IoT Based Water Level Monitoring and Pump Control using ESP8266 NodeMCU

Microproject Report

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1. Introduction and Objectives

Abstract: This project presents an IoT-based system that automatically monitors and controls the water level in a tank using an ultrasonic sensor and NodeMCU ESP8266 microcontroller. The system measures the water level in real-time and uploads data to the ThingSpeak cloud platform. It automatically turns the water pump ON or OFF based on predefined water levels, ensuring efficient water usage and preventing overflow or dry run. The IoT integration enables remote monitoring through the internet.

Objectives:

- To design an automated water level monitoring system using IoT.

- To interface an ultrasonic sensor with NodeMCU ESP8266 for real-time level detection.

- To control a water pump automatically through a relay module.

- To send water level data to ThingSpeak for online visualization.

- To minimize manual intervention and prevent water wastage.

2. Block / Functional Diagram and Explanation
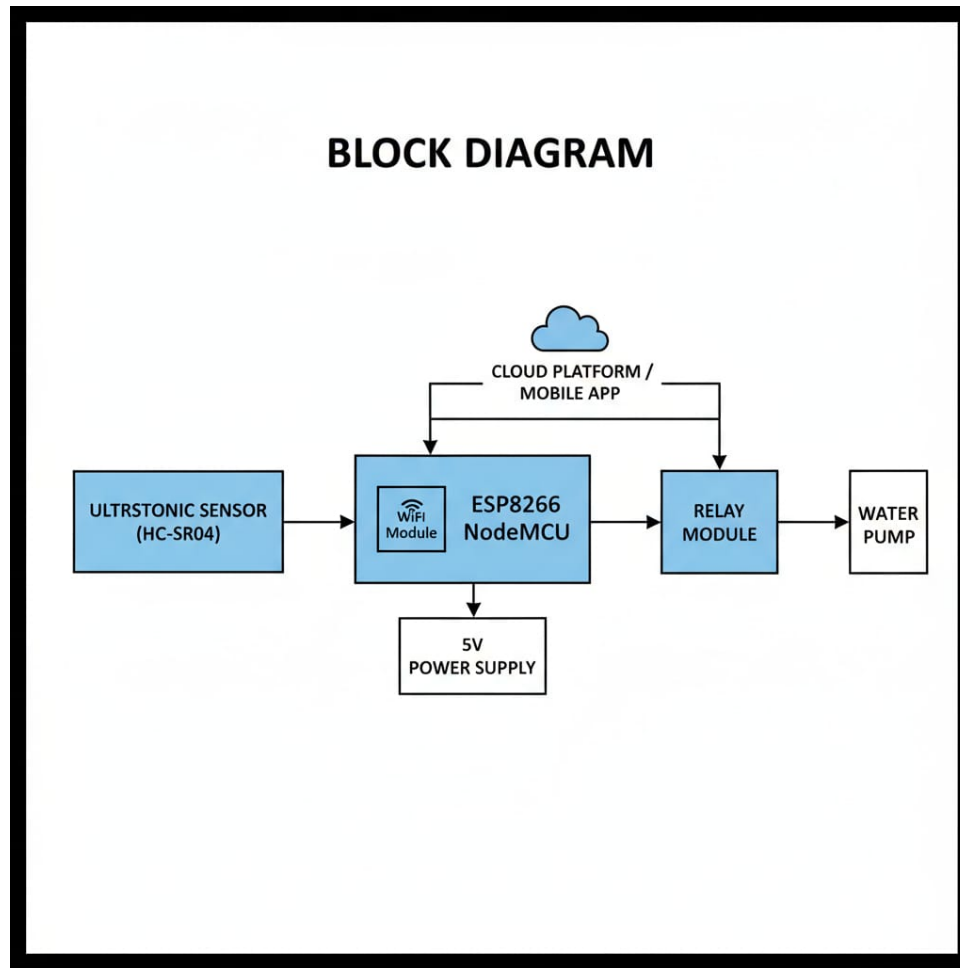
(Figure 1: Functional Block Diagram of IoT-Based Water Level Monitoring System)

Explanation:

- The **ultrasonic sensor (HC-SR04)** measures the distance between the sensor and the water surface.

- The **NodeMCU ESP8266** processes this data and calculates the water level percentage.

- When the water level drops below a set threshold, the NodeMCU activates the **relay module** to switch the pump ON.

- When the tank is full, the relay turns the pump OFF automatically.

- The measured level data is transmitted to the **ThingSpeak cloud** via Wi-Fi for online monitoring.

CIRCUIT DIAGRAM
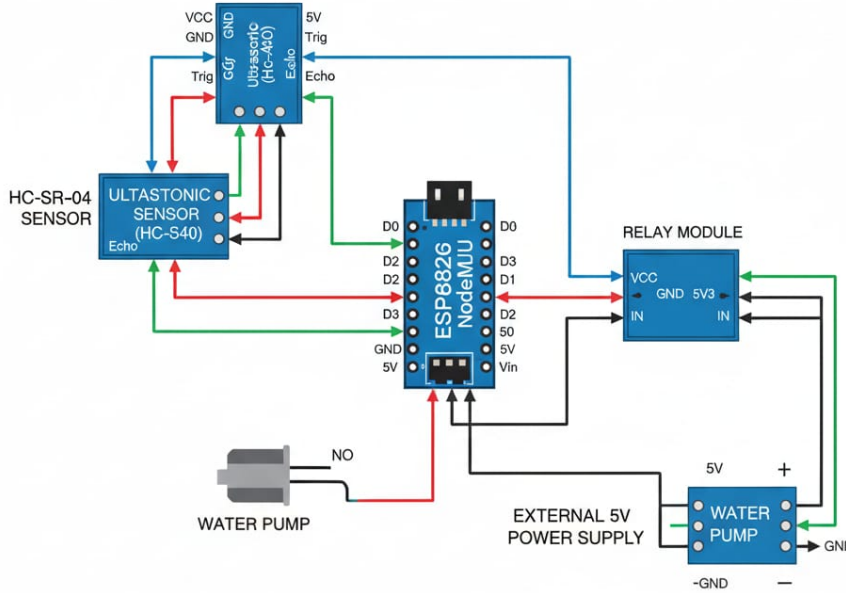
3. Circuit Diagram, Components and Working Principle

(Figure 2: Circuit Diagram of the Proposed System)

Components Used:

- NodeMCU ESP8266 Microcontroller

- Ultrasonic Sensor (HC-SR04)

- 5V Relay Module

- Water Pump

- Jumper Wires, Breadboard, Power Supply

Working Principle: The ultrasonic sensor continuously measures the distance to the water surface. The NodeMCU converts this distance into a percentage representing the tank's fill level. When the distance indicates a low level (below 35 cm), the relay energizes and the pump turns ON. When the level reaches the upper limit (below 8 cm), the relay deactivates and the pump turns OFF. The NodeMCU also connects to Wi-Fi and updates the ThingSpeak channel with the water level, distance, and pump status every 15 seconds.

4. Description of Developed Code and Interfacing Logic

The code initializes the NodeMCU pins for the ultrasonic sensor and relay. It reads the distance using the `pulseIn()` function and converts it to a water level percentage. Two thresholds are defined for pump control to avoid frequent switching — this is called **hysteresis logic**.

Code Working Explanation:

- Connects NodeMCU to Wi-Fi using SSID and password.

- Reads distance from HC-SR04 every 2 seconds.

- Converts distance into tank level percentage.

- Turns the pump ON when level is low (distance ≥ 35 cm).

- Turns the pump OFF when level is high (distance ≤ 8 cm).

- Sends the data (level, distance, pump status) to ThingSpeak every 15 seconds.

- Displays readings and pump state on the serial monitor.

5. Image of Working Model
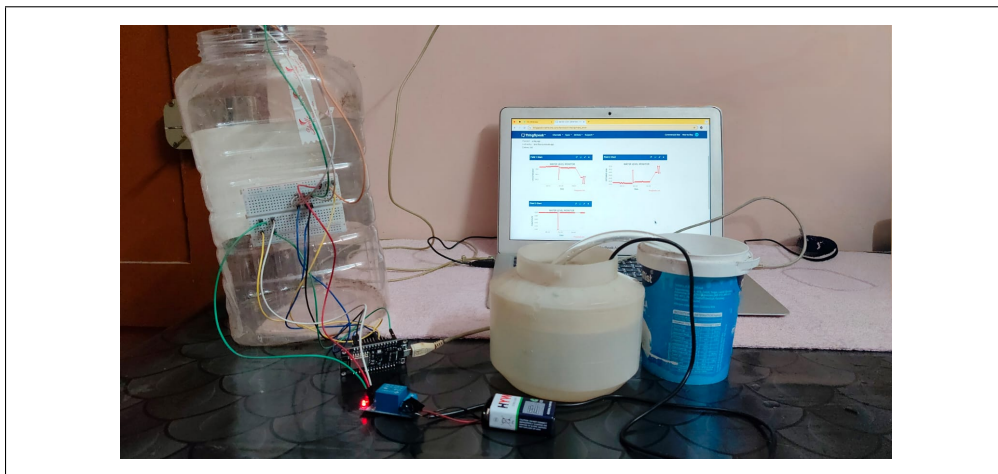
(Figure 3: Prototype of IoT-Based Water Level Monitoring System)

6. Expected and Observed Results / Outcomes

Expected Results:

- The system should accurately detect the water level using the ultrasonic sensor.

- The pump should turn ON and OFF automatically based on preset levels.

- Real-time water level data should be uploaded to the ThingSpeak cloud.

Observed Results:

- The ultrasonic sensor provided stable readings of tank level.

- The relay module successfully controlled the pump as per logic.

- ThingSpeak dashboard displayed water level, distance, and pump state accurately.

- The system operated automatically without manual intervention.

Conclusion

The developed IoT-based water level monitoring system effectively automates the process of water tank management. The integration of NodeMCU and ThingSpeak enables continuous monitoring and control through the internet. This system can be extended for smart home and industrial water management applications.