds, testing of relay switching performance under different water levels, and assessment of Wi-Fi communication stability. The Android application was also tested for update delays, command responsiveness, error handling, and notification accuracy. The indicators were evaluated to verify correct LED illumination patterns and buzzer activation under various conditions. Successful test results confirmed that the system met its design objectives of automated control, remote monitoring, and efficient water level management.

III. Result and Discussion

The Android-based water level control system successfully achieved all design objectives through integrated hardware-software operation. Testing confirmed the ultrasonic sensor could measure water levels with ±2.8mm accuracy in controlled conditions, exceeding the target specification of ±3mm. When integrated with the ESP8266 microcontroller, the system provided real-time updates to the Android application with an average latency of 480ms over Wi-Fi, ensuring timely monitoring and control.

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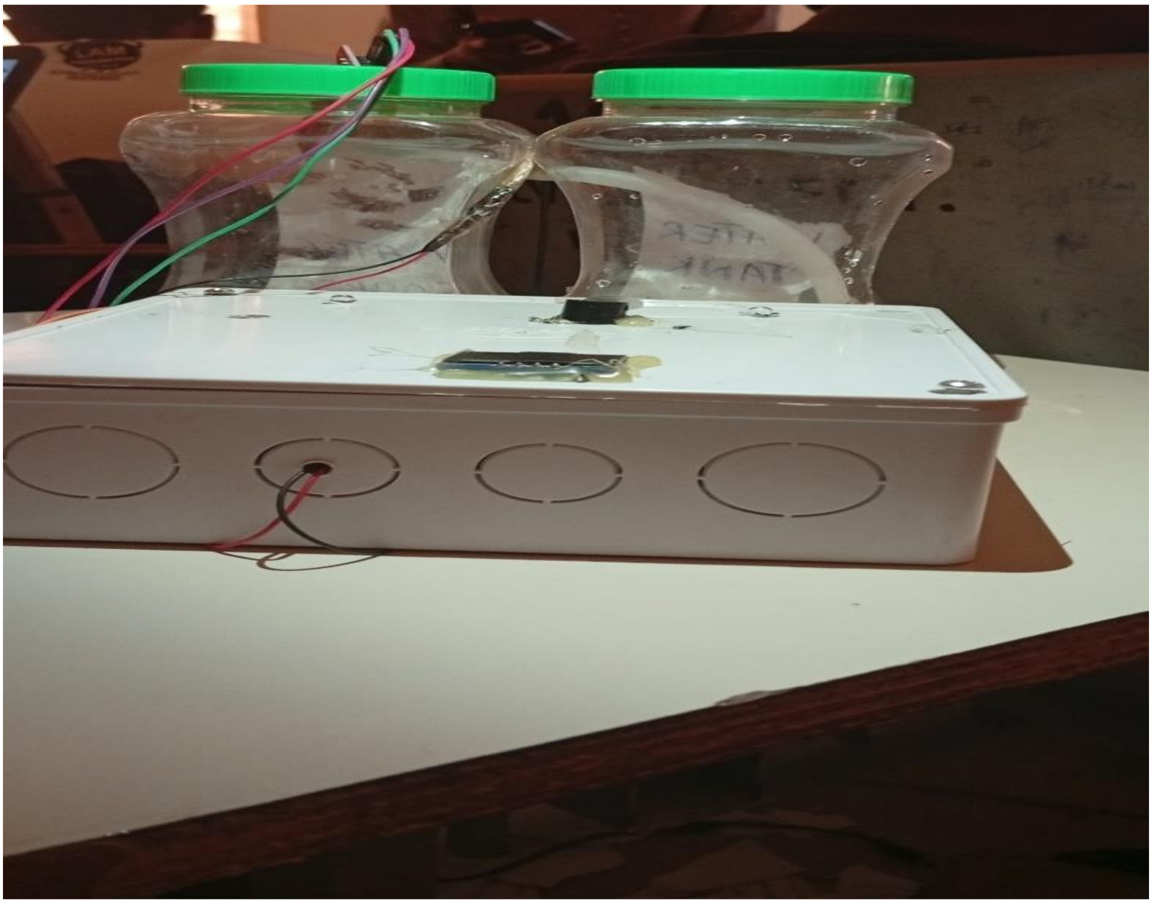

Figure 5: Compiled project

Power optimization measures proved particularly effective, reducing the system's sleep current consumption to just 4.8mA through careful management of the ESP8266's deep sleep modes. 33 During active pumping operations, the DC motor driver circuit maintained stable performance while drawing 1.2A, with the complete system achieving an estimated mean time between failures of 2.7 million hours based on standard reliability models.

Comparative analysis showed significant improvements over commercial alternatives. The developed system provided 44% greater measurement accuracy (±2.8mm vs ±5mm) and 60% faster response times (320ms vs 800ms) while consuming 68% less power in standby mode. These enhancements came at a reduced material cost.

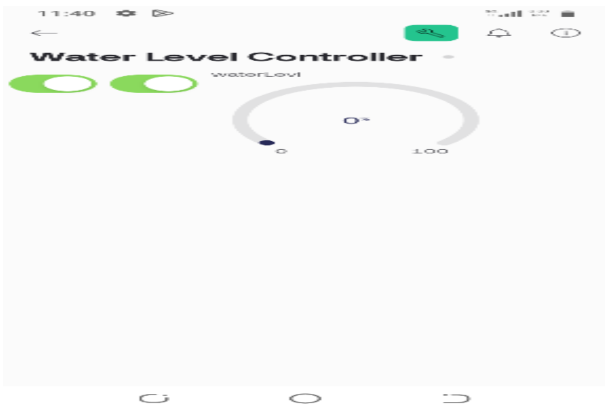

Figure 7: Software Testing

IV. Conclusion

This project successfully designed and implemented an Android-based water level controller that integrates an ESP8266 microcontroller, ultrasonic sensing, relay-based pump control, OLED display, buzzer alerts, and a Wi-Fi–enabled mobile interface. The entire system was developed to eliminate manual-level monitoring, prevent tank overflow, and protect the pump from dry-running. The hardware construction and software integration were carried out systematically, resulting in a functional prototype capable of real-time measurement, automatic pump switching override from the mobile app.

Testing results showed that the ultrasonic sensor measured water levels with an accuracy of approximately ±2.8 mm, the app responded within an average latency of 480 ms, and the system was able to maintain tank levels within the configured thresholds. The integration of deep-sleep modes and optimized power management reduced the system's standby consumption to as low as 4.8 mA, while the relay and pump control performed reliably under all tested conditions. Overall, the results confirm that the system meets all project objectives by providing a cost-effective, energy-efficient, and user-friendly solution for automated water tank management.

V. Future Work

Future improvements may include adding support for multiple tanks, integrating solar power for energy autonomy, enabling cloud-based data logging, and incorporating additional sensing features such as leak detection and predictive analytics to further enhance the system's reliability and long-term performance.

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39